Australian Government

National Land & Water Resources Audit

Natural Resources Information Management

TOOLKIT

VERSION 2.0

Building capacity to implement natural resources information management solutions.

ANZLIC

the Spatial Information Council

www.nlwra.gov.au

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Foreword

The Natural Resources Information Management Toolkit (the Toolkit) has been prepared by the National Land & Water Resources Audit (the Audit) and ANZLIC – the Spatial Information Council (ANZLIC), to assist regional natural resources management groups to discover, access, visualise and manage their data and information. The Toolkit has been developed in close cooperation with all jurisdictions and has been targeted at regional groups to build capacity and facilitate the two-way flow of data and information. It can be used as a textbook document, teaching aid or as a series of stand-alone modules.

The Toolkit has three components:

1. Executive Summary

Information on high-level issues for managers to consider and build into business processes.

2. Concise Guide for Technical Managers

A short version guide containing essential checklists.

3. Technical Modules

The how-to guide, comprising eleven modules, for natural resources management (NRM) regional groups involved with natural resources data and information management. Each module is a stand-alone document and ordered hierarchically, from general principles to detailed practices.

It is acknowledged that when dealing with capacity building and the issue of data and information management at a regional level, there can be no one-size-fits-all product. It is also important to recognise that in many cases each state and territory may have its own initiatives including governance guidelines and protocols related to data and information management. In this respect, the Toolkit has been designed to complement activities being carried out by respective state and territory jurisdictions.

Following the strong support received for Version 1.0 of the Toolkit, the Natural Resources Information Management Toolkit Version 2.0 project was undertaken to build on the lessons learnt from the earlier version, and incorporate new material identified during a user review of Toolkit Version 1.0 and specific focus sessions with selected user groups.

Toolkit users are encouraged to communicate with their respective state and territory coordination contacts to ensure they obtain the correct information for their jurisdiction—this includes point-of-truth and authoritative datasets, and any additional detailed information on methodologies for data collection, such as classification schemes and data content standards, in addition to material on data access and licensing agreements.

Geoff Gorrie

Chair

National Land & Water Resources Audit Advisory Council

Warwick Watkins

Chair

ANZLIC – the Spatial Information Council

Background

The Natural Resources Information Management Toolkit Version 2.0 project was implemented under the joint sponsorship of the Audit and ANZLIC, as part of a strategy aimed at building capacity at regional level to implement natural resources information management solutions.

Development was carried out in close cooperation with state and territory jurisdictions and several regional groups. In doing so, an attempt has been made to complement existing initiatives and look for common approaches to achieve best practice in spatial data and information management.

The Toolkit will assist project managers, staff, and participating parties at national and state/territory levels, and more specifically at regional levels, to obtain full value from the investment in collection, management and use of data to fulfil project requirements.

The aim of the Toolkit is to compile a resource that:

- assists in building capacity at regional and local levels to manage, utilise and share natural resources data and information more effectively
- increases the awareness, understanding and skills of individuals responsible for data and information management
- facilitates the development and adoption of internationally accepted standards and guidelines for information management, and thereby promotes best practices in information management
- gives participants in NRM projects access to practical information management tools to reduce set up costs and duplication of effort
- supports the development of community networks through open and efficient sharing of information resources and knowledge, and assists the establishment of information loops between regional, state/territory and national levels
- ensures the sustainable management of data used or created in projects
- allows others to fully and appropriately exploit the information generated from NRM projects.

Throughout the development of the Toolkit, effort has been made to provide general material that will assist NRM regional groups. It is acknowledged that each state and territory has its own initiatives related to data and information management, including governance guidelines and protocols. It is recommended that users of this Toolkit establish contact with their respective state/territory jurisdiction representatives to ensure that they obtain the latest information related to data standards, collection procedures and other information regarding protocols, including access and licensing arrangements.

Following feedback from lessons learnt during the collation of Toolkit Version 1.0, plus results of a user survey and specific focus sessions, Version 2.0 of the Toolkit has recently been completed. Changes include:

- additional case study material
- a specific module on partnerships and working together
- material on project justification and risk management —included within the project management module
- development of a 'Local Tab' section to guide users to contacts and information at jurisdictional level
- inclusion of a capacity building road map to enable NRM regional bodies to determine where they fit on a capability spectrum. (To this end, signposts have been incorporated into each module to provide a guide to raising capacity in relation to various components in the development of an integrated information management solution and spatial data infrastructure).

In addition, the Toolkit has been re-formatted so that material can be downloaded as a Word or PDF document, thereby enabling users to print hard copies and copy material for use in other documents. Finally, given the importance of promoting cooperation and partnerships to enhance capacity and improve efficiencies, an additional module has been included to address the specific issues of *partnerships and working together*.

Please report any issues or feedback relating to the Toolkit to the National Land & Water Resources Audit, Data & Information Coordinator (email: info@nlwra.gov.au) or the ANZLIC National Project Manager (email: info@anzlic.org.au).

Toolkit Version 2.0 is available online from the Audit web site at www.nlwra.gov.au/toolkit.

Capacity building

A major goal of the Audit is to strengthen the capacity of regional NRM bodies to access and manage the data they need to address their natural resources issues.

The intention is to build networks of people and technology to share information and improve its usefulness and accessibility.

Release of the Toolkit Version 2.0 is well timed to help support regional NRM bodies faced with the challenge of how best to efficiently and effectively manage information assets as part of their core business.

Executive summary

One of the prerequisites for NRM involves the establishment and maintenance of a database of relevant information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify, model and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making and planning processes are closely linked to the quality and completeness of the information and the manner in which it is made available; for which issues relating to data access, management, integration, analysis and communication are key components.

In recent times best practices have evolved to assist data related tasks in NRM projects. Successful projects have generally adopted an integrated information management solution—combining leadership, people, technology, applications and data into a framework that ensures tools and procedures are in place to maintain and transform data into useful information products that support core business operations and the decision-making process.

Under current arrangements, funding for NRM projects is increasingly being channelled from government agencies to NRM regional groups (including catchment management authorities and resource information centres) via specific investment strategies. Activities carried out by these groups often involve gaining access to data, developing new data, and processing existing data. It is important these data become part of the national resource base and, following completion of the initial project, are made available to the broader community. Managers should concentrate on the need to achieve the goal of developing an integrated information management solution in which the acquisition, processing and dissemination of data and information is carried out within a collaborative framework. This can be achieved through the establishment of a spatial data infrastructure, involving the creation of guidelines, standards and procedures within a framework that is supported by a scientifically based and technically competent distributed group of data custodians and related agencies.

The Australian, state and territory governments are all currently involved in the development of the Australian Spatial Data Infrastructure (ASDI).

Whenever possible, managers of regional projects should facilitate the development and implementation of data policies at a local level which are based on best practice principles, such as those outlined in the **ANZLIC Policy Statement on Spatial Data Management**. For example:

- creation of an easily accessible, distributed data network to manage and disseminate data collected as part of project and other activities in support of corporate objectives
- development of core datasets as standard or base-line products, and a range of other products and services as needed to support economic, ecological and social development
- provision of best practice quality assurance mechanisms and procedures to create validated, well-documented datasets to meet priority information needs

- establishment of partnerships with industry, government and others (e.g. educational institutions) to develop skills and maximise use
- where possible avoidance of duplication in data capture and expenditure on system development
- archiving of data to ensure their availability for multiple use and safeguard for future generations.

Achievement of the above principles requires adoption of best practice in data and information management for data collectors, owners, custodians and groups or agencies that generate information.

Roles, responsibilities and multi-level interactions

Further to the above, it is important to appreciate the complexity and loops or interactions that are involved in the development of an integrated information management solution, and the extent of multi-level relationships.

Within the current paradigm for NRM programs, activities are being undertaken at a number of levels, namely national, state/territory and regional (and in many cases sub-regional). Different decisions and policies are taken at each level, where different issues of management and planning are being addressed.

At each level there is a requirement for the following:

- strategy
- policy development
- action planning or project activities that tackle priorities
- operational planning to undertake the work
- monitoring and evaluation
- reporting and review.

Based on results of recent experiences it has been found that the greater the interaction between the various levels, the better the result. This involves the development of procedures that support the flow of data and information in both directions.

> As a general principle, the level of detail increases with progress from the national to the local level, with a corresponding increase in user engagement at the local level.

National level responsibilities

These are concerned with national coordination, standards, development of nationally consistent datasets, funding initiatives and allocation of resources. In many cases national actions relate to the development of national priorities. National policy decisions and fiscal measures affect many people and wide areas.

State/territory level responsibilities

State/territory level responsibilities include coordination, fostering and development of partnerships, data production and maintenance and determination of priorities in consultation with regions.

The state/territory is the next level of policy development below national. When policies are initiated nationally, priorities have to be translated into programs and projects at the state/territory level.

In many cases activities at a state or territory level are carried out to fulfil requirements of a regulatory act. Often this means that states and territories have overarching policies, guidelines and protocols that determine the methodologies and standards used in data collection and management.

Regional level responsibilities

These could include some source data production and maintenance, interpretation and implementation of standards and policies, and delivery of local plans and monitoring to the community.

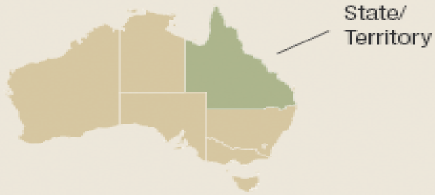
Prior to commencing any data collection activities, regional groups are encouraged to contact their state/territory coordinators to obtain information related to standards and recommended methodologies.

An example of the various levels of interaction, roles and responsibilities is illustrated at Figure A.

Figure A Examples of roles, responsibilities and multi-level interactions for natural resources management.

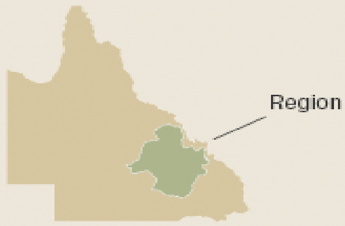
There's nothing we need more right now than **teamwork among national, State/ Territory and local governments and regional groups**. It doesn't come naturally.

1 NATIONAL LEVEL



- National priority development
- Coordination, standards
- National datasets
- Funding intiatives

2 STATE/TERRITORY LEVEL

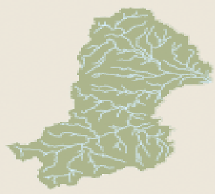


- Coordination and partnerships
- Data production and maintenance
- Priorities translated to programs and projects

3 REGIONAL LEVEL

- Data production and maintenance
- Interpretation
- Implementation of standards
- Monitoring and evaluation

4 LOCAL LEVEL



- Develop local plans
- Data collection
- On-ground action and work

↕ Shows a two way flow of data and information

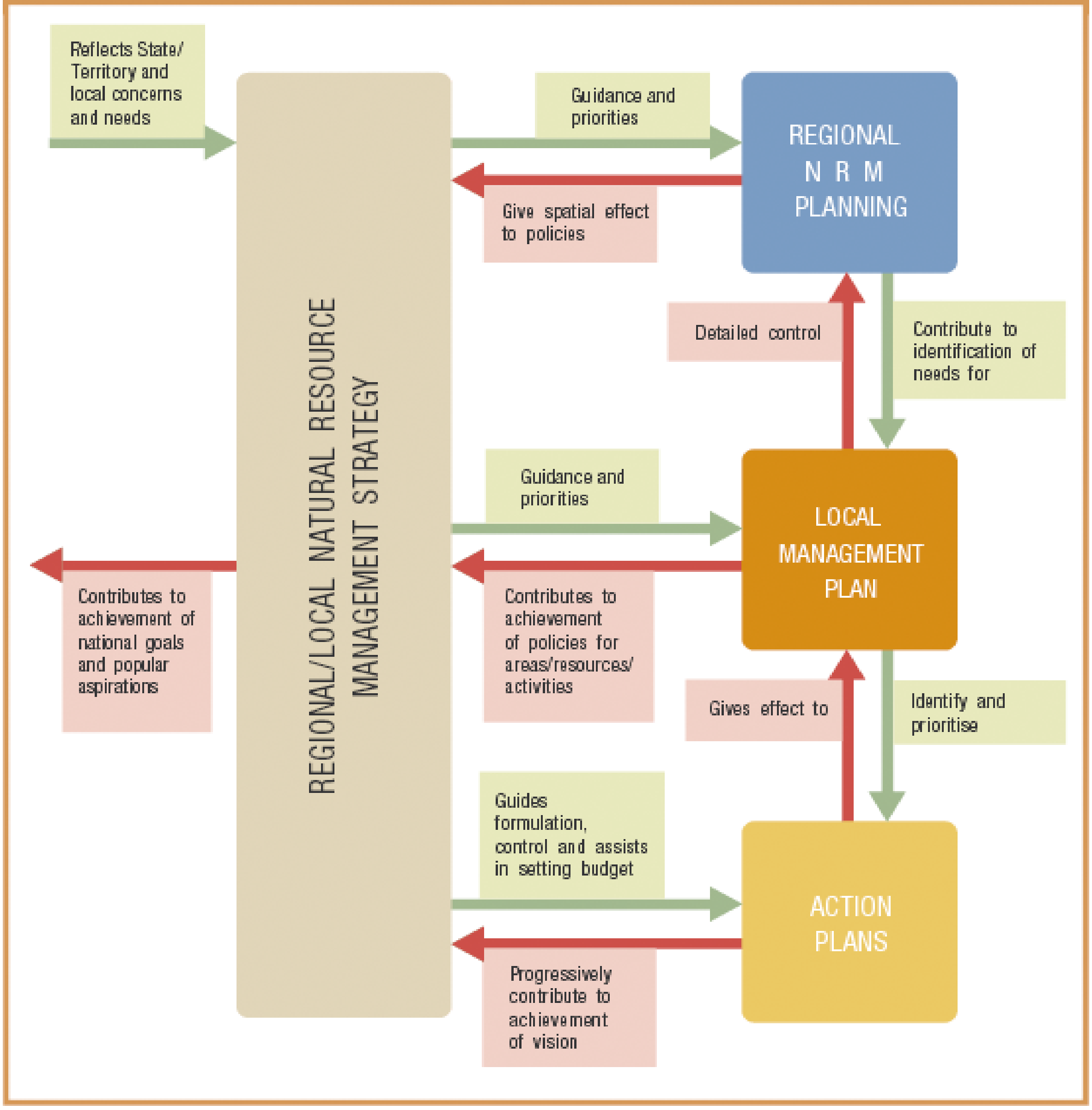
Practical results

The major results obtained from adoption of the current paradigm of funding for NRM project activities are:

- establishment of agreed directions and expected outcomes for NRM projects
- establishment of a clear basis for organisation, control, communication of planning and implementation
- development of a consistent, coherent and integrated basis for decision making in support of other planning and management activities and business interests.

An example of the practical benefits of such an approach is illustrated at Figure B.

Figure B – The practical effects of a regional natural resources strategy.



Summary

The successful development of an integrated information management solution requires careful planning and dedicated resources. This involves the development and acceptance of standards through the use of common data, systems and a participatory information management structure, i.e. networks of people sharing information, resources and knowledge. This is also the basis of the Australian Spatial Data Infrastructure development.

Best practice elements

Leadership

Leadership is required to ensure that activities in the development of an integrated information management solution remain coordinated and focused. When involved in collaboration with other agencies the designation of a lead agency among the partners, with dedicated resources to be able to provide coordinating mechanisms, is a key ingredient to facilitation of successful implementation. In other words, someone has to bear the responsibility for coordination, outputs and thus outcomes.

Steering committee/board of directors

Adoption of an integrated information management solution and establishment of a data infrastructure often involves the creation of organisational responses such as a data utility and policy/standards group. To be effective some formal arrangement is required to oversee implementation and provide vision, direction and approval of resources. Typical roles for such a committee involve:

- partnership development and policy framework
- communication/participation
- data standards
- system requirement priorities
- data collection and maintenance priorities
- training.

Training and expertise

The development of an integrated information management solution and data infrastructure needs to be accompanied by a training strategy to build and sustain capacity. One of the key lessons learnt from past initiatives is that not enough attention has been given to capacity building and the development of corporate knowledge bases that enable data and information to be readily available to all partners and stakeholders. The following key issues should be considered:

- identification of skills and training needs
- recognition that specific training in spatial information systems and other software packages (e.g. databases) may be required along with training in application development, system and network administration and program management.

Focal point

A key component to the successful implementation of an integrated information management solution involves having a focal point for the development and implementation of a number of component activities. The use of local resource information centres is one such method of establishing a focal point that has proven successful in some areas. Under this scenario the centre often facilitates the following tasks:

- communication (providing and disseminating information among partners)
- technology support, planning and implementation
- support to the management/steering committee
- development of information products and services
- training and capacity building
- independent and important advice to the community.

Information policy

Access to accurate and up-to-date data and information in a timely fashion is critical to the successful management of natural resources. A number of key information policy issues need addressing, and include:

- cost
- format
- system design
- copyright
- privacy
- liability.

Partnerships and working together

The development of an integrated information management solution and data infrastructure presents many opportunities for partnerships. Information access enables groups and partners to do things in new ways, provide new services and information products, and reduce the reliance on traditional approaches. A single agency is unlikely to have all the resources, skills and knowledge required to undertake the development of all aspects involved in developing an integrated management solution and data infrastructure. Having organisations and partners working together from the outset is vital to ensure activities occur in a way that supports all the partners in their use of data.

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State/territory government

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Note:

This Concise Guide for Technical Managers provides a series of checklists as memory joggers for those managing natural resources data and information projects. Some of the lists are in fact aide memoirs, documenting optional elements that technical managers may wish to consider if relevant to their project. The checklists correspond to the twelve modules of the Toolkit.

0 Capability Road Map – Enhancing Information Management Capacity

There is a wide variety of data and information management capacity across the various natural resource management (NRM) groups throughout Australia which relates to their size, complexity, location, funding, individual and organisational capacity, and time in existence.

Within the context of the need for ongoing improvements in the capacity of NRM regional bodies for managing data and information, it is important to consider a spectrum of information management capabilities. This can be viewed as part of a road map scenario giving consideration to where each NRM group is currently positioned and where they would like to be in the short, medium, and longer term.

The concept of capability spectrums is well established in the information technology industry and within quality management and allied disciplines across all industry sectors.

It is useful to consider the application of the capability-raising concepts to regional NRM groups as the methodologies do not consider current capability as a problem, but merely a starting point for improvement.

The following capability model (Table 0–1)—based on a simple five-stage maturity model as commonly used by the information technology industry—is presented for consideration. The model allows all NRM groups (regardless of their current capabilities) to consider what is needed to improve their capacity, and subsequently develop an action plan to move forward.

Table 0–1 An indicative capability framework for spatial information management within NRM regional bodies

Level	Name	Description
1	Individual capabilities	Individual staff members within NRM regional body are developing one or two projects or a business process.
2	Managed individual capability	The projects of individuals are recognised by the NRM regional group and are being managed, with standards in place. A linkage exists with some business processes and procedures. Training resources are allocated, responsibilities have been assigned and evaluations are taking place regularly.
3	Organisational capability	All NRM group business processes and projects are defined and managed using formal program management procedures. Linkage of all business processes to defined user needs exists. Internal benchmarking is occurring and compares data and information management with other business activities.
4	Quantitatively managed organisation capability	Quantified measures of process efficiency are taken across the NRM region. Data and information management processes, standards, training and support are measured quantitatively.
5	Optimising	Continuous improvement of processes is occurring based on quantified measures of process efficiency and range of management processes to constantly improve measured performance.

It is a useful exercise to consider where your NRM regional group is placed on this capability spectrum and where you intend to go (and how). Specifically, Modules 1 to 11 of this Toolkit are designed to support you in that journey. For some regional groups, raising capability by one or two levels may be sufficient. For others, a strategic plan for high level improvement progressing towards Level 5 may be more appropriate. Regardless, the focus should be on moving forward; either through the development of shared spatial information system services with other NRM regions/organisations, or through your own spatial information system implementation. A module-by-module road map for increasing capability is included at Table 0–2. Signposts are included in each module to guide managers in raising their NRM region's capability.

Table 0–2 A capability raising road map for spatial information management in NRM regional bodies

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
1	Information management and the sustainable development of natural resources – an introduction to information management systems	Develop spatial information management plan including resource needs (people, funds and equipment), business drivers and governance	Comprehensive organisation-wide information management plan linked to business process analysis and underpinned by internal benchmarking	Development of formal measures demonstrating contribution of spatial information to business process efficiency including external benchmarking	Internal and external benchmarking drives continuous improvement process, including appropriate governance models to rapidly enact process improvements
2	Data management principles	Individual people or units have documented data management processes, policies and procedures	Organisation-wide data management processes, policies and procedures in place	Business process review for ensuring compliance with data management processes, policies and procedures	Development of metrics for data management compliance, including continuous external benchmarking
3	Interpretation and visualisation of data – an introduction to spatial info. systems	Understanding of spatial information systems by key staff members	Organisational understanding of spatial information systems	Cost benefit of spatial information systems analysed and recognised	Regular reviews of understanding, implementation and use of spatial info. systems
4	Spatial data priorities, standards and compliance	Individual people or departments have documented spatial data management standards, processes, policies and procedures	Organisation-wide spatial data management standards, processes, policies and procedures	Business process review for ensuring compliance with spatial data management standards, processes, policies and procedures	Development of metrics for spatial data management standards and compliance, including continuous external benchmarking
5	Spatial data	Individual	Formal spatial data	Development of	Continuous effort

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
	discovery and access	understanding of spatial data clearing houses and peer support networks	access and use arrangements within and between regional bodies and other organisations; organisation mandate for peer support	feedback mechanisms to ensure spatial data quality and access align with business drivers across regional bodies	for improving, discovery and access of spatial data by all sections of NRM regional bodies
6	Project management and justification – lessons learnt, pitfalls and best practice procedures	Implement standardised project management, including individual or departmental level business cases	Implement program level organisation-wide project management, including systematic business cases	Analysis of project and program performance in project planning, management and post-project review, including cost benefit analysis of business cases	Comparative benchmarking of project performance between NRM bodies and allied organisations/ sectors
7	Guidelines for selecting spatial information systems software and hardware	System procurement driven by individual or departmental business needs; funded, endorsed plan for system procurement and implementation; selection checklists and criteria followed	System procurement fully integrated with business needs and procurement decisions undertaken on an organisation-wide basis	System audits, user reviews and business alignment assessment; user groups providing quantified feedback on systems	Quantified internal feedback on system usage and performance regularly compared with other organisations
8	Enhancing capability for using spatial information	The projects of individuals are recognised by the organisation or NRM regional body and are being managed; standards are in place and linkage exists to some business processes and procedures; training resources are allocated, responsibilities assigned and evaluations are taking place	All processes are defined and managed through program management of all projects; linkage of all business processes to defined customer needs exists; internal benchmarking is occurring and compares spatial information management with other business activities	Quantified measures of process efficiency across the organisation or NRM regional body; spatial information management process, standards, training and support are measured quantitatively	Continuous improvement process based on quantified measures of process efficiency and range of management processes to constantly improve measured performance
9	Map production guidelines	Unit or departmental documented map production guideline(s)	Organisation-wide documented map production guideline(s)	Comparative analysis and alignment of regional map production guideline(s)	Formal processes in place to ensure continuous improvement and change management of map production guideline(s) generated by quantified

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
					regional analysis and user feedback
10	Introduction to GPS and best practice guidelines	Low understanding of GPS principles; GPS procurement driven by individual needs	Understanding of GPS principles; GPS procurement integrated with needs and procurement based on endorsed plan	Good understanding of GPS principles; formal methods for GPS survey and processing; procurement integrated with needs and procurement based on endorsed plan	Benchmarking of performance, with continuous effort for improving
11	Partnerships and working together – the potential for collaboration	Individuals or departments service the spatial information requirements of others	Organisational mandate for collaboration across all functional areas of an NRM group and formalised agreements for working with other organisations	Performance measures established for internal and external service agreements	Benchmarking of performance measures for service agreements; combined agreements for collaborative spatial information usage

1 Information management and the sustainable development of natural resources

The business case for spatial information

One of the prerequisites for NRM involves the establishment and maintenance of a database of relevant information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify, model and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making and planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis and communication are key components of effective spatial information management.

Increasingly NRM regional bodies are using spatial data and information as a core part of their business operations and this often involves gaining access to, developing new, and processing existing data. Changes to existing data and the creation of new data should become part of the national resource base and, following completion of the initial project, subsequently be made available to the broader community.

The new natural resources management framework

The contemporary view of sustainable management of natural resources is best achieved by adopting a regional approach involving the development of strong cooperative partnerships between government bodies, the community, on-ground land managers and educational institutions to develop plans that address regional needs.

The shift to a regional approach in Australia was demonstrated in the nationwide implementation of the National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (NHT). The success of both initiatives was dependent on regional communities being able to develop and implement their own plans for NRM.

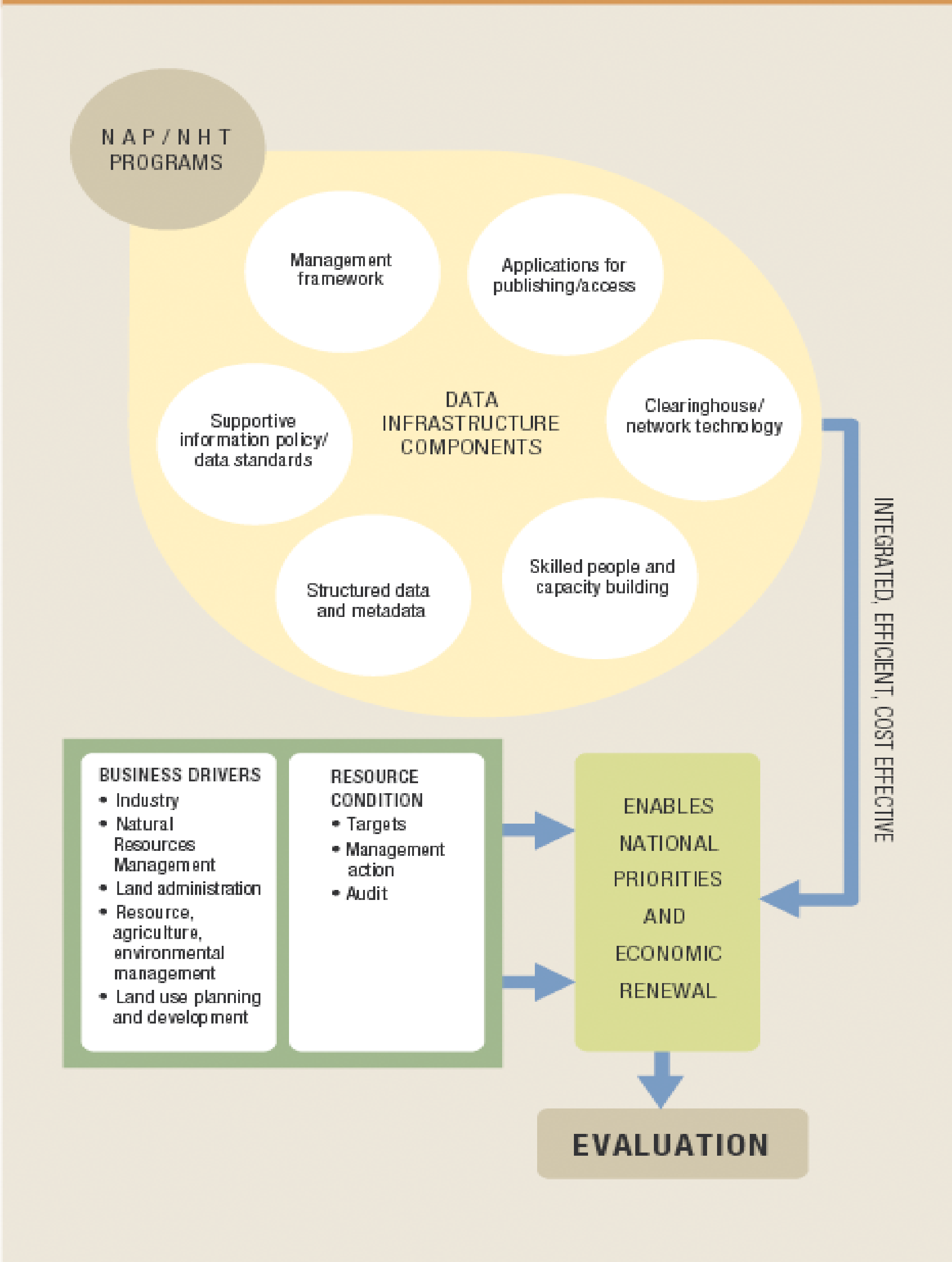
Need for an integrated information management solution

Coupled with this new funding approach is the fact that regional organisations and groups are becoming increasingly involved in the collection, management and use of data to fulfil project requirements. In addition, many groups are involved in integrating information technology (IT) within their organisation. To be effective, IT must be supported by policies and practices that view data and information as long-term assets. This requires dedicated management and coordination within a controlled environment to facilitate delivery to decision makers of the right information in the correct format in a timely fashion.

In recent times best practices have evolved to assist in data-related tasks in NRM projects. Successful projects involving spatial information management have generally adopted an integrated information management solution—combining the elements of leadership, people, technology, applications and data into a framework that ensures tools and procedures are in place to maintain and transform data into useful information products. An integrated solution also provides opportunities to do new things, and to improve the way current activities are done, in ways currently not foreseen or possible. An illustration of how these elements fit together when viewed through an NRM lens is shown at Figure 0–1.

An integrated solution also promotes the development and acceptance of standards through the use of common data, systems and a participatory information management structure. This has the potential to reduce costs and increase the value of the data.

Figure 0–1 Effective tools and technologies are one component of an integrated information management solution.



Integrated management best practice guidelines

	Checklist for information management
☐	**Leadership:** Leadership is required to ensure that activities in the development of information management systems remain coordinated and focused. When involved in collaboration with other agencies the designation of a lead agency among the partners, with dedicated resources to be able to provide coordinating mechanisms, is a key ingredient to facilitating successful implementation.
☐	**Steering committee/board of directors:** Adoption of an integrated management solution and establishment of a data infrastructure often involves the creation of organisational responses such as a data utility and policy/standards group. To be effective some formal arrangement is required to oversee implementation and provide vision, direction and approval of resources. Typical roles for such a committee involve: ▪ partnership development and policy framework ▪ communication/participation ▪ data standards ▪ system requirement priorities ▪ data collection and maintenance priorities ▪ training.
☐	**Training and expertise:** The development of an integrated management solution and data infrastructure needs to be accompanied by a training strategy to build and sustain capacity. One of the key lessons learnt from past initiatives is that not enough attention has been given to capacity building and the development of corporate knowledge bases that enable data and information to be readily available for all partners and stakeholders. The following key issues should be considered: ▪ identification of skills and training needs ▪ recognition that specific training in spatial information systems and other applications (e.g. databases) may be required along with training in application development, system and network administration and program management.
☐	**Focal points within NRM regional bodies:** A key component to the successful implementation of an integrated management solution involves having a focal point for the development and implementation of a number of component activities, including the following tasks:

	Checklist for information management
	■ communication (providing and disseminating information among partners) ■ technology support, planning and implementation ■ support for the management/steering committee ■ development of information products and services ■ training and capacity building.
☐	**Information policy:** Access to accurate and up-to-date data and information in a timely fashion is critical to the successful management of natural resources. A number of key information policy issues need addressing, and include: ■ cost ■ format ■ system design ■ copyright ■ privacy ■ liability.
☐	**Partnerships and working together:** The development of an integrated management solution and data infrastructure presents many opportunities for partnerships. Information access enables groups and partners to do things in new ways, provide new services and information products, and reduce the reliance on traditional approaches. A single agency is unlikely to have all the resources, skills and knowledge required to undertake the development of all aspects involved in developing an integrated management solution and data infrastructure. Having organisations and partners working together from the outset is vital to ensure activities occur in a way that supports all the partners in their use of data.

ANZLIC policies and guidelines

ANZLIC has prepared a number of policies and guidelines to assist in the development of policies and protocols for spatial data management that are relevant for use at a regional level. These documents are available online at http://www.anzlic.org.au/policies.html.

Additional information

For detailed information refer to *Module1: Information management and the sustainable development of natural resources*

Other useful information is included in the Audit's publication, Australian Natural Resources Information 2002 http://www.anra.gov.au/topics/publications/national/introduction.html

2 Data management principles

Wherever possible, managers should give consideration to the following guiding principles for data management.

	Checklist for guiding principles for data management
☐	**Don't reinvent the wheel:** Expedite the project process by not reinventing the information management wheel.
☐	**Look for efficiencies in data collection:** Where possible data should be captured once for multiple/generic use.
☐	**Share wherever possible:** Where possible share data and foster the development of networks and partnerships.
☐	**Present a sound business case:** Data collection is expensive. There must be good business justification to support any data collection activity.
☐	**Reduce duplication:** Avoid duplication in data acquisition. Where possible team up with others.
☐	**Look before you collect:** Find out what already exists. Look for existing point-of-truth and authoritative datasets.
☐	**Fitness-for-purpose:** Undertake fitness-for-purpose assessments prior to using external datasets.
☐	**Classification systems:** Check for standards and existing classification systems or methodologies. Use existing systems and facilities wherever possible.
☐	**Think beyond your immediate use:** Manage data to maximise their value both during and after the project. Give priority to the broadest value data that are of benefit to multiple processes.
☐	**Data custodianship:** Select the most robust organisation with the broadest span of interest as the most appropriate custodian of high-value general use information. Reinforce and support data custodians and where possible negotiate access arrangements.
☐	**Metadata:** Complete metadata documentation is required for every dataset to demonstrate best practice. Metadata provides information about datasets such as accessibility, currency, completeness, fitness-for-purpose and suitability for use.

Benefits of good data management

Good data management policies and procedures ensure that data are treated as valuable assets. It is important to remember that data management and standards are tools to facilitate improved decision making in NRM. In general the benefits of good data management are reflected through:

- better decision making
- maximising use
- avoiding duplication
- maximising integration and interoperability
- improving equity of access
- improving communications
- facilitating partnerships.

Additional information

For more detailed information refer to *Module 2: Data management principles*

For other related information refer to *Module 4: Spatial data priorities, standards and compliance*

3 Interpretation and visualisation of data – an introduction to spatial information systems

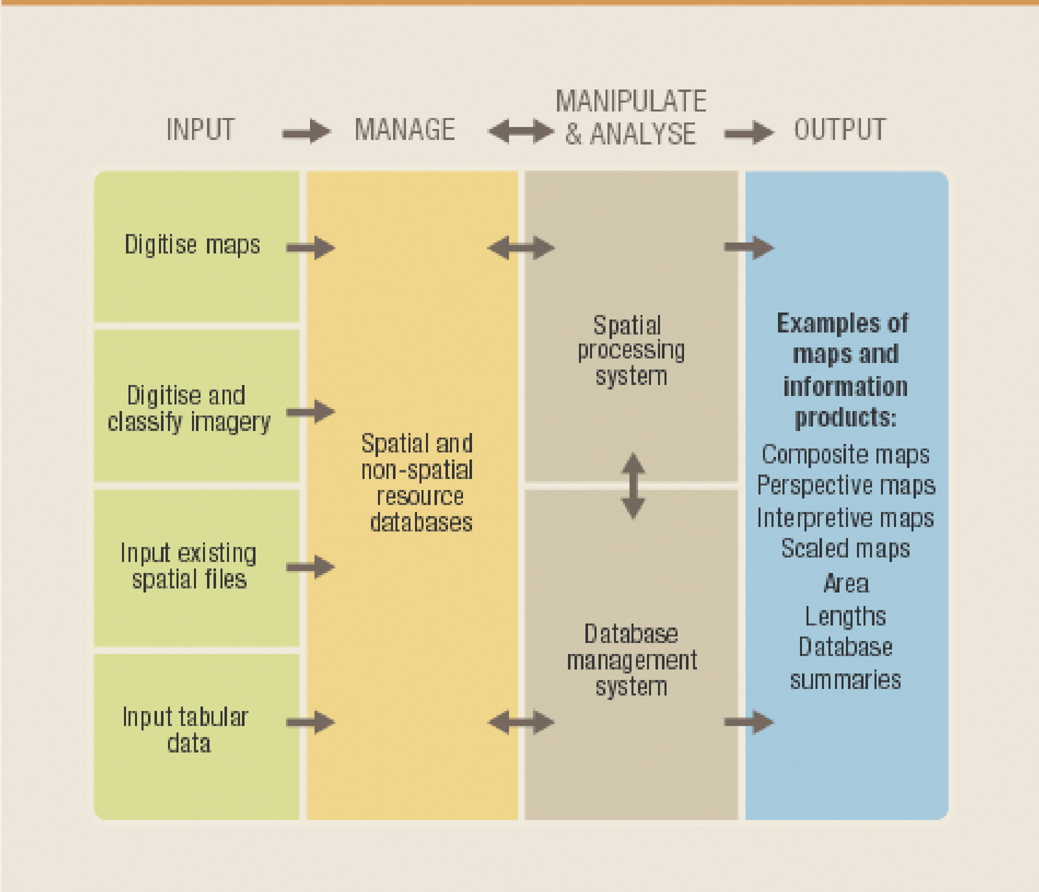
Increasingly, many NRM regional bodies and organisations throughout Australia are integrating mapping and spatial information system (SIS) technology into their business processes.

For the purpose of this document, spatial information systems include geographic information systems (GIS), image processing applications for raster data (e.g. satellite images and aerial photographs) and spatially-enabled databases.

Spatial information and information management systems allow users to manage, understand, question, interpret, manipulate, model and visualise data in new ways.

One of the major strengths of an SIS is its ability to link numerous databases of information within a single system. In this sense many datasets previously confined to simple external spreadsheets or large regulatory databases can be integrated into an SIS to generate a new level of information and analysis. A theoretical schematic for an SIS is illustrated at Figure 0–2.

Figure 0–2 Theoretical schematic for a spatial information system.



The goal of information systems is to assist the conversion of data into information and knowledge to achieve results.

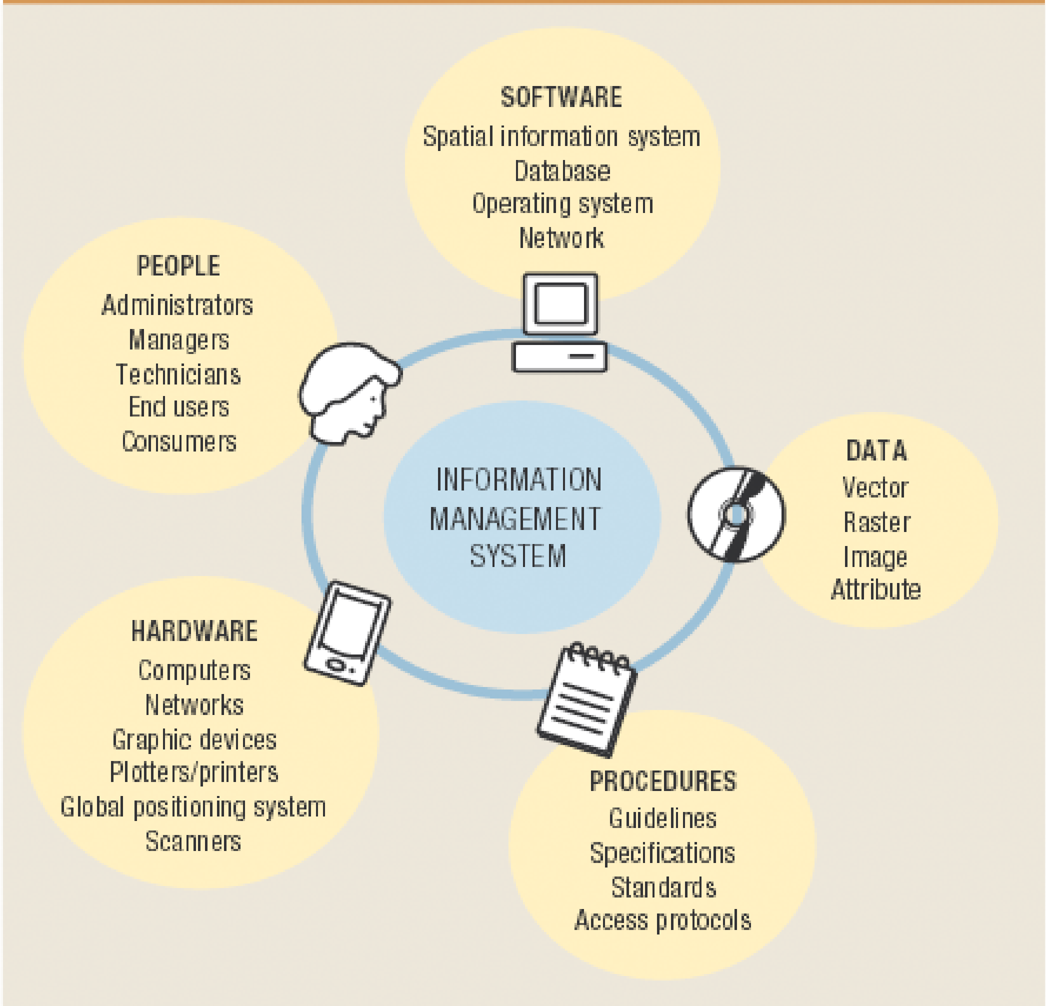
In general terms ***data*** refers to a collection of facts, concepts or instructions in a formalised manner suitable for communication or processing by humans or computer. ***Spatial data*** refers to data that have positional values related to them. In some situations the term ***geospatial data*** is used as a further refinement. This refers to spatial data that have been geo-referenced to a location above, on or below the earth's surface.

Information is the term applied to data that have been value-added, processed and interpreted. ***Geoinformation*** is a specific type of information that involves the interpretation of spatial data. It can be argued that it is the transformation of data to information products that brings a level of understanding and knowledge, and the ability to make informed interventions to improve the management of natural resources. A schema for this concept is illustrated at Figure 0–3.

Figure 0–3 Schematic illustration of the progression of data into knowledge.

As with all organisations and groups dealing with sophisticated technology, new tools can only be used effectively if they are properly integrated into the entire business strategy and operation. In this sense, an SIS should not be considered as a single piece of software but within the framework of an information management system, including people, procedures, data, software and hardware. This framework is illustrated at Figure 0–4.

Figure 0–4 Framework for an integrated information management solution.



An increasing number of agencies, universities and other groups are developing spatial data in SIS ready formats. When coupled with the development of simple free desktop spatial visualisation applications and improvements in technology (e.g. web-based mapping) it enables an increasing number of people to distribute, publish, share and use datasets that were previously available only to specialists.

Additional information

For more detailed information refer to *Module 3: Interpretation and visualisation of data – an introduction to spatial information systems*

4 Spatial data priorities, standards and compliance

Most agencies and NRM regional bodies are both information providers and clients; i.e. they collect and use data for their own purposes, use data provided by others, as well as make data available to other users, most importantly their state/territory equivalents. Standards form a key ingredient underpinning the management of data and information.

Benefits of standards for data include:

- increased data sharing
- higher quality data
- improved data consistency
- increased data integration and interoperability
- better understanding of data
- improved documentation of information resources
- improved control over data updating activities and development of new versions of datasets
- improved data security.

It is important that organisations involved in NRM appreciate the importance of standards, and the elements involved in their development. Such an understanding assists in asking the right questions when searching for data, planning data capture programs, or negotiating technical support for provision of data services.

An important goal in the development of an integrated information management solution is to facilitate the development, publishing and acceptance of data standards. Such standards are a key ingredient for all users and producers of data and information. They are particularly important in any co-management, co-maintenance or partnership where data and information need to be shared or aggregated.

Regional groups need to focus on the development of standards, and ensure they are widely promoted and adopted by the user community.

The peak body responsible for the promotion and coordination of standards for spatial data in Australia is ANZLIC – the Spatial Information Council.

ANZLIC policy in relation to the development of standards may be summarised as follows:

- Where possible adopt the following in order of priority:
  - international standard
  - national standard
  - regional or jurisdictional standard
  - local standard.
- Where possible adopt a minimum standard, i.e. less is better than more.
- Give consideration to a particular version of a standard (note: standards are constantly being updated).

Standards evolve

Standards often change in parallel with changes in technology and business processes. A process with built-in continued participation and review is important so that standards evolve rather than drop out of favour as parties find new individual approaches. It is recommended that NRM regional groups maintain close contact with their respective state or territory representatives to ensure they are kept up-to-date with the latest information on standards.

A wide range of support material is available on the development and application of standards relating to NRM datasets.

ANZLIC has produced a series of policy documents and support material on standards, including a Policy Statement on Spatial Data Management, and Model Data Access and Management Agreements which serve as useful templates for regional groups. All documents are available online from the ANZLIC website at

http://www.anzlic.org.au/policies.html.

The publication Australian Natural Resources Information 2002, produced by the Audit, also provides useful background material. This report is available online at:

http://audit.ea.gov.au/anra/data/docs/national/Data_Contents.html

Within most jurisdictions each state, territory or discipline (e.g. land resource assessment) has its own overarching policies and standards for data collection, maintenance and classification criteria. **Regional groups are encouraged to contact their respective state or territory representatives to obtain information on the most appropriate standards for their region and subject matter.**

The following guidelines should be kept in mind when developing standards.

Spatial standards

Following is a list of various spatial data standards that practitioners need to be aware of, or may encounter, when managing or searching for data.

	Checklist for spatial data standards
☐	**Map projections:** A map projection may be described as a mathematical model that transforms the spatial relationships of features on the earth's three-dimensional surface to locations on a flat map or two-dimensional surface. In order to achieve this, some method must be used to depict a map in two dimensions, as a flat map does not accurately reflect the shape of the earth.
☐	**Datum:** In reality the earth only approximates a sphere. For small-scale maps such as an atlas (which often represent a large area such as a country), map makers treat the earth as a sphere. For large-scale maps that may reveal far more detail for a given area compared with small-scale maps, the earth must be treated as an ellipsoid or spheroid. A datum consists of a set of parameters and control points that are used to accurately define the three-dimensional shape of the earth.
☐	**Coordinate system:** A coordinate system provides a reference to measure horizontal and vertical distances on a map. Coordinate systems are usually defined by a map projection, spheroid reference, datum, and a number of other parameters such as standard parallels, a central meridian and possible shifts in the x and y directions. The two most common coordinate systems are geographic (i.e. latitude/longitude) and the Map Grid of Australia (MGA) (i.e. easting and northing).
☐	**Scale and accuracy:** The term scale refers to a statement of measure. It is often the ratio of the distance on a map as related to the true distance on the ground. In general, maps with smaller scales (e.g. 1:1 million) show less detail. This is also the case for SIS datasets, which are often derived from maps or images at given scales. SIS software functionality enables the user to zoom in closely on a dataset and print it at very large scales. Please note that such zooms or prints are not any more accurate than the maps or images that they were derived from. When considering scale and accuracy, there is also the need to distinguish between accuracy and precision for both raw and derived data. ***Accuracy*** is associated with reliability to conform to a given standard and a lack of bias. In contrast, ***precision*** involves the ability to make fine distinctions. **Note:** Your local state or territory coordinator can provide additional information about which map projections, datum and coordinate system is appropriate for your region and purpose.

Non-spatial standards

A number of non-spatial standards are involved in the management and use of datasets. Following is a brief overview of what issues may need to be considered.

	Checklist for non-spatial data standards
☐	**Data acquisition/collection standards:** Methods and processes for collection of new or conversion of existing data
☐	**Database structure and content:** Organisation, representation and content of files and data elements
☐	**Data processing standards:** Standards to which data are subjected to for the purposes of data manipulation and conversion into information products
☐	**Data quality standards:** Includes such things as: ■ accuracy ■ precision ■ resolution ■ reliability ■ reproducibility ■ currency ■ relevance ■ ability to audit ■ completeness ■ timeliness
☐	**Database maintenance standards:** Process and timing of updates, including additions, changes and deletions to datasets
☐	**Data dissemination standards:** Access and dissemination processes and products (e.g. maps, reports) plus other elements such as copyright, privacy and Freedom of Information (FoI)
☐	**Terminology/symbology standards:** Terms or symbols which must be used or adhered to
☐	**Presentation standards:** Methods for displaying and formatting information from a dataset for display/presentation purposes
☐	**Quality control and assurance standards:** Used to achieve a specified quality and to check the quality of an existing dataset
☐	**Data classification:** Standards which outline procedures to be followed when using a certain methodology
☐	**Storage procedures:** Procedures to be used for data storage, archiving or back-up
☐	**Data analysis procedures:** Standards for comparing, contrasting, assembling or evaluating a dataset for an application or specified product
☐	**Data transfer:** Standards for data transfer are independent of technology and applications and facilitate the moving of data among systems. This occurs without the prior specification of the intended end use of the data.

Checklists and scorecards are often used to assess compliance of a dataset to a particular standard as part of quality control and assurance processes. An example of a compliance checklist taken from the Audit's 'Australian Natural Resources Information 2002' document follows.

<table>
<tr><th></th><th>Compliance of the 1996/97 Land Use of Australia map with standards for the Australian Spatial Data Infrastructure</th></tr>
<tr><td>☐</td><td>Access

Are the data easily accessible?

■ Land use data are available free of charge online via the Australian Natural Resources Data Library.

■ Data may be mapped through the Australian Natural Resources Atlas Map Maker. Detailed regional summaries of land use for each river basin are available through the Australian Natural Resources Atlas.</td></tr>
<tr><td>☐</td><td>Are the data documented?</td></tr>
<tr><td></td><td>■ Summary documentation and full metadata are available through the Australian Natural Resources Data Library and the Australian Spatial Data Directory.</td></tr>
<tr><td>☐</td><td>Supply

Are licence arrangements in place to ensure that the information is accessible, while protecting copyright, intellectual property, privacy and confidentiality?

■ A licence agreement exists between the Audit and ANZLIC, and is supported by the Australian, state and territory government agencies.</td></tr>
<tr><td>☐</td><td>Quality</td></tr>
<tr><td></td><td>Do the data meet national guidelines or standards?

■ Data meet the following national guidelines:

▪ Spatial data are available in the Geocentric Datum of Australia (GDA94).

▪ Attribute data use the Australian Land Use Management Classification Version 4, October 2000. The Executive Steering Committee for Australian Land Use Mapping monitors compliance with the classification.

▪ Download of data from the Australian Natural Resources Data Library is subject to an agreement with licence conditions.</td></tr>
<tr><td>☐</td><td>Maintenance

Are there national coordination arrangements in place to help ensure that data are being assembled, maintained and delivered in a nationally consistent way without duplication of effort?

The Australian Government Department of Agriculture, Fisheries and Forestry coordinates the Executive Steering Committee for Australian Land Use Mapping with representation from the Australian, state and territory governments.

Are custodians of the data maintaining the data according to national guidelines or standards?

The Australian Government Department of Agriculture, Fisheries and Forestry maintains data according to the Australian Land Use Management Classification.

Source: Australian Natural Resources Information 2002, National Land & Water Resources Audit (http://audit.ea.gov.au/anra/data/docs/national/Data_Contents.html).</td></tr>
</table>

Additional information

For more detailed information refer to *Module 4: Spatial data priorities, standards and compliance*

5 Spatial data discovery and access

Timely access to data and information in a suitable format is critical to informed decision making by NRM regional groups. Currently a wide range of data and information products is readily available—these include spatial databases, spreadsheets, reports, imagery and photos, multimedia documents, tables, posters and maps that are freely available to support the management of natural resources. A number of specific services have been established to facilitate the discovery, visualisation, access and distribution of these resources.

Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify, model and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making and planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis and communication are key components.

A number of specific services have been established to facilitate the discovery, visualisation, access and distribution of NRM data and information. The philosophy underpinning the creation of a number of these services (e.g. the Australian Natural Resources Data Library and the Australian Natural Resources Atlas) is that the development of datasets is an expensive activity, and datasets accrue far greater value if they are readily accessible to a wide range of users.

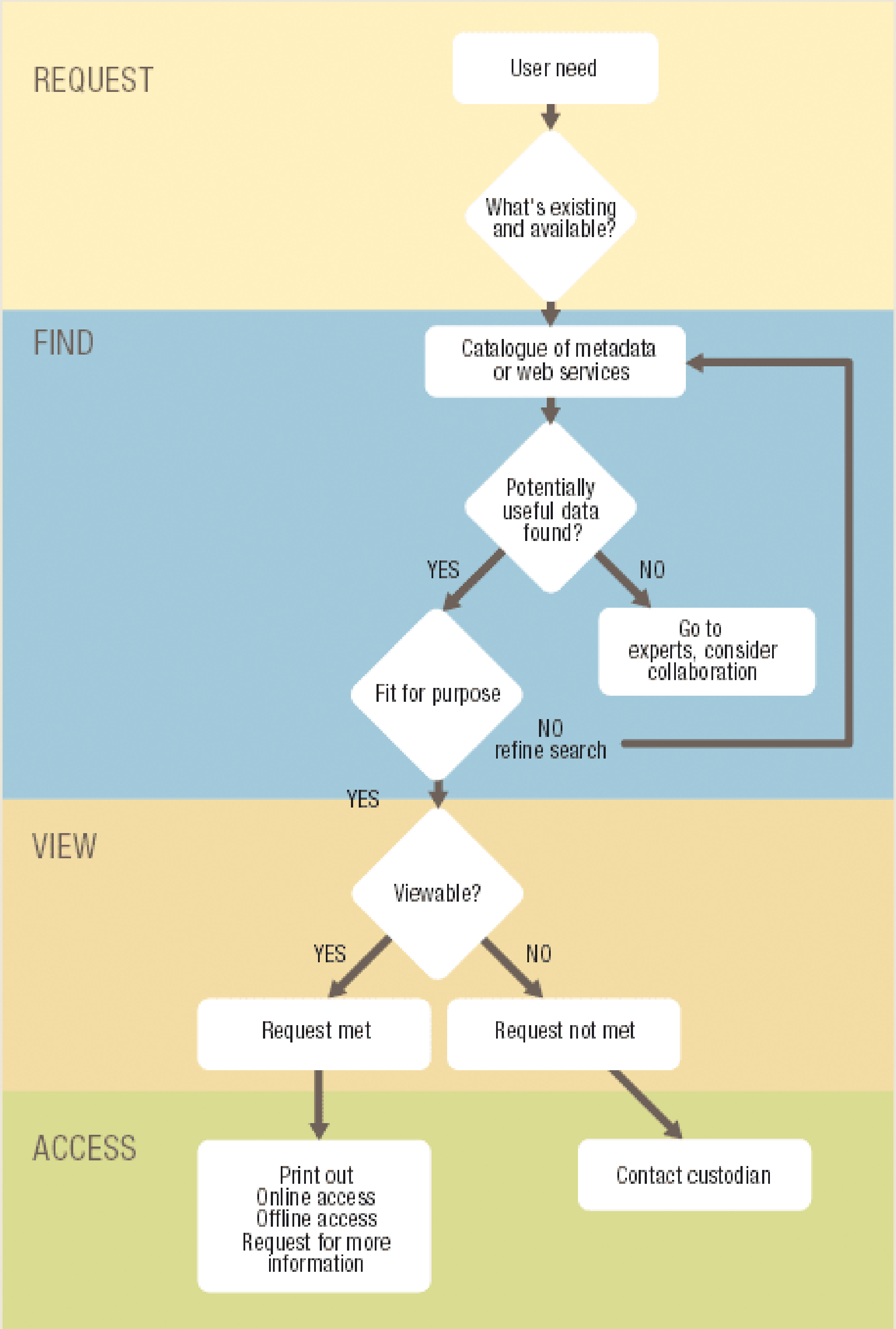
To be successful, accessing and publishing of data should be carried out within a controlled framework. This protects the rights and responsibilities of data providers and data receivers. A number of model frameworks exist for regional groups to develop similar protocols, e.g. the ANZLIC guidelines and policies available online at http://www.anzlic.org.au/policies.html.

The process of acquiring existing data, often referred to as data discovery, involves a number of steps all of which are carried out within a controlled framework:

1. Searching (request and find) to determine the data actually exists
2. Viewing and assessing their fitness for use
3. Completion of accessing and licence agreements
4. Supply or delivery.

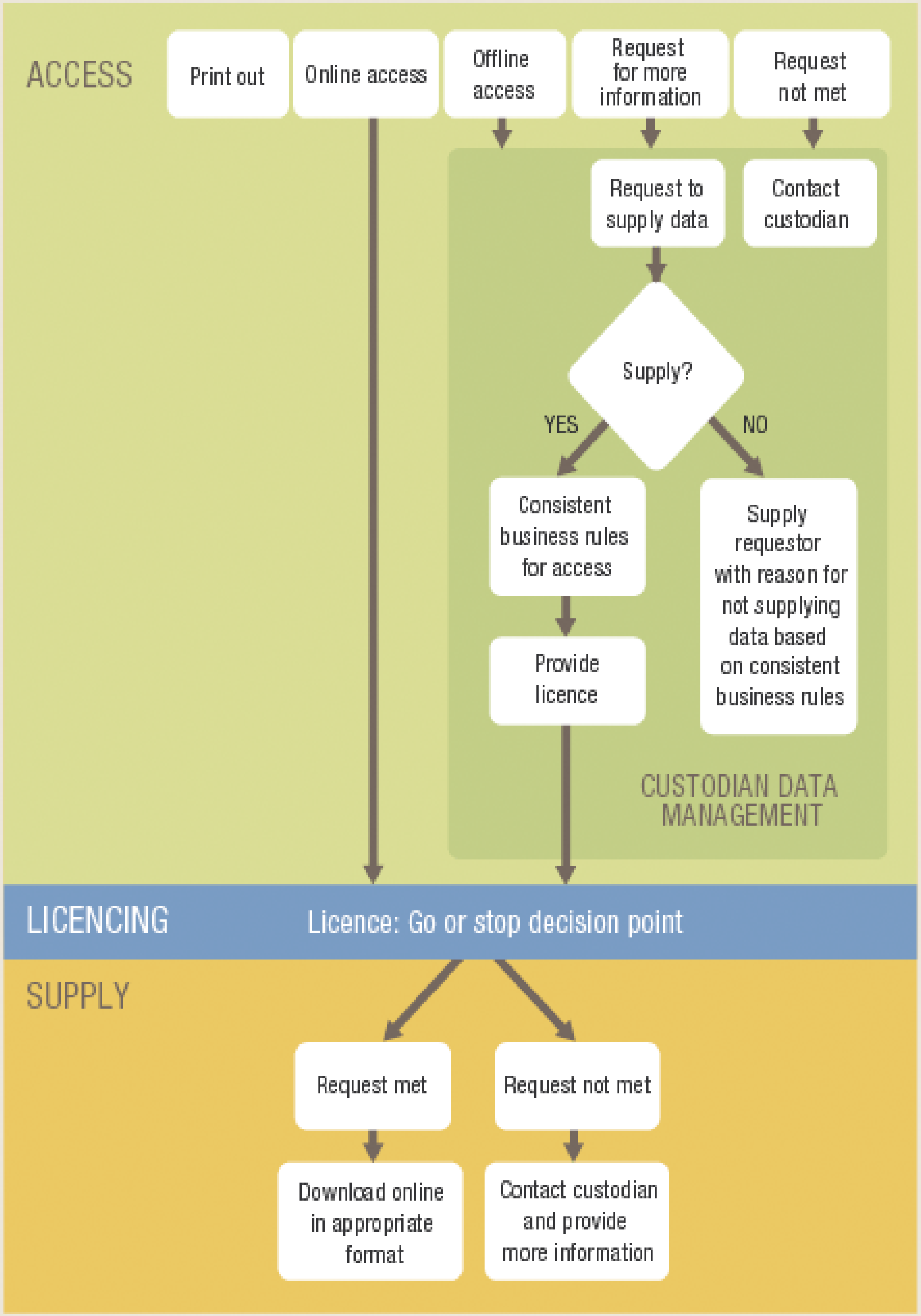
This process is illustrated in the flow-chart at Figure 0–5: parts (i) and (ii).

Figure 0–5(i) Flow chart for discovering and accessing spatial data and information: a user's perspective.



(continued)

Figure 0–5(ii) Flow chart for discovering and accessing spatial data and information: a user's perspective.



The major sources of natural resources data and information available at a national level may be found at the following sites:

Australian Spatial Data Directory: http://asdd.ga.gov.au/asdd/

Australian Natural Resources Atlas: http://www.anra.gov.au

Australian Natural Resources Atlas Theme Reports: http://www.anra.gov.au

Australian Natural Resources Data Library: http://adl.brs.gov.au/

Australian Resources Online: http://www.anra.gov.au/aro/

Australian Agriculture and Natural Resources Online: http://www.aanro.net/

Discover (NRM) Information Geographically:

http://www.environment.gov.au/erin/dig/index.html

Environmental Reporting Tool: http://www.environment.gov.au/erin/ert/index.html

Geoscience Australia: http://www.ga.gov.au/

Additional information is available online via the Australian Spatial Data Directory at

http://asdd.ga.gov.au/asdd

Many jurisdictions have developed 'clearing houses' and one-stop-shops where state/territory agencies lodge information about their spatial data. These clearing houses generally have associated policies and standards that ensure the consistency of their spatial data resources.

Queensland: http://www.qsiis.qld.gov.au and http://www.information.qld.gov.au/

Western Australia: http://www.walis.wa.gov.au/

New South Wales: http://www.canri.nsw.gov.au/ and http://www.nratlas.nsw.gov.au/

Tasmania: http://www.thelist.tas.gov.au/

ACT: http://asdd.ga.gov.au/asdd/tech/node/act-1.html and http://www.gim.act.gov.au/actLocate/index.dwt

Victoria: http://www.land.vic.gov.au and http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/vrohome

Northern Territory: http://www.ntlis.nt.gov.au/ and http://www.ntlis.nt.gov.au/imfPublic/imf.jsp?site=nt_atlas

South Australia: http://www.asdd.sa.gov.au/ and http://www.atlas.sa.gov.au/

Additional information

For more detailed information refer to *Module 5: Spatial data discovery and access*

6 Project management and justification – lessons learnt, pitfalls and best practice procedures

An awareness of lessons learnt from other organisations (and their experiences) can assist to ensure that projects are designed and implemented to achieve maximum benefit. There are many examples where an integrated management solution has been successful in NRM projects. However there are also examples of projects that have failed to return any measurable benefit to the organisation.

Tips for the successful implementation of information technology in NRM projects include:

1. Understand the problem before jumping to a solution
2. Always include key stakeholders in the feasibility process
3. Carefully assess internal development capabilities
4. Define requirements clearly
5. Distinguish the problem from the symptoms surrounding it
6. Resolve political issues.

Many organisations throughout the world have invested heavily in SIS software and data capture programs. Unfortunately in some cases the implementation processes have not operated in an effective or efficient manner and the anticipated benefits have not been realised. Careful adherence to proven project management principles and learning from others' mistakes should assist regional managers to implement successful projects.

A consistent approach to managing IT and SIS projects can improve project management and outcomes considerably. Many large organisations—including state/territory and Australian government agencies, and private companies—now use project management approaches based on proven methodologies. The project management systems used by the Tasmanian and NSW State Governments provide good examples with a wide range of free resources. More information on these systems is available online at:

http://www.egovernment.tas.gov.au/

http://nrims.nsw.gov.au/policies/imf/index.shtml

The Tasmanian system has two different styles of business case documents for small and large projects providing a very valuable resource to support justification of expenditure on spatial information by NRM regional bodies.

(http://www.egovernment.tas.gov.au/themes/project_management/project_management/resources).

Additional information

For more detailed information refer to *Module 6: Project management and justification – lessons learnt, pitfalls and best practice procedures*

7 Guidelines for selecting spatial information system software and hardware

Managers need to make judgments and decisions when selecting new spatial information systems, upgrading existing systems or evaluating whether to change to another system. Software and hardware selection should be based on the range of actual functionality and applications needed by an organisation. It is important to be aware of context, and not be influenced by the loudest voice. If in doubt, get additional advice.

In recent years there has been a proliferation of SIS software and an almost exponential increase in the range of functionality or tools available.

It is important to remember that SIS hardware and software are part of an integrated information management solution, and therefore they need to be considered in relation to other components (e.g. procedures, standards and protocols), designed to provide ready access to data and information, and support best practice procedures. As such, NRM regional groups are encouraged to purchase software products that are fully compliant with OpenGIS® specifications, enabling them to interoperate with other information systems.

Best practice guidelines and standards are available to assist in the design and evaluation of SIS software and hardware. The following is a summary of issues that need to be addressed when choosing an SIS software product:

	Checklist for selecting spatial information system software
☐	**Do you need a spatial information system or a mapping package?** If so, what scale or type—simple desktop viewer, professional workstation, custom application?
☐	**Cost:** Hardware and software requirements (including ongoing maintenance)
☐	**Type of operating system** that will be used (e.g. Linux, Unix, Windows, Mac)
☐	**Format requirements:** Ability to handle raster (pixel data), vector (point, line, polygon data) or both formats
☐	**Local support:** Are you going to be able to get immediate help if you have problems?
☐	**Complexity/personnel resources (including staff and training):** For a beginner, it will be important to have a user friendly SIS, i.e. one with an easy to understand graphic user interface (GUI). Ensure that budget funds are available for initial training and continued capacity building activities for both SIS technical and casual user groups.
☐	**Company, agency or organisation requirements (general and specific):** Develop a needs assessment. Can specific benchmark requirements be met? Does the software fulfil a variety of needs? Does the system have the functions needed?
☐	**Reliability of system and vendor:** Will they be around for the next ten years to service equipment and provide technical support?
☐	**Scalability, maintenance and upgrading:** Does the technology have an update or production development program? Does it offer a migration path or suite of options? Will you need to buy add-ons and are they available?
☐	**Support material:** Is there a pool of people, locally or within your organisation, which uses your preferred SIS? If so, will it be possible to get help from more experienced users? Capacity building is one of the most important aspects in the successful implementation of an SIS.
☐	**Maintenance and licensing:** What maintenance and licensing options are available?
☐	**Interface with other software used and interoperability:** For example, between computer aided drafting (CAD), mapping, image processing, database and web systems.
☐	**Open system support:** Does the software support OpenGIS® specifications, World Wide Web Consortium standards and the Australian Spatial Data Infrastructure?

Additional information

For more detailed information refer to *Module 7: Guidelines for selecting spatial information system software and hardware*

8 Enhancing capability for using spatial information

Decisions to train staff in SIS, hire new staff with existing SIS skills, or hire consultants, are no different from any other technical issue faced by NRM regional groups.

In many cases these groups may need access to activities related to increasing GIS capacity including training, recruitment of new staff or hiring specialist firms or consultants to provide guidance and recommendations, or to undertake specific software development or data analysis tasks.

A wide range of SIS staff training options are now available in Australia. These range from full-time university courses to short courses, in-house training and mentoring through professional associations, cadetships and informal networks. There are also a number of tertiary training courses that provide specific SIS skills (which are credited within the tertiary education system).

Best practice guidelines are available to assist in determining when a consulting firm is required and what to look for when choosing one.

	Checklist for selecting a consulting firm
☐	Where possible, use stakeholders or partners to determine what is needed and then task a particular unit or resource information centre with the responsibility of sourcing a consultant.
☐	Similar to choosing software, decide what is required and not what potential clients may offer.
☐	Where possible, develop a matrix or scorecard on what the consultants offer and your requirements.
☐	Leave room for evaluating intangibles. For example, factors involved may include: ▪ Potential for on-going relationship and support ▪ Skills—do the consultants have the breadth and depth to meet your needs? ▪ Distance—are the consultants available at close call?

Additional information

For more detailed information refer to *Module 8: Enhancing capability for using spatial information*

9 Map production guidelines

To be effective, maps need to convey relevant information to the expected audience.

Managers need to make sure that mechanisms are in place, as part of quality assurance procedures, to ensure that map production fulfils relevant compliance criteria. In this respect, checklists identifying minimum requirements for internal and external map production are a useful method of facilitating quality control.

The following list, based on material from the operations manual prepared for the Audit, provides an example of a checklist identifying mandatory and optional elements for the production of Audit maps. It serves as a useful template for the production of maps in most project type activities.

	Checklist for map production
Mandatory elements	
☐	**Title:** A descriptive name of the map
☐	**Publisher:** The name of the publisher (e.g. NLWRA), place of publication and date of publication
☐	**Copyright:** A statement indicating who holds copyright for the map and the year of publication
☐	**Acknowledgments and source:** The origin and nature of the information shown on the map, including derived or interpreted data—the statement should also indicate the currency of the data
☐	**Scale:** A scale bar with optional representative fraction in the form of 'Scale 1: xxx xxx'
☐	**Legend:** Clearly depicted colouring and display characteristics for the information shown on the map—the legend should display symbols or coloured boxes with a brief description of each
☐	**Colours and shading:** In general for large areas on the map use light colours. For small areas use dark colours. Ensure that readers of the map are able to easily distinguish between the colours. For maps to be viewed on a screen do not use colour spectrums (e.g. blue-green-yellow-red) as they do not print out well in black and white and some colour-blind people have difficulty reading them on the web (particularly red-green combinations). The main principle to follow when choosing colour ramps to represent increasing or decreasing values is to use colours of increasing intensity or darkness. This allows the maps to be printed out in black and white and still accurately convey the information. Do not use a red colour ramp. While this is a little constraining, it ensures that our information products will cater for as broad an audience as possible.
☐	**Symbols:** Use established simple and clear symbols wherever possible. Symbols portraying related objects or concepts should have common characteristics.
☐	**Font:** The number of different fonts and font sizes used should be kept to a minimum. Fonts that are sans (without) serifs, such as Verdana, Univers, Triumvirate or Helvetica are recommended, particularly for web products.

	Checklist for map production
☐	**Projection and datum** Australian continent: ■ Users need to compare areas >> Albers Equal-Area Projection. ■ Users need to compare distances/angular relationships >> Lambert Conformal Conic Projection. Small local areas of the Australian continent use the Map Grid of Australia (MGA94). Data are mapped using the Geocentric Datum of Australia (GDA94). For Albers Equal-Area, the parameters used when creating a map of Australia should be set to: ■ Map units: metres ■ Projection: Albers Equal-Area Conic ■ Spheroid: GRS80 or WGS84 ■ Central Meridian of 132 degrees East (132°E) ■ 1st standard parallel 18 degrees South (18°S) ■ 2nd standard parallel 36 degrees South (36°S).
☐	**North arrow:** Only show if the clear delineation of north will be advantageous. If a graticule is used then a north arrow is redundant. Do not use a north arrow for small-scale maps with projections in Albers Equal-Area Conic or Lambert Conformal Conic as north varies across the map.
Optional elements	
☐	**Map number:** This should be included if the map is part of a numbered series. It is normally grouped with the title.
☐	**Contact:** Use the format 'For further information contact [name and/or position], [phone], [email].'
☐	**Status and constraints:** The status of the map may be draft, working map, version number, etc. Access constraints may include confidential, internal use only.
☐	**Caveats:** A statement of the reliability and restrictions on use
☐	**Graticule:** At scales larger than 1:5 million the minimum requirement to delineate geographic coordinates (e.g. latitude and longitude) is to display labelled graticule 'tics' (short lines) around the borderline of the map sheet.
☐	**Additional text:** Additional text should generally be the same font, size and colour as text for the publication block.
☐	**Logos:** Where a number of organisations are responsible for the content and publication of a map, each organisation's logo should receive equal prominence, however, logos should not be overly prominent on the map. Where more than one logo is included, they should be of the same size and prominence and generally grouped together.

Additional information

For more detailed information refer to *Module 9: Map production guidelines*

10 Introduction to GPS and best practice guidelines

Recent progresses in technology, and reductions in the cost of many products, have made it possible for general practitioners to have access to equipment previously considered the domain of specialists. The global positioning system (GPS) is one such piece of equipment becoming increasingly used by the general community. GPS receivers are widely used in NRM projects, e.g. determining the location of a stream recoding station, through to precision agricultural tasks relating yield to paddock locations, and sophisticated geodetic control surveys.

As with any data collection exercise, GPS surveys can be time consuming and expensive. As such, they should be treated like any other data collection and processing activity, and be carefully designed and planned to return maximum benefit.

Additional information

For more detailed information refer to *Module 10: Introduction to GPS and best practice guidelines*

11 Partnerships and working together – the potential for collaboration

One of the additional benefits of introducing spatial information systems (SIS) into organisations and NRM regional bodies is that it can encourage cooperation and communication across the multiple sectors that require and use spatial information in their everyday work. It can also encourage organisations and NRM regional bodies to work together with neighbouring groups, plus local, state/territory and Australian governments.

The collection of data for an SIS can be costly and may require the purchase of specialised equipment and technical expertise. Careful planning is required to ensure that collection activities are well coordinated and that, where possible, data can be collected once and used many times by different business units within a single organisation. There are also potential cost savings in working together with other groups.

Based on lessons from practice, NRM regional bodies that work together on spatial information initiatives will experience some or all of the following advantages:

- broad support for vision and expectations
- champion individuals/community support
- knowledgeable, respected participants
- frequent contact with national (higher order) organisations
- proactive, open, and inclusive processes/procedures to enable maximum participation/diverse perspectives
- improved understanding/outreach.

Experiences from groups working together through regional networks in Australia underline the benefits that can be achieved. These benefits are also highlighted in Queensland with an initiative by the state government to collaborate with local governments in the development of spatial information systems.

Additional information

For more detailed information refer to *Module 11: Partnerships and working together – the potential for collaboration*

MODULE O: Capability Road Map - Enhancing Information Management Capacity

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

MODULE O

0 Capability road map – enhancing information management capacity

There is a wide variety of data and information management capacity across various NRM groups throughout Australia which relates to their size, complexity, location, funding, individual and organisational capacity, and time in existence.

Within the context of the need for ongoing improvements in the capacity of NRM regional bodies for managing data and information, it is important to consider a spectrum of information management capabilities. This can be viewed as part of a road map scenario giving consideration to where each NRM group is currently positioned and where they would like to be in the short, medium, and longer term.

The concept of capability spectrums is well established in the information technology industry and within quality management and allied disciplines across all industry sectors.

It is useful to consider the application of the capability-raising concepts to regional NRM groups, as the methodologies for capability raising do not consider current capability as a problem, but merely a starting point for improvement.

The following capability model (Table 0–1)—based on a simple five-stage maturity model as commonly used by the information technology industry—is presented for consideration. The model allows all NRM groups, regardless of their current capabilities, to consider what is needed to improve their capacity, and subsequently develop an action plan to move forward on the capability spectrum.

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Table 0–1 An indicative capability framework for spatial information management within NRM regional bodies

Level	Name	Description
1	Individual capabilities	Individual staff members within the NRM regional group are developing one or two projects or a business process.
2	Managed individual capability	The projects of individuals are recognised by the NRM regional group and are being managed, with standards in place. A linkage exists with some business processes and procedures. Training resources are allocated, responsibilities have been assigned and evaluations are taking place regularly.
3	Organisational capability	All NRM group business processes and projects are defined and managed using formal program management procedures. Linkage of all business processes to defined user needs exists. Internal benchmarking is occurring and compares data and information management with other business activities.
4	Quantitatively managed organisation capability	Quantified measures of process efficiency are occurring across the NRM region. Data and information management process, standards, training and support are measured quantitatively.
5	Optimising	There is a continuous improvement process based on quantified measures of process efficiency and range of management processes to constantly improve measured performance.

It is a useful exercise to consider where your NRM regional group is placed on this capability spectrum and where you intend to go (and how). Specifically, Modules 1 to 11 of this Toolkit are designed to support you in that journey. For some regional groups, raising capability by one or two levels may be sufficient. For others, a strategic plan for level improvement progressing towards Level 5 may be more appropriate. Regardless, the focus should be on moving forward, either through the development of shared spatial information system services with other NRM regions/organisations, or through your own spatial information system implementation. A module-by-module road map for increasing capability is included at Table 0–2.

Table 0–2 A capability raising road map for spatial information management in NRM regional bodies

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
1	Information management and the sustainable development of natural resources – an introduction to information management systems	Develop spatial information management plan including resource needs (people, funds and equipment), business drivers and governance	Comprehensive organisation-wide information management plan linked to business process analysis and underpinned by internal benchmarking	Development of formal measures demonstrating contribution of spatial info. to business process efficiency, including external benchmarking	Internal and external benchmarking drives continuous improvement process, including appropriate governance models to rapidly enact process improvements
2	Data management principles	Individual people or units have documented data management processes, policies and procedures	Organisation-wide data management processes, policies and procedures in place	Business process review for ensuring compliance with data management processes, policies and procedures	Development of metrics for data management compliance, including continuous external benchmarking
3	Interpretation and visualisation of data – an introduction to spatial information systems	Understanding of spatial information systems by key staff members	Organisational understanding of spatial information systems	Cost benefit of spatial information systems analysed and recognised	Regular reviews of understanding, implementation and use of spatial information systems

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
4	Spatial data priorities, standards and compliance	Individual people or departments have documented spatial data mgt standards, processes, policies and procedures	Organisation-wide spatial data management standards, processes, policies and procedures	Business process review for ensuring compliance with spatial data management standards, processes, policies and procedures	Development of metrics for spatial data management standards and compliance, including continuous external benchmarking
5	Spatial data discovery and access	Individual understanding of spatial data clearing houses and peer support networks	Formal spatial data access and use arrangements within and between regional bodies and other organisations; organisation mandate for peer support	Development of feedback mechanisms to ensure spatial data quality and access align with business drivers across regional bodies	Continuous effort for improving discovery and access of spatial data by all sections of NRM regional bodies
6	Project management and justification – lessons learnt, pitfalls and best practice procedures	Implement standardised project management, including individual or departmental level business cases	Implement program level organisation-wide project management, including systematic business cases	Analysis of project and program performance in project planning, management and post-project review, including cost benefit analysis of business cases	Comparative benchmarking of project performance between NRM bodies and allied organisations/ sectors
7	Guidelines for selecting spatial information system	System procurement driven by individual or departmental	System procurement fully integrated with business needs and procurement	System audits, user reviews and business alignment assessment;	Quantified internal feedback on system usage and performance regularly

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
	software and hardware	business needs funded, endorsed plan for system procurement and implementation; selection check-lists and criteria followed	decisions undertaken on an organisation-wide basis	user groups providing quantified feedback on systems	compared with other organisations
8	Enhancing capability for using spatial information	The projects of individuals are recognised by the organisation or NRM regional body and are being managed; standards are in place and linkage exists to some business processes and procedures; training resources are allocated, responsibilities assigned and evaluations are taking place	All processes are defined and managed through program management of all projects; linkage of all business processes to defined customer needs exists; internal benchmarking is occurring and compares spatial information management with other business activities	Quantified measures of process efficiency across the organisation or NRM regional body; spatial information management process, standards, training and support are measured quantitatively	Continuous improvement process based on quantified measures of process efficiency and range of management processes to constantly improve measured performance
9	Map production guidelines	Unit or departmental documented map production guideline(s)	Organisation-wide documented map production guideline(s)	Comparative analysis and alignment of regional map production guideline(s)	Formal processes in place to ensure continuous improvement and change management of map

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
					production guideline(s) generated by quantified regional analysis and user feedback
10	Introduction to GPS and best practice guidelines	Low understanding of GPS principles; GPS procurement driven by individual needs	Understanding of GPS principles; GPS procurement integrated with needs and procurement based on endorsed plan	Good understanding of GPS principles; formal methods for GPS survey and processing; procurement integrated with needs and procurement based on endorsed plan	Benchmarking of performance, with continuous effort for improving
11	Partnerships and working together – the potential for collaboration	Individuals or departments service the spatial information requirements of others	Organisational mandate for collaboration across all functional areas of an NRM group and formalised agreements for working together with other organisations	Performance measures established for internal and external service agreements	Benchmarking of performance measures for service agreements; combined agreements for collaborative spatial information usage

Signposts are included in each module to guide managers in raising their NRM region's capability.

MODULE 1

MODULE 1: Information Management and the Sustainable Development of Natural Resources - An Introduction to Information Management Systems

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

One of the prerequisites for natural resources management (NRM) involves the establishment and maintenance of a database of relevant information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify, model and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making and planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis and communication are key components.

In recent times best practices have evolved to assist data-related tasks in NRM projects. Successful projects have generally adopted an integrated information management solution; combining leadership, people, technology, applications and data into a framework that ensures tools and procedures are in place to maintain and transform data into useful information products that support core business operations and the decision-making process.

Under current arrangements, funding for NRM projects is increasingly being channelled from government agencies to regional groups (e.g. catchment management authorities and resource information centres). This often involves gaining access to, developing new, and processing existing data. It is important these data become part of the national resource base, and following completion of the initial project, are subsequently made available to the broader community.

The **Natural Resources Information Management Toolkit** (the Toolkit) is being implemented under the joint sponsorship of the National Land & Water Resources Audit (the Audit) and ANZLIC – the Spatial Information Council (ANZLIC), as part of a strategy aimed at **building capacity to implement natural resources information management solutions**. The Toolkit will assist project managers, staff and participating parties at national, state/territory and regional levels to obtain full value from the investment in collection, management and use of data to fulfil project requirements.

The aim of the Toolkit is to compile a resource that:

- assists in building capacity at regional and local levels to manage, utilise and share natural resources data and information more effectively
- increases the awareness, understanding and skills of individuals responsible for data and information management in NRM programs

- facilitates the development and adoption of internationally accepted standards and guidelines for information management and thereby promotes best practices in information management
- gives participants in NRM projects access to practical information management tools to reduce set-up costs and duplication of effort
- supports the development of community networks through open and efficient sharing of information resources and knowledge, and assists the establishment of information loops between regional, state/territory and national levels
- ensures the sustainable management of data used or created in projects
- allows others to fully exploit the information generated from natural resource management projects.

It is acknowledged that each state and territory has its own initiatives related to data and information management, including governance guidelines and protocols. The intent of this guideline is to provide background information on natural resources management programs, emphasising the recent shift in focus of funding programs to a regional level, and to provide an introduction to information management.

Actions

Managers should concentrate on developing integrated management solutions in which the acquisition, processing and dissemination of data and information is carried out within a collaborative framework. This can be achieved through the establishment of a spatial data infrastructure, involving the creation of guidelines, standards and procedures within a framework that is supported by a scientifically based and technically competent distributed group of data custodians and related agencies.

The Australian, state and territory governments are all currently involved in the development of the Australian Spatial Data Infrastructure (ASDI). Managers of regional projects should facilitate the development and implementation of data policies at a local level, which are based on best practice principles, such as those outlined in the *ANZLIC Policy Statement on Spatial Data Management*. For example:

- creation of an easily accessible, distributed data network to manage and disseminate data collected as part of project and other activities in support of corporate objectives
- development of core datasets as standard or base-line products, and a range of other products and services as needed, to support economic, ecological and social development
- provision of best practice quality assurance mechanisms and procedures to create validated, well-documented datasets to meet priority information needs

- establishment of partnerships with industry, government and others (e.g. educational institutions) to develop skills and maximise use
- where possible avoidance of duplication in data capture, and expenditure on system development
- archiving of data to ensure availability for multiple use and safeguard for future generations.

Achievement of the above principles requires adoption of best practice in data and information management for data collectors, owners, custodians and groups or agencies that generate information.

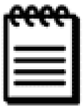
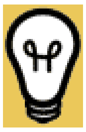
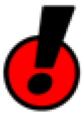
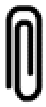
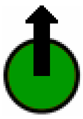
This guideline is designed to provide a brief overview to assist regional groups in developing strategies that address data and information issues and thereby assist in sustainable NRM. Additional and more detailed information related to program development and data management is presented in other chapters of the Toolkit.

Acknowledgments

This module sources material produced by the Audit; the Australian Government Department of the Environment, Water, Heritage and the Arts; Bureau of Rural Sciences; Geoscience Australia; ANZLIC; and Spatial Knowledge Engineering, Incorporated. These sources are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

1.1 Overview of NRM programs

1.1.1 The new NRM framework

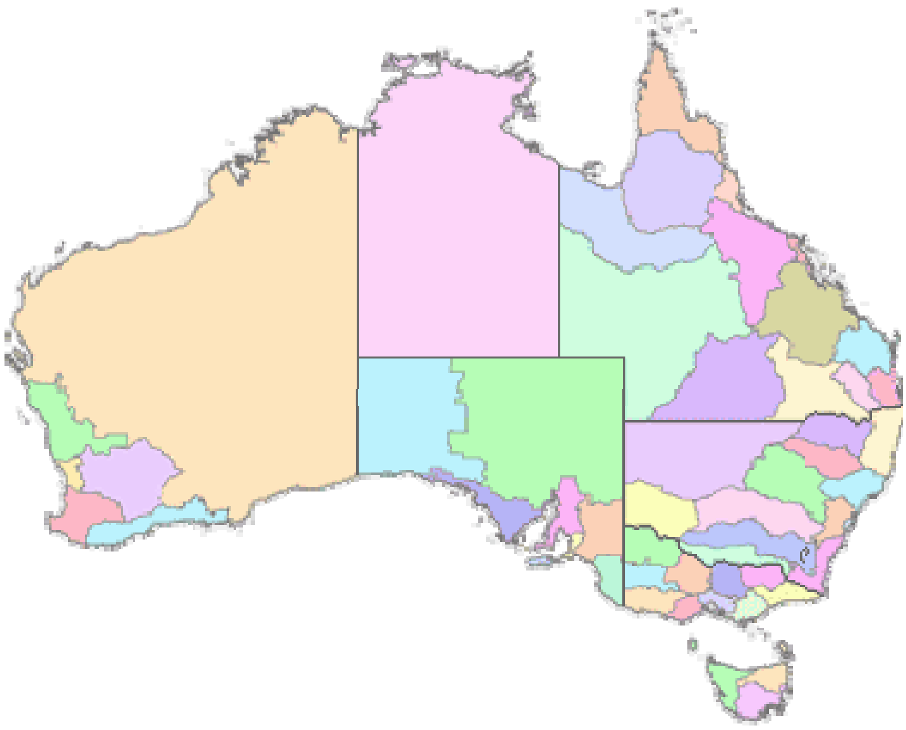
The contemporary view of sustainable management of natural resources is that it is best achieved by adopting a regional approach involving the development of strong cooperative partnerships between government bodies, the community, on-ground land managers and educational institutions, to develop plans that address regional needs.

The shift to a regional approach in Australia was demonstrated in the nation-wide implementation of natural resource management programs. The success of these initiatives is dependent on regional communities being able to develop, own and implement plans for NRM.

Development of regional boundaries

The Australian, state and territory governments have developed a system of regional boundaries for the purpose of identifying NRM priorities. A total of 56 NRM regions have now been identified to facilitate the integrated delivery of NRM priority issues, in association with state and territory governments (see Figure 1–1, and http://www.nrm.gov.au/index.html).

Figure 1–1 The 56 NRM regions across Australia
(Source: http://www.nrm.gov.au/index.html)



Establishment of regional bodies

Though actual implementation procedures vary between state and territory jurisdictions, each region will have at least one regional body established to undertake the tasks for managing and protecting the region's natural resources.

Development of regional NRM plans and improved efficiencies

A major task to be undertaken by regional bodies under the framework outlined above, involves the development of a single NRM plan for the region. These plans form the basis for investment from the natural resource management programs and thereby streamline operations by removing the need for individual project plans to access different types of government funding.

Regional plans outline the means for identifying and achieving the region's NRM targets, and involve an agreement between government and the community with respect to an investment strategy for implementing the plan, and the definition of goals and contributions that all parties will undertake.

In principle, regional plans detail catchment-wide activities and address a range of NRM issues including land and water management, biodiversity, and agricultural practices.

Such an approach has potential to leverage increased efficiencies and effectiveness in overall program delivery.

Accreditation of regional plans

The Australian and state and territory governments invest in community-based regional plans once they have passed an accreditation process based on criteria agreed by the various governments through the Natural Resource Management Ministerial Council (NRMMC).

Key elements of the accreditation criteria by which plans are assessed, require regional bodies to demonstrate that their plans:

- are based on a whole-of-region approach
- cover the full range of NRM issues and incorporate environmental, social and economic aspects
- are underpinned by scientific analysis of natural resources conditions, problems and priorities
- have effective involvement of all key stakeholders in the development and implementation of the plan
- focus on addressing the underlying causes rather than symptoms or problems

- include strategies to implement agreed NRM policies to protect the natural resources base
- demonstrate consistency with other planning processes and legislative requirements applicable to the region
- establish targets at the regional scale which are consistent with the national framework for NRM standards and targets
- identify strategic, prioritised actions to address the range of NRM issues and achievements of regional targets within an established timeframe
- provide for the continuous development, monitoring and review of improvement in the plan.

Funding arrangements

Following accreditation of a region's NRM plan, the regional body is responsible for developing investment strategies or business plans that are aimed at attracting investment in the regional plan. Such a strategy should detail specific actions, costs and time frames required to implement the regional plan and achieve regional targets and returns on investment as detailed in the plan.

All Australian, state and territory government and regional joint investment decisions for NRM programs are based on a region's investment strategy, and it is considered an essential milestone prior to the final agreement being signed by the relevant regional group and the Australian and relevant state/territory governments to formally release investment funds.

Bilateral agreements

Bilateral agreements are developed in a joint process of consultation and negotiation between the Australian government and the states and territories, and include the state or territory government's undertakings on land and water reforms. They also identify regional bodies responsible for the development and delivery of NRM plans, and some of the administrative and accountability arrangements.

> A major strength of the current NRM programs lies in the opportunity for enhanced capacity building and improved monitoring and evaluation procedures undertaken at a regional level.

Additional information on NRM regions, regional NRM plans and bilateral agreements is available from the following website:

http://www.nrm.gov.au/index.html

Specific information on state and territory regions is also available at:

http://www.nrm.gov.au/nrm/region.html

1.2 Role of the Toolkit

The range of issues, capacity and characteristics of regional NRM groups throughout Australia is extremely varied. This variety relates to various factors including size, location, population, complexity and funding, etc. The Toolkit aims to provide information that will be of value to all NRM groups. Each group is increasingly becoming more involved in managing data and information to improve the management of resources. The challenge is how to best use and manage data and information to support core business processes.

The Toolkit has been designed to provide universal principles of best practice for data and information management. In doing so, it is pitched at a strategic level thereby ensuring commonality between various NRM bodies while using specific examples from a range of sources to illustrate particular issues.

The aim of the Toolkit is to compile a resource that:

- assists in building capacity at regional and local levels to manage, utilise and share natural resources data and information more effectively
- increases the awareness, understanding and skills of individuals responsible for data and information management in NRM programs
- facilitates the development and adoption of internationally accepted standards and guidelines for information management and thereby promotes best practices
- gives participants in NRM projects access to practical information management tools to reduce set-up costs and duplication of effort
- supports the development of community networks through open and efficient sharing of information resources and knowledge, and assists the establishment of information loops between regional, state/territory and national levels
- ensures the sustainable management of data used or created in projects
- allows others to fully exploit the information generated from NRM projects.

1.3 Capacity building road map

There is a wide variety of data and information management capacity across various NRM groups throughout Australia which relates to their size, complexity, location, funding, individual and organisational capacity, and time in existence.

Within the context of the need for ongoing improvements in the capacity of NRM regional bodies for managing data and information, it is important to consider a spectrum of information management capabilities. This can be viewed as part of a road map scenario giving consideration to where each

NRM group is currently positioned and where they would like to be in the short, medium, and longer term.

The concept of capability spectrums is well established in the information technology industry and within quality management and allied disciplines across all industry sectors.

It is useful to consider the application of the capability-raising concepts to regional NRM groups as the methodologies do not consider current capability as a problem, but merely a starting point for improvement.

The following capability model (Table 1–1)—based on a simple five-stage maturity model as commonly used by the information technology industry—is presented for consideration. The model allows all NRM groups, regardless of their current capabilities, to consider what is needed to improve their capacity, and subsequently develop an action plan to move forward on the capability spectrum.

Table 1–1 An indicative capability framework for spatial information management within NRM regional bodies

Level	Name	Description
1	Individual capabilities	Individual staff members within NRM regional body are developing one or two projects or a business process.
2	Managed individual capability	The projects of individuals are recognised by the NRM regional group and are being managed, with standards in place. A linkage exists with some business processes and procedures. Training resources are allocated, responsibilities have been assigned and evaluations are taking place regularly.
3	Organisational capability	All NRM group business processes and projects are defined and managed using formal program management procedures. Linkage of all business processes to defined user needs exists. Internal benchmarking is occurring and compares data and information management with other business activities.
4	Quantitatively managed organisation capability	Quantified measures of process efficiency across the NRM region are occurring. Data and information management process, standards, training and support are measured quantitatively.
5	Optimising	There is continuous improvement of processes based on quantified measures of efficiency and range of management strategies to constantly improve measured performance.

It is a useful exercise to consider where your NRM regional group is placed on this capability spectrum and where you intend to go (and how). Specifically, Modules 1 to 11 of this Toolkit are designed to support you on that journey. For some regional groups, raising capability by one or two levels may be sufficient. For others, a strategic plan for level improvement progressing towards Level 5 may be more appropriate. Regardless, the focus should be on moving forward; either through the development of shared spatial information system (SIS) services with other NRM regions/organisations, or through your own SIS implementation. A module-by-module road map for increasing capability is included at Table 1–2.

Table 1–2 A capability-raising road map for spatial information management in NRM regional bodies

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
1	Information management and the sustainable development of natural resources – an introduction to information management systems	Develop spatial information management plan including resource needs (people, funds and equipment), business drivers and governance	Comprehensive organisation-wide information management plan linked to business process analysis and underpinned by internal benchmarking	Development of formal measures demonstrating contribution of spatial information to business process efficiency including external benchmarking	Internal and external benchmarking drives continuous improvement process, including appropriate governance models to rapidly enact process improvements
2	Data management principles	Individual people or units have documented data management processes, policies and procedures	Organisation-wide data management processes, policies and procedures in place	Business process review for ensuring compliance with data management processes, policies and procedures	Development of metrics for data management compliance, including continuous external benchmarking
3	Interpretation and visualisation of data – an introduction to spatial information systems	Understanding of spatial information systems by key staff members	Organisational understanding of spatial information systems	Cost benefit of spatial information systems analysed and recognised	Regular reviews of understanding, implementation and use of spatial information systems
4	Spatial data priorities, standards and compliance	Individual people or departments have documented spatial data management standards, processes, policies and procedures	Organisation-wide spatial data management standards, processes, policies and procedures	Business process review for ensuring compliance with spatial data management standards, processes, policies and procedures	Development of metrics for spatial data management standards and compliance, including continuous external benchmarking
5	Spatial data discovery and access	Individual understanding of spatial data clearing houses and peer support networks	Formal spatial data access and use arrangements within and between regional bodies and other organisations;	Development of feedback mechanisms to ensure spatial data quality and access align with business drivers	Continuous effort for improving discovery and access of spatial data by all sections of NRM

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
			organisation mandate for peer support	across regional bodies	regional bodies
6	Project management and justification – lessons learnt, pitfalls and best practice procedures	Implement standardised project management, including individual or departmental level business cases	Implement program level organisation-wide project management, including systematic business cases	Analysis of project and program performance in project planning, management and post-project review, including cost benefit analysis of business cases	Comparative benchmarking of project performance between NRM bodies and allied organisations/ sectors
7	Guidelines for selecting spatial information system software and hardware	System procurement driven by individual or departmental business needs; funded, endorsed plan for system procurement and implementation; selection check lists and criteria followed	System procurement fully integrated with business needs and procurement decisions undertaken on an organisation-wide basis	System audits, user reviews and business alignment assessment; user groups providing quantified feedback on systems	Quantified internal feedback on system usage and performance regularly compared with other organisations
8	Enhancing capability for using spatial information	The projects of individuals are recognised by the organisation or NRM regional body and are being managed; standards are in place and linkage exists to some business processes and procedures; training resources are allocated, responsibilities assigned and evaluations are taking place	All processes are defined and managed through program management of all projects; linkage of all business processes to defined customer needs exists; internal benchmarking is occurring and compares spatial information management with other business activities	Quantified measures of process efficiency across the organisation or NRM regional body; spatial information management process, standards, training and support are measured quantitatively	Continuous improvement based on quantified measures of process efficiency and range of management strategies to constantly improve measured performance
9	Map production	Unit or departmental documented map production	Organisation-wide documented map production	Comparative analysis and alignment of regional map	Formal processes in place to ensure continuous improvement and

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
	guidelines	guideline(s)	guideline(s)	production guideline(s)	change management of map production guideline(s) generated by quantified regional analysis and user feedback
10	Introduction to GPS and best practice guidelines	Low understanding of GPS principles; GPS procurement driven by individual needs	Understanding of GPS principles; GPS procurement integrated with needs and procurement based on endorsed plan	Good understanding of GPS principles; formal methods for GPS survey and processing; procurement integrated with needs and procurement based on endorsed plan	Benchmarking of performance, with continuous effort for improving
11	Partnerships and working together – the potential for collaboration	Individuals or departments service the spatial information requirements of others	Organisational mandate for collaboration across all functional areas of an NRM group and formalised agreements for working together with other organisations	Performance measures established for internal and external service agreements	Benchmarking of performance measures for service agreements; combined agreements for collaborative spatial information usage

Signposts are included in each module to guide managers in raising their NRM region's capability.

1.4 Information management

Increasingly, international reviews are revealing that the successful implementation of regional NRM plans is underpinned by the adoption and utilisation of appropriate information technology to improve efficiency in project activities. **To be effective, the use of information technology must be supported by policies and practices that view data and information as a long-term asset, requiring dedicated management and coordination, to produce increased efficiency and effectiveness in business operations.** This means being able to deliver the right information, in the correct format, in a timely fashion to decision makers.

Unfortunately, in many situations there is a barrier between what management and staff need, and what they actually have—they need easy access to relevant information; tools that support the use of the data; understanding of the data through standards and metadata; clear direction for priorities;

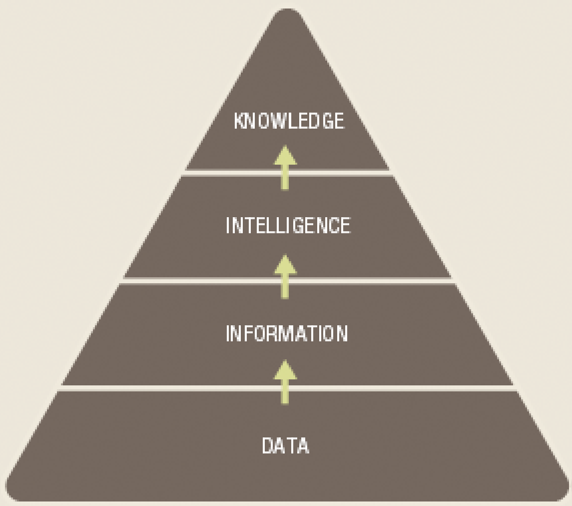
and training in the use of the technologies. What they most often encounter is data that are highly dispersed, not easily accessible, and not conforming to a standard, which when coupled with complicated technologies and bureaucratic management and support components, do not make the job any easier. As a consequence:

- time, effort and money are wasted in duplicating effort in data collection, management and analysis
- results are not transferable or easily shared
- decisions are difficult to communicate which often culminates in management having difficulty assigning priorities and resources.

Similarly, international and Australian experience demonstrates that a large number of organisations and regional bodies are both information providers and clients, and that there has often been a sizeable investment in data collection activities. This investment has not always resulted in increased efficiency and the transfer of data to information and knowledge.

It has been argued that it is the transformation of data to decision making which ultimately brings a level of knowledge, and an ability to make informed interventions to improve the management of natural resources. A schema for this concept is illustrated at Figure 1–2.

Figure 1–2 Schematic illustration of the progression of data into knowledge.



The goal of information systems is to convert data into information. Data are considered to be the input to a process where information is created. For example, daily rainfall recorded over long periods can be used to produce a monthly mean average for a particular location.

Issues

While the benefits of having access to and being able to use data and information may be well understood and accepted, the reality for many is:

- the technology is not accessible to most people because it is too complicated to use and is too expensive to acquire
- data are incomplete and not easily accessible
- data are not up-to-date and often lack any documentation on their accuracy and reliability
- only a few elite ‘technology gurus’ have the know-how and tools to analyse and synthesise information.

Today’s spatial information and web technologies can enable sophisticated analysis, sharing, publishing and access, however as mentioned, in many cases, a lot of money and time are spent with few results.

There are many reasons why these implementations might fail:

- lack of leadership or senior management support
- failure to identify the full implementation costs—focusing on hardware and software costs while data, training, and applications development costs are missed or underestimated
- insufficient or inappropriate expertise and experience on the implementation team
- reliance on experts and technology to dictate the business processes, instead of facilitating and supporting the organisation’s information needs.

The following table illustrates some of the issues associated with information and an inability to access and integrate the data.

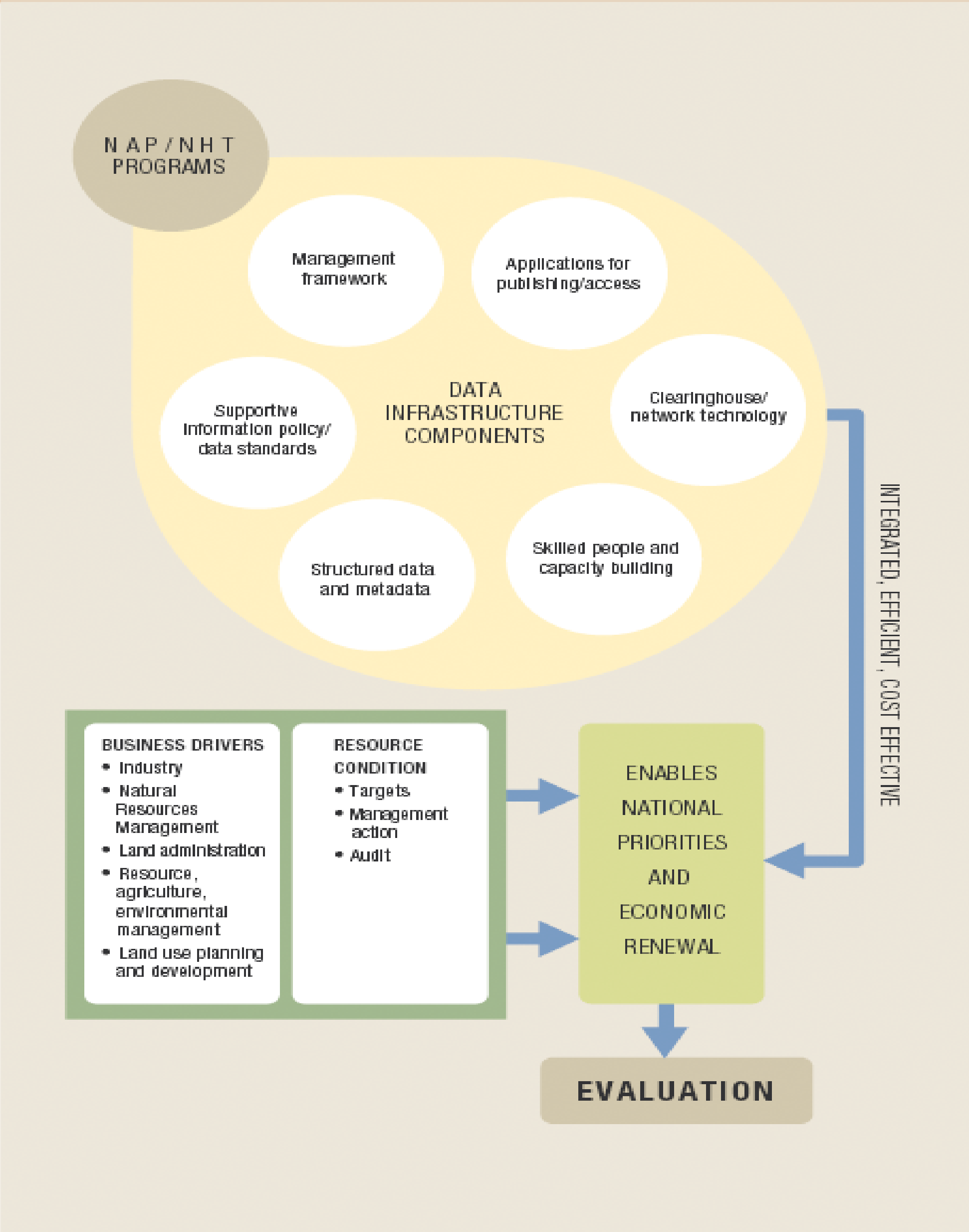
Without an integrated solution …	This results in …
Data are dispersed within and among organisations	■ difficulty accessing the data
Data are collected and stored according to different standards	■ incompatibility among datasets of similar themes and subject matter within and among organisations ■ large databases with limited usefulness ■ difficulties integrating data from other locations or with other themes ■ data not being useable with some computer technology
Data are collected for a single purpose	■ a fragmented database ■ gaps in coverage or overlapping coverage ■ increased costs ■ lost opportunity and lost investment
Data are poorly documented and publicised	■ limited or no availability to potential users ■ data collection duplication where data already exists
Management cannot set up information policies for access and use of data	■ multiple 'owners' and a 'silo' mentality that is not conducive to sharing or partnership ■ difficulty in setting priorities for data management and systems development ■ information is not treated as a corporate resource (like financial resources and human resources)
Focus on 'high-end' solutions for specialists	■ most management and staff not having the simple tools they require to access and use the information ■ focus on advanced analysis, not on information presentation for decision making, monitoring or evaluation ■ the readily available, up-to-date data from various sources, such as space-borne imaging is not usable by most

It is against this background that the Audit and ANZLIC are promoting an integrated information management solution, and in particular the development of a **Natural Resources Information Management Toolkit** aimed at an integrated set of practical guidelines suitable for immediate use in implementing best practices in information management in NRM projects.

1.4.1 Need for integrated information management and a data infrastructure

An integrated information management solution successfully combines leadership, people, computer hardware and software, applications, and data into a framework or infrastructure that ensures the appropriate tools and rules are in place to maintain data and turn them into useful information products to support operations and decision making (Figure 1–3).

Figure 1–3 Effective tools and technologies are one component of an integrated information management solution.



An integrated information management solution is needed for two key reasons:

1. management capability
2. value and cost.

Management capability

Public and private sector policy, planning, decision making and action all rely on good data and supporting systems. If the data and systems are not in place, management capability and economic growth do not meet their maximum potential.

An integrated solution ensures that good data are accessible and that the appropriate applications are in the hands of the people who need them. An integrated solution also provides opportunities to do new things, and to improve the way current activities are done, in ways currently not foreseen or possible.

Value and cost

Data—particularly geographic data—can be expensive to collect, manage and maintain. The integrated system's framework and mechanisms enable and promote the sharing and distribution of data, thus reducing costs and increasing their value. An integrated system also promotes the development and acceptance of standards through the use of common data systems and a participatory information management structure. This also reduces costs and increases the value of the data.

1 ⏩ 2

Develop spatial information management plan including resource needs: human resources, budget allocations and required technologies. The plan should be closely tied to business drivers and be developed with ongoing governance in mind.

1.5 Components of an integrated management solution and spatial data infrastructure

As mentioned previously, a number of elements are involved in the development of an integrated information management solution and the development of a spatial data infrastructure (SDI) to assist NRM. It should be noted that each jurisdiction normally has its own specific guidelines, policies and protocols.

The latest information on the development of the Australian Spatial Data Infrastructure (ASDI) is available on the ANZLIC web site: http://www.anzlic.org.au/infrastructure.html

A copy of the ANZLIC Action Plan for implementing the Australian Spatial data infrastructure is available for download from the ANZLIC web site: http://www.anzlic.org.au/publications.html

Additional information is presented in Section 1.4 of this module.

The following information is a guide to assist regional groups.

1.5.1 Management and organisation framework

Leadership

Examination of successful NRM initiatives at a regional level reveals that all have a senior management authority and/or leadership present at some stage during the development and implementation of the project. Leadership is required to ensure that activities in the development of a data infrastructure remain coordinated and focused. An overarching vision or goal to which all partners subscribe is important. The designation of a lead agency among the partners, with dedicated resources able to provide coordinating mechanisms, is a key ingredient to expediting development. An additional leadership role is to maintain enthusiasm and continuously promote the vision and goals. In this sense leaders often act as 'champions' to ensure success.

Leadership is especially important in the initial stages of implementing an integrated management solution at regional locations.

Sample organisational models/responses

Several organisational models are possible for implementing an integrated management solution, however often one is more suitable than another based on specific circumstances, mandates or drivers, namely:

Partnership

- typically business driven
- supportive policy environment for data access and sharing

Data utility

- given authority by government to create and maintain framework data
- services and profit stem from this model

Committee

- multi-department/organisational membership with staff undertaking specific roles of implementation

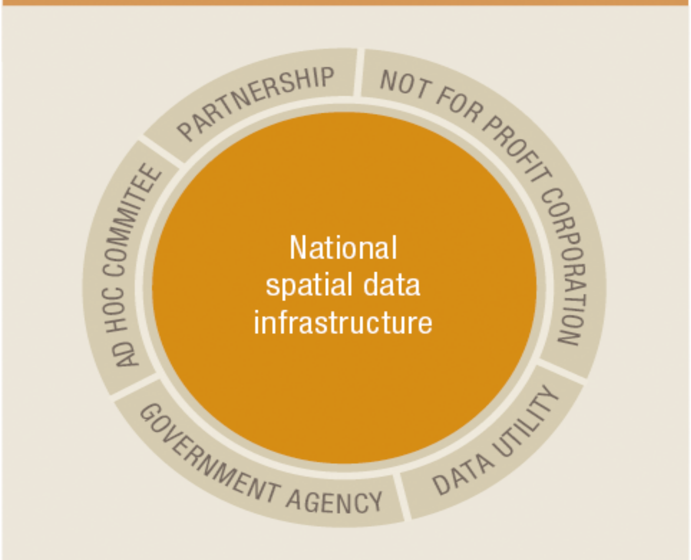
Non-profit corporation or bodies

- separate from government with broad participation by board of directors
- frequently has some form of enacting legislation

Government agency

- responsibilities given to lead government agencies to enact

Figure 1–4 Sample organisational models.



Steering committee/board of directors

The adoption of an integrated management solution and establishment of a data infrastructure often involves the creation of organisational responses such as a data utility and policy/standards group. To be effective some formal arrangement is required (in the form of a steering committee or board) to oversee implementation and provide vision, direction and approval of resources. In general, such a committee has overall direction authority, and is the key body in ensuring that products and services reflect the expectations and needs of the organisations and user groups they serve.

Typical roles for such a committee or board involve the following:

Partnership development and policy framework

The steering committee or board is responsible for driving the development of data sharing and co-maintenance policies/directions and its membership should reflect any partnerships in the implementation.

Communication/participation

Steering committee members should be responsible for 'championing' the adoption and use of the system components within and beyond their organisation or group. They should also ensure their organisation or agency participates in the development of communication materials in support of the integrated management solution.

Data standards

The steering committee should be responsible for approving authority for data standards used by the system/partnership, and ratifying any data standards processes.

System requirement priorities

As well as setting priorities for new system requirements, the steering committee should also be responsible for determining any new requirements.

Data collection and maintenance priorities

The steering committee should assist in ratifying new business processes that maintain the framework databases, e.g. sharing and incorporation of information gathered by agencies to support their ongoing work. It should also be responsible for setting priorities related to data capture, cleaning and maintenance. The steering committee should also be aware of and adhere to over-arching policies as part of wider initiatives at the Australian, state or territory government levels.

Training

The steering committee should participate in the determination of training needs to build capacity within the various partners to more fully benefit from the overall implementation of the system.

1.5.2 Training and expertise

Training and development

The development of an integrated management solution and data infrastructure needs to be accompanied by a training strategy to build and sustain capacity.

One of the key lessons learnt from past initiatives is that not enough attention has been given to capacity building and the development of corporate knowledge bases (and use of simple viewing tools) that enable data and information to be readily available for all partners and stakeholders via a range of publishing media, e.g. the internet.

The following key elements should be considered:

- identification of skills and training needs required to implement an integrated management solution
- specific capacity in SIS concepts and software training may be required along with training in application development, system and network administration, database development and maintenance, and program management
- development of a suite of standard and custom products and services often improves efficiency and effectiveness.

Further information on training and recruitment for acquiring skills in spatial information management is provided in *Module 8: Enhancing capability for using spatial information*

Inventory of skills

The establishment of an inventory of skills amongst key partners involved in the development of regional plans for NRM is one method of determining training or educational priorities. In this regard the use of a questionnaire may assist to rapidly obtain information from each partner. (Refer Module 8 for additional information on training)

Spatial information systems expertise

Obtaining high quality professional SIS expertise is often difficult and relatively expensive—a fact that is common to both city and regional locations. In many situations it is not appropriate to have access to full-time SIS professionals within an organisation. There are examples where the establishment of 'collaborative' resource information centres has proven to be very effective in developing databases and providing products and services to a range of partners or clients, as it reduces the requirement that all agencies have expertise within their organisation.

The introduction of standards (e.g. file naming conventions, metadata and protocols for data sharing) and simple visualisation tools are assisting to make it much easier for people to obtain access to, and use, spatial information. As a result, casual users familiar with basic desktop computer programs can now undertake tasks such as displaying spatial information and making a map.

Focal Points

A key part to the successful implementation of an integrated management solution involves having a local focal point for the development and implementation of a number of component activities, including the following roles:

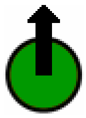
- communication—providing and disseminating information among government agencies, key stakeholder groups and partners, as well as other clients such as local business, individuals and the media

- technology support, planning and implementation
- support to management and steering committee/board of directors; identification of issues, facilitation etc.
- development of information products and services, such as standard maps, data distribution CDs and web-based mapping applications
- training and capacity building
- mediation and independent advice.

1.5.3 Information policy

Information access policy considerations

Access to accurate and up-to-date data in a timely fashion is critical to the successful management of natural resources. Many people involved in the development of SIS and database activities have experience of being refused access to data. In many cases this is a result of an absence of policy relating to the provision of data to other users, or an explicit restriction on providing the dataset.



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Develop formal measures to demonstrate the contribution of spatial information to business process efficiency including external benchmarking.

A number of key information policy issues need to be addressed:

Cost

Consideration needs to be given to the cost of providing data versus the cost of providing access to data. In many cases some users only want access to view data as opposed to actually obtaining a copy of the dataset in a format that can be used and manipulated within SIS or database programs.

Cost can be both a barrier for the user to acquire certain datasets, as well as for the provider to supply data in the format or extent requested. In many situations a case exists for low or no cost to acquire data that has been captured using public funding. However this needs to be considered in relation to some situations where the absence of a homogenous policy around cost recovery by public agencies can inhibit the flow of data and information even more. Higher prices for data are likely to limit distribution and access.

Format

Format issues are of particular concern, including that in which the data are stored (e.g. a satellite image may be stored in a number of different image file formats), and the media on which the dataset is stored (e.g. CD-ROM or DVD). It should also be noted that technology is making many formats obsolete in a very short time (e.g. the 5'' disk was very common a number of years ago but is hardly used at all today).

System design

System design issues must consider how they provide access, especially where certain records contain elements of information that need to have restricted distribution.

Copyright

Copyright and intellectual property rights need to be addressed as part of an information access policy. Note: Policies for copyright and intellectual property rights can be complex to develop, however useful models and templates are available (refer to web links provided at Section 1.6 of this module).

Privacy

When collecting data it is important to clarify what is private and what is to be made available in the public domain. In some cases specific data such as the age structure, species and production figures for a forest compartment may not be available to the public, however, a map (or SIS layer) of the forest concession boundaries may be freely available.

Privacy legislation normally requires that personal information be made available to the person, and that it be protected from others. Clear parameters are needed for personal information. The following is a guide for the collection of new data as they relate to privacy:

- justify the need for the personal information to be collected
- provide notification of any secondary use of such information
- maintain an index of all databases containing personal information
- provide individuals with the opportunity to verify the accuracy of the information—including a means by which the individual can have inaccuracies dealt with.

ANZLIC's Guideline for Privacy is available online from the ANZLIC website at http://www.anzlic.org.au/policies.html

Liability

Liability involves how protected an organisation is from legal recourse. This is very important in the area of data and information management especially where damage is caused to an individual or organisation as a result of misuse or inaccuracies in the data. Liability is often dealt with using end-user agreements and licences. As a guide, accuracy should always be reflected in the metadata. This is one reason why metadata are very important when data are made more widely available.

Summary of current ANZLIC information management policies

ANZLIC and the Audit believe that the nation is best served by data management policies that encourage and facilitate the use and integration of data and that price should not be an impediment to the transfer of data. Where possible, prices should be established at the lowest level (i.e. free or the cost of transfer) to encourage efficient and effective use, avoid duplication and overlap in data collection and maintenance, and promote data integration.

The ANZLIC website has a number of guidelines suitable for use as templates in the development of policies and protocols at a regional level.

To date ANZLIC has developed:

- Guidelines for Custodianship (of spatial data)
- Policy Statement on Spatial Data Management
- Metadata protocol and standard metadata profile
- Guiding Principles for Spatial Data Access and Pricing Policy
- Privacy guidelines for spatial information
- Access to Sensitive Spatial Data, and is currently developing liability guidelines.

More information about ANZLIC's policies and guidelines is available online on the ANZLIC website at: http://www.anzlic.org.au/policies.html

1.5.4 Partnerships

The development of an integrated management solution and data infrastructure presents many opportunities for partnerships. Information access enables groups and partners to do things in new ways, provide new services and information products, and reduce the reliance on traditional approaches.

A single agency or organisation is unlikely to have all the resources, skills and knowledge required to undertake the development of all aspects of a data infrastructure and implementation of an integrated management solution. Having organisations and partners working together from the outset is vital to ensure activities occur in a way that supports all the partners in their use of data. It also means that a greater amount and wider range of resources are incorporated in the development process. In this respect the involvement of both public and private partners, as well as academic/educational groups and individual experts, in a consortium approach often yields the best results.

There is a range of mechanisms for the development of partnerships, as outlined in *Module 6: Project management and justification – lessons learnt, pitfalls and best practice procedures*. Importantly, Module 6 outlines the benefits found internationally for working with all levels of government on shared spatial information issues and problems.

Module 11: Partnerships and working together – the potential for collaboration outlines the potential approaches to developing partnerships with other local governments and/or private partners on spatial information management.

1.6 Additional support

Considerable resource material related to NRM programs, the development of spatial data infrastructures and the establishment of resource information centres is available on the web. Following are some selected examples.

1.6.1 Material on Australian Government investment programs

Caring for Our Country: http://www.nrm.gov.au/

National Action Plan for Salinity and Water Quality:

http://www.napswq.gov.au/napswq/index.html

Natural Heritage Trust: http://www.nht.gov.au/

1.6.2 Material on spatial data infrastructures and policies

General resource material

'Snapshot of SDI Development in Australia':
http://www.geom.unimelb.edu.au/research/publications/IPW/024_Warnest%20REF.pdf

ANZLIC policies: http://www.anzlic.org.au/policies.html

Australian Spatial Data Infrastructure (ASDI): http://www.ga.gov.au/nmd/asdi

Global Spatial Data Infrastructure (GSDI): http://www.gsdi.org

US Federal Geographic Data Committee (FGDC): http://www.fgdc.gov

Survey of national and regional spatial data infrastructure activities around the globe:
http://www.spatial.maine.edu/~onsrud/GSDI.htm

GSDI Cookbook: http://gsdi.org/gsdicookbookindex.asp

State and territory spatial data infrastructure activities

Queensland: http://www.qsiis.qld.gov.au and http://www.nrw.qld.gov.au/about/index.html

Western Australia: http://www.walis.wa.gov.au and the Shared Land Information Platform (SLIP) http://spatial.agric.wa.gov.au/slip/

New South Wales: http://www.canri.nsw.gov.au/policies plus the natural resources information management strategy http://nrims.nsw.gov.au/

Tasmania: http://www.dpiwe.tas.gov.au and http://www.thelist.tas.gov.au/

Australian Capital Territory: http://www.actpla.act.gov.au/tools_resources/maps_land_survey

Victoria: http://www.land.vic.gov.au/land/lcnlc2.nsf/FID/-869AEC581C5361B84A256C390082E029?OpenDocument#VSDD and Victoria's Resources Online http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/naturalresources-home

Northern Territory: http://www.ntlis.nt.gov.au

South Australia: http://www.environment.sa.gov.au/mapland/sicom/ and http://www.environment.sa.gov.au/mapland/

See also material in local tab section for additional information.

Examples of spatial data infrastructure projects

Australia

Herbert Resource Information Centre: http://www.hric.org.au/hric_site/hric.asp

Overseas

General: http://www.gsdi.org/

Canadian Geospatial Data Infrastructure: Aims to be a source of geospatial information and services in Canada: http://www.geoconnections.org/publications/Technical_Manual/html_e/toc.html

INSPIRE: The Infrastructure for Spatial Information in Europe: http://www.ec-gis.org/inspire/

As is the case in many countries, the general situation on spatial information in Europe is one of fragmentation of datasets and sources, gaps in availability, lack of harmonisation between datasets at different geographical scales, and duplication in collection of data and information. These problems make it difficult to identify, access and use data that are available.

Fortunately, awareness is growing at national and EU levels about the need for quality geo-referenced information to support understanding of the complexity and interactions between human activities and environmental pressures and impacts. The INSPIRE initiative intends to trigger the creation of a European spatial information infrastructure that delivers integrated spatial information services to the users. These services should allow the users to identify and access spatial or geographical information from a wide range of sources (from the local to the global level) in an interoperable way for a variety of uses. The target of INSPIRE includes policy-makers, planners and managers at European, national and local levels and the citizens and their organisations. Possible services are the visualisation of information layers, overlay of information from different sources, spatial and temporal analysis, etc.

1.6.3 Example GIS needs assessment

http://www.fgdc.gov/grants/2004CAP/2004FinalReport/184-04-3-ME-ReportFinal.pdf

1.6.4 Material on capability-raising frameworks

Capacity Building Resource Manual—developed by the Australian Cooperative Venture for Capacity Building, this manual provides a framework for practitioners to develop, implement and evaluate capacity-building projects and activities. It includes case studies to illustrate the framework and the theory of capacity building, and provides additional references about capacity building:
http://www.rirdc.gov.au/reports/HCC/07-102sum.html
Download the report: http://www.rirdc.gov.au/reports/HCC/07-102.pdf

Federal Government Public Service Commission building organisational capability material: http://www.apsc.gov.au/buildingcapability/index.html including the Building capability: A framework for managing learning and development in the APS at:
http://www.apsc.gov.au/publications03/capability.htm

1.6.5 Material on establishing collaborative resource information centres

The Herbert Resource Information Centre has material available online about Collaborative Resource Information Centres.

Collaborative Resource Information Centres: Guidelines for Establishment and Management

Web reference: http://www.hric.org.au/hric_site/downloads/hric_pub/cric_kit/Guidelines.pdf

Collaborative Resource Information Centres: Resource Kit

Web reference: http://www.hric.org.au/hric_site/downloads/hric_pub/cric_kit/Resource%20Kit.pdf

Collaborative Resource Information Centres: Australian Spatial Data Infrastructure Project

Web reference: http://www.hric.org.au/hric_site/downloads/hric_pub/cric_kit/ASDI_proj.asp

MODULE 2

MODULE 2: Data Management Principles

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

All agencies, departments and resource centres collect, create, store and utilise data in some form—most of which has been obtained at considerable cost. It has been estimated that 90 per cent of the costs of establishing a GIS can be attributed to the development of the thematic datasets, and that in excess of 80 per cent of all data have some geographical components and can therefore be referenced to geographical locations such as points, lines or areas.

Experience reveals that treating data as long-term assets and managing them within a coordinated framework produces considerable savings and ongoing value.

Most jurisdictions throughout Australia have established policies governing access and use of data and information, along with custodianship guidelines and information management strategies. Proper processes and procedures for data and information management are the foundation of an efficient management system.

This guide provides background information on 'best practice' for managing data as assets and valued resources. The primary audience is those responsible for managing spatial data and information, although the principles described are equally applicable to other types of data.

Policies and procedures are required to guide the transition from tactical, project-based data collection and management to a strategic information infrastructure that will inform decision making on a wide range of issues. In many situations data are incomplete, not easily accessible, not up-to-date, and often lack any documentation on accuracy and reliability. As such, utilising the data outside of the immediate discipline or agency that collected them can be difficult.

Module 2: Data management principles provides a framework within which the activities of data collectors, managers and information providers can be integrated.

If organisational management is convinced that the tangible benefits from investing in data management outweigh the costs, then it will be given the priority it requires.

Actions

Managers should focus on the need to achieve an integrated information management solution. Such a solution would successfully combine leadership, people, computer hardware and software applications and data into a framework ensuring the appropriate tools and rules are in place to maintain the data and turn them into useful information products in support of operations and decision making.

The goal will be achieved through the formalisation of an infrastructure, production of guidelines, and the development of standards and procedures to support data management and processing. Managers should facilitate the development and implementation of a data policy which addresses the following key elements:

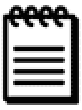
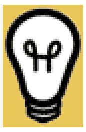
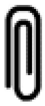
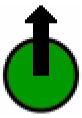
- creation of an easily accessible data system which can efficiently disseminate data collected as part of project activities to the widest range of users
- development of core datasets as baseline products
- provision of 'best practice' quality assurance mechanisms and procedures to produce validated, well-documented datasets that meet priority information requirements
- archiving of all data collected to ensure their availability for multiple use and to safeguard the investment for future use
- improvement of the effectiveness and efficiencies of policy and program development through the coordination of data and information activities
- provision of timely and up-to-date data and information products to support a wide range of activities.

Acknowledgements

This module draws heavily on material produced by the UK Intra-governmental Group on Geographic Information working group on Principles and Practice of Geographic Information Data Management. The source of this material is duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

2.1 Introduction

2.1.1 What is data management?

This document addresses the key aspects of data management giving consideration to the following ‘guiding principles’:

- Don’t re-invent the information management wheel.
- Where possible capture data once for multiple/generic use.
- Avoid duplication in data acquisition—share and co-operate wherever possible.
- Use existing systems/facilities wherever possible.
- Manage data to maximise their value both during and after the project that they were collected for.
- Give priority to the broadest value data—of benefit to multiple processes.
- Develop and implement metadata standards and documentation procedures.
- Where possible develop and implement (or adopt existing) data publishing standards.
- Contribute to long-term strategic goals for data and information management
- Select the most robust organisation with the broadest span of interest as the most appropriate custodian of high-value general use information.
- Reinforce and support data custodians and where possible negotiate access.

2.1.2 Guiding principles

The term ‘data management’ embraces the full spectrum of activities involved in handling data, including:

- data policy
- data ownership
- data documentation and metadata compilation
- data quality, standardisation, harmonisation and audit
- data life-cycle control
- data custodianship
- data security and access constraints
- data access, data sharing and dissemination/licensing arrangements
- data publishing.

1 ⏩ 2

Individual people or departments have documented data management processes, policies and procedures. Use the sections in Module 2 as a guide to link the documentation of processes, policies and procedures to actual business processes within an NRM region.

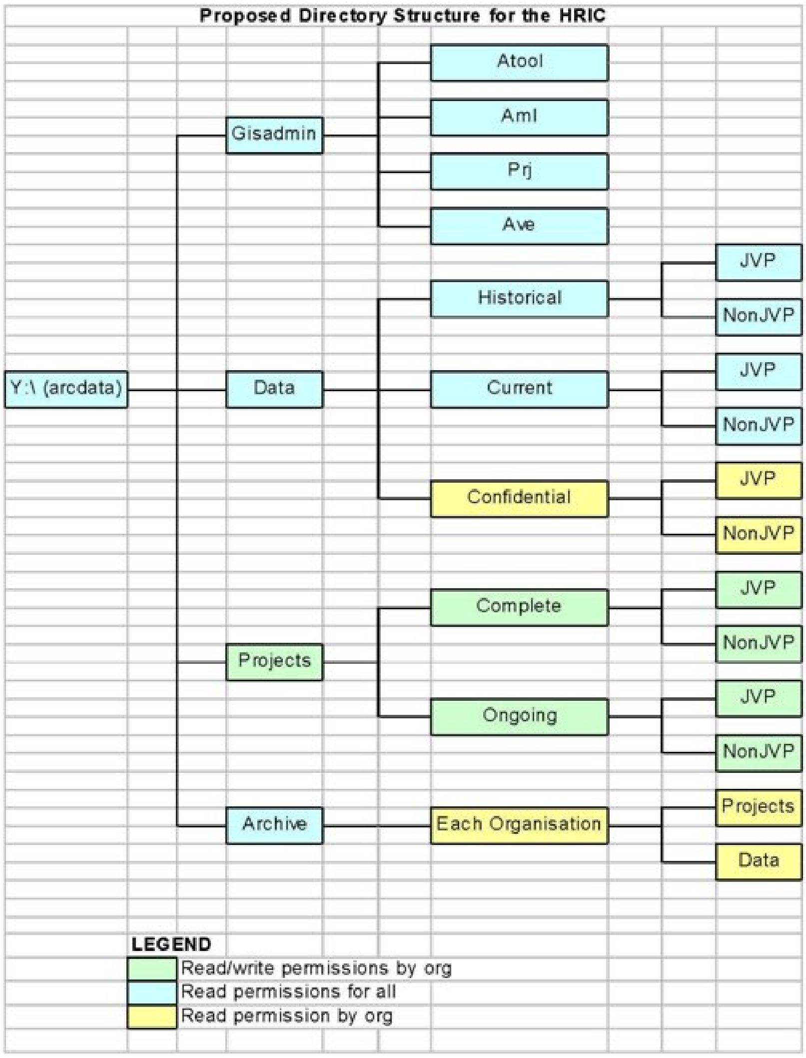
2.2 Why do we need to manage data?

Most government projects and agencies own large amounts of data and information which have potential benefit for a wide range of user groups. All groups and agencies suffer from limited resources and as a result are under increasing pressure to maximise efficiency and effectiveness wherever possible. As such, expenditure on data should be used effectively and data sharing arrangements established for data capture (e.g. field survey/monitoring) or acquisition (e.g. satellite imagery). In practice NRM groups often hold data covering numerous themes from a variety of sources. This can lead to data management issues and inefficiencies if not dealt with in a structured fashion. The following information provides guidelines to assist in managing data in an efficient and effective manner.

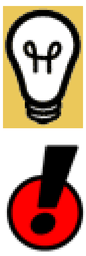
2.1.3 File naming conventions and directory structure

To be efficient, data managers need a file structure and naming convention that is practical and reflects the nature of the agency's or group's core business. If the majority of the organisation's data are tiled (or map-sheet based) it is likely that a file and naming structure based on the tiles is used to store data. If the core business involves temporal (time-based) monitoring with regular updates, (e.g. every month a new dataset is produced) a file and naming structure that reflects the time series is more appropriate.

An example of a file naming and directory structure within an NRM setting from the Herbert Resource Information Centre's Data Principles and Guidelines publication is given below.



The Herbert Centre is a joint initiative with a number of partners including local government and industry. The above document can be found at the following web address: http://www.hric.org.au/hric_site/hric_info/Policies/Policies.asp.



Another important reason for effective and efficient management of data is to ensure the continuity of the corporate knowledge base. Management practices in the form of standards, protocols and procedures are required so others can find and utilise data. **Lack of adherence to simple data management practices can cause major problems if staff changes occur and new operators are not familiar with the existing system.** In many cases this can lead to data becoming 'lost', inaccessible or 'sterile' and therefore not usable, resulting in severely reduced value and return on investment. The costs of agencies maintaining out-dated or redundant datasets can be very significant.

Agencies that need to maintain data for historical purposes and regulatory requirements may require special archiving practices to reduce maintenance and storage overheads.

2.1.4 Key drivers for improved data management

There are many factors ‘driving’ the need for improved data management including:

- the strong direction from the Australian, state and territory governments to improve services and make more effective use of resources
- increasing recognition that data collected at public expense must be properly managed to make them accessible to the public, to realise their potential and justify their considerable production and maintenance costs
- increasing pressure from customers for easier and quicker access to the right data and information to be made available at little or no cost
- increased focus within organisations and governments on the need to rationalise and combine data in order to improve efficiency and add value
- data publishing standards to assist in the development of seamless, consistent datasets between jurisdictions
- controls required by data owners governing the use of their data to safeguard intellectual property rights and to maintain confidentiality of sensitive data.

Regardless of the specific business context, most agencies and NRM regional bodies producing data will be judged on the ease with which the data and information are made available, as well as the quality of the information. Those able to publish, share, access, integrate and use information will benefit most.

2.1.5 Statutory requirements for data and information management

NRM regional groups, state/territory and local governments may be required by law to collect, manage and archive datasets in particular ways. Statutory obligations may be placed on the type, frequency and extent of archiving required. Given that these requirements may vary across jurisdictions (e.g. database on noxious weeds or invasive animals) it is recommended that NRM groups contact the relevant state or territory agency to clarify any statutory requirements for data and information management.

For example, in Western Australia the State Records Act (2000) requires that a records management plan—outlining archiving practices—is produced by all government agencies. To facilitate the process the Western Australian State Records Commission produced a self-evaluation guide to assist agencies in developing such a plan. Likewise the Australian Capital Territory ‘Territory Records Office’ has a dedicated website providing extensive guidance on developing record keeping policy and programs as part of the Territory Records Act 2002. Refer: http://www.territoryrecords.act.gov.au/.

2.1.6 Benefits of good data management

Data management policies and procedures ensure that data are treated as valuable assets. Implementing such policies and procedures yields many benefits. In general the benefits of good data management are reflected through:

- **Better decision making:** Ready access to existing spatial data is essential for many decision-making tasks such as protecting the environment, development planning, managing assets, improving living conditions, and national security. This leads to improved decisions being made at local, regional, national, and global levels on issues of environmental, economic, and social importance.
- **Maximising use:** Ready access to NRM regional groups' and other agencies' data will encourage more extensive use of a valuable public resource for the benefit of the community.
- **Avoiding duplication:** By sharing data the need for separate bodies to collect the same data will be avoided resulting in significant cost savings in data collection and maintenance.
- **Maximised integration:** By adopting common standards for the collection and transfer of data more integration of individual and often disparate databases is possible.
- **Custodianship:** The identification of custodians for the principal datasets enables users to identify those responsible for implementing prioritised data collection programs and developing data standards.
- **Equity of access:** A more open data transfer policy ensures better access by the whole community.
- **Security and access constraints:** Data is accessible only by those authorised to do so ensuring integrity and confidentiality where required.
- **Communication:** Communication on many levels (even program goals, objectives and results) is enhanced.
- **Improved data publishing efficiencies:** Adherence to standards and procedures streamlines data publishing activities making it more efficient for others to utilise existing datasets.
- **Partnership and new business process opportunities:** Value-added benefits created by providing new (and often unexpected) services to the user community.

2.3 Principles of good data management

2.1.7 Data policy

The first step for any organisation or NRM group wishing to implement good data management procedures is to define a data policy. This is a set of broad, high-level principles which form the guiding framework in which data management can operate. In most cases these have been identified at national and state or territory levels and can be readily adopted by NRM groups. See Section 2.4 for further information on establishing a data policy.

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Business processes are reviewed to ensure compliance with an organisation's or NRM regional body's documented data management processes, policies and procedures.

2.1.8 Data ownership

A key aspect of good data management involves the clear identification of the owner of the data. In most cases this is the NRM regional body or organisation which originally commissioned the data and has managerial and financial control of them. The data owner generally has legal rights over the data, along with copyright and intellectual property rights. This applies even where the data are collected, collated or disseminated by another party by way of contractual agreements, etc.

Data ownership implies the right to exploit the data, and in situations where the continued maintenance becomes unnecessary or uneconomical, the right to destroy them. Ownership can relate to a data item, a merged dataset or a value-added dataset. Intellectual property rights can be owned at different levels, e.g. a merged dataset can be owned by one organisation, even though other organisations own the constituent data. If the legal ownership is unclear, the risk exists for the data to be wrongly used, used without payment of royalty to the owner, neglected or lost.

All data, information and knowledge must have an 'owner' so, in this sense, whatever is produced by an agency or group must have an 'owner'.

As such, it is important for data owners to establish and document the following:

- the ownership, intellectual property rights and copyright of their data so they are safeguarded
- the statutory and non-statutory obligations relevant to their business to ensure the data are compliant
- the policies for data security, disclosure control, release, pricing and dissemination

- the agreement reached with users and customers on the conditions of use, set out in a signed memorandum of agreement or licence agreement, before data are released.

It is important to ensure data ownership information is included within the metadata description and related data documentation.

2.1.9 Data documentation and metadata compilation

All datasets should be identified and documented to facilitate their subsequent identification, proper management and effective use, and to avoid collecting or purchasing the same data more than once.

To provide an accurate list of datasets held by the NRM regional body or organisation, a catalogue of data should be compiled. This is a collection of discovery level metadata for each dataset, in a form suitable for users to reference. These metadata should provide information about the content, geographic extent, currency and accessibility of the data, together with contact details for further information.

All business-related datasets, once catalogued, should also be documented in a detailed form suitable for users to reference when using the data. These detailed metadata should describe the content, characteristics and use of the dataset, using a standard detailed metadata template.

2.1.10 Data quality, standardisation, harmonisation and audit

Good data management ensures datasets are able to successfully meet current needs and are suitable for further exploitation. The ability to integrate data with other datasets is likely to add value, encourage ongoing use of the data and contribute to recovering the costs of collecting the data.

To maximise the potential and use of datasets, NRM regional bodies and organisations should:

- use standard data definitions and formats
- define quality standards and apply the appropriate validation processes to each dataset
- ensure that data are quality assured and approved as fit for purpose before use or release
- encourage the use of appropriate state, national and international standards, in particular those which are relevant to geographic information.

ANZLIC has prepared a suite of inter-related policies and guidelines aiming to assist organisations achieve 'best practice' in spatial data management. This includes:

- ***Guidelines for Custodianship of spatial data***

- ***Policy Statement on Spatial Data Management***
- ***Metadata protocol and standard metadata profile***
- ***Guiding Principles for Spatial Data Access and Pricing Policy***
- ***Privacy Guidelines for Spatial Data***
- ***Access to Sensitive Spatial Data***

ANZLIC is currently developing or updating guidelines about 'liability'.

ANZLIC's guidelines and policies are available at:

http://www.anzlic.org.au/policies.html

An example of using processes for improving data quality from the Glenorchy City Council is provided at Attachment 2–1. This council is using a procedural approach to 'cleanse' its spatial data which ensures both accuracy and consistency of use.

2.1.11 Data life-cycle control

Good data management requires the whole life cycle of data to be managed carefully. This includes:

- business justification, to ensure consideration has been given to why new data are required, as opposed to existing data being amended, how data can be specified for maximum use including the potential to meet other possible requirements, and why the costs of handling, storing and maintaining the data are acceptable and recoverable
- data specification and modelling, processing, database maintenance and security, to ensure that data will be fit for purpose and held securely in their own databases
- ongoing data audit, to monitor the use and continued effectiveness of existing data
- archiving to ensure data are maintained effectively until they are no longer needed or are uneconomical to retain.

2.1.12 Data custodian

A number of focal points often exist within government agencies and NRM groups where data are gathered, compiled and analysed as part of the normal course of business. Each jurisdiction has a role to undertake in managing the data over and above the responsibilities of data owners.

An appointed agency, group or position (not a person, as the responsibility should remain with the position if an individual transfers to another job) is given formal responsibility to act as custodian of each major dataset by the owner. This agency, group or position should be made responsible and accountable for the management and care of the data holdings under their control, in line with the defined data policy.

2.1.13 Data access and dissemination

This aspect will depend on the business and financial policy of the organisation or NRM group, however as a guide the following information is provided:

- Public access to data should be provided where possible
- Access to data should be granted to customers and commercial organisations when the request complies with the organisation's, group's or resource centre's business strategy, and does not infringe on any copyright or intellectual property rights, or any statutory or non-statutory obligations
- The right to use or provide access to data can be passed to a third party subject to agreed pricing and dissemination policies.

Within the NRM sector, ANZLIC and the Audit have developed a Data Access and Management Agreement signed by all jurisdictions in September 2001. The agreement provides for consistent access arrangements to datasets held by the Audit and its jurisdictional partners—refer: http://www.anzlic.org.au/get/2375374673.

2.4 Establishing a data policy

The Australian and state/territory governments have overarching policies which govern data management practices. The following information provides a guide to assist regional groups in establishing a data policy statement.

2.1.14 Data acquisition

- All projects and activities, which give rise to substantial datasets should establish at the outset whether suitable data already exists in a potentially usable form, or whether new data need to be acquired.
- Prior to data collection activities being approved, the project must establish how the data will be acquired, who will be responsible for full exploitation of them and, how the benefits will be maximised and shared.
- Subsequent data handling and storage needs must be considered and plans put in place ensuring databases are maintained in such a way that maximum use can be made of them.
- Consultation should be carried out with respective state, territory and Australian government representatives to determine the correct protocol, methodology or

classification procedures to use. In many cases specific guidelines for data collection and management are available.

Examples include: Salinity Mapping Methods in the Australian Context: User Guide available from the internet: http://www.nrm.gov.au/publications/salinity-mapping/index.html Guidelines for land use mapping in Australia: http://adl.brs.gov.au/mapserv/landuse/nat_scale_tec.html Surveying and Mapping Nationally Significant Weeds: http://www.affashop.gov.au/PdfFiles/pc13456.pdf

2.1.15 Fitness for purpose and point of truth

- Prior to using any dataset it is recommended the user undertake an assessment to determine the appropriateness of the dataset, or fitness for purpose, for the intended use. This involves assessment of such criteria as scale, resolution, accuracy, classification system and integrity of the dataset.

- Where possible (especially where more than one version of a dataset exists) users should obtain clarification from relevant state or territory jurisdictions to determine the authoritative, or point or truth, dataset. Using outdated or unofficial datasets for certain themes can lead to major problems in analysis and a lack of interoperability and integration with other datasets. For example, the IBRA Region dataset for Australia has undergone a number of revisions. Similarly the NRM regional boundaries have been changed over time. Users need to make sure they have the most recent dataset for their analysis.

2.1.16 Data care (custodial duties)

- Databases should be managed closely, with clear responsibility for custodianship established and individuals made accountable for ensuring data custodian procedures are followed.

- Data should be held securely in their own database, and adequate provision made for their long-term care. Disaster recovery and back-up procedures should also be in place.

- All data should be validated and quality assured prior to being used or archived.

- Easy access should be given to data holdings, both for staff and bona fide external customers and users.

- Data which are not required to be retained (for legal reasons or otherwise), should not be destroyed or put at risk without first exploring all possibilities.

Note: It is rare for natural resource thematic data to be destroyed.

2.1.17 Data use and exchange

- Memoranda of agreements or licence agreements (with respect to the subsequent use of the data) should be established with users and customers who receive data. These should include confidentiality declarations and conditions of use.

- Intellectual property rights should be protected in relation to any development of information, by specifying any restrictions on the use of the data in formal licensing arrangements.

- Adequate provision needs to be made for the widest possible public access to data and associated metadata.

- Pricing agreements should consider the cost of recovering the handling of data and information, in line with any policies or overarching obligations that may apply.

> ANZLIC and the Audit have developed a **model agreement** for use in NRM programs, which incorporates guidelines for custodianship, metadata, archiving, accessing, data licensing and pricing within an operational context. For information refer to the Model Data Access and Management Agreement: http://www.anzlic.org.au/get/2375374755.

2.5 Implementing data management – key roles and responsibilities

> To be successful, data management procedures must be implemented across the whole organisation under the guidance of a member of the executive board or committee**. It is often good practice to identify a data management 'champion' at this level who is prepared to take this role and see it through.** Other key roles are the data policy manager and the data custodians assigned to key datasets.

The following information is provided to help organisations and groups establish these key roles and implement good data management policies and procedures.

2.1.18 Data management 'champion'

The data management 'champion' is responsible for:

- Ensuring that policies on data management are in line with overarching policies and obligations at a higher level (e.g. state/territory)

- Directing the development, implementation and maintenance of the detailed data policies, standards, procedures and guidelines across the whole organisation or group

- Reporting progress to the executive board on the performance achieved against targets set for improvement in data quality, and the value gained from effective data management.

In some situations, especially those involving a number of sites, a data management steering group may also be required.

2.1.19 Data policy manager

The data policy manager may require the help of local data managers to undertake the following tasks:

- developing and maintaining the data policy statement and other corporate guidance
- appointing and monitoring the performance of data custodians
- issuing guidance and training activities for staff
- ensuring local practice in individual business areas meets the standards set for the whole organisation
- ensuring the organisation maintains a central metadata resource.

2.1.20 Data custodianship

Data custodians are responsible for ensuring the following minimum standards are applied for each dataset:

- The dataset must be documented in the catalogue following the standards for discovery metadata, to enable the ownership, intellectual property rights, custodianship and accessibility factors to be determined.
- The policy for exploiting the dataset and making it available to other parties must be agreed and documented.
- The dataset and its conditions of use must comply with all statutory and non-statutory obligations of the organisation and any overarching policies at a state, territory and Australian government level.
- The data must follow standard classifications and definitions where appropriate, and must comply with all relevant standards, codes of practice and other protocols.
- The data must be fully validated and quality assured with sufficient detailed metadata to enable their use by third parties without reference to the originator of the data.
- The data must be stored, managed and accessed in line with agreed data management and security/confidentiality policies.
- The release or use of data by internal and external users must be authorised with agreement to the conditions of use documented.

- The costs and benefits of continuing to maintain the dataset must be reviewed periodically.

2.6 Additional support

Considerable information on data management policies is available from respective state, territory and Australian government jurisdictions. Though not exhaustive the following web resources can be used as a starting point.

ANZLIC – a suite of Guidelines and Policies available at: http://www.anzlic.org.au/policies.html

State and territory material

Queensland: http://www.qsiis.qld.gov.au

Western Australia: http://www.walis.wa.gov.au/

New South Wales: http://www.canri.nsw.gov.au/policies/ with additional information on the NSW Information Management Framework available at: http://nrims.nsw.gov.au/policies/imf/index.shtml

Tasmania: http://www.dpiwe.tas.gov.au/

ACT: http://www.actpla.act.gov.au/tools_resources/maps_land_survey

Victoria: http://www.land.vic.gov.au/Land/lcnlc2.nsf/childdocs/F31E2DE1F7D75F504A256A4F0017DA3E?open

Northern Territory: http://www.ntlis.nt.gov.au/

South Australia: http://www.environment.sa.gov.au/mapland/sicom/sicom/index.html

Herbert Resource Information Centre – Guidelines and Policies: http://www.hric.org.au/hric_site/hric_info/Policies/Policies.asp

Information on data standards

For additional information on key data criteria refer to Toolkit *Module 4: Spatial data priorities, standards and compliance*.

2.7 Glossary

Data: A collection of facts, concepts or instructions in a formalised manner, suitable for communication or processing by humans or computer.

Data custodian: Organisation or agency with a specific guardianship responsibility for datasets. Their concern specifically relates to security and confidentiality requirements embodied in legislation, and they should be familiar with the access limitations and the quality of datasets under their control. Given that the custodian organisation does not necessarily have managerial or financial responsibility for the datasets under their control, they can be different agencies or groups from the data owner.

Data owners: Individuals or groups, who are responsible for the management and financial accountability of a dataset. Data owners also have legal ownership rights to the dataset even though it may have been collected, collated or disseminated by another party.

Data policy: A broad set of high-level principles forming a guiding framework in which data management can take place.

Information: Data that have been value-added, processed and interpreted. People work with and act upon information. *Geo-information* is a specific type of information that involves the interpretation of spatial data. It has been argued that it is the transformation of data to decision making which brings a level of understanding and knowledge, and the ability to make informed interventions to improve the management of natural resources.

Metadata: The summary information or characteristics of a set of data. In the area of geographic information or information with a geographic reference this generally means the what, who, where, when and how of the data.

Spatial Data: Data that have some positional (location) values related to them.

Attachment 2–1 Data cleansing approach of Glenorchy City Council

Note: the following example is taken from the local government spatial information toolkit. Its source is duly acknowledged.

The following discussion is from Graham Hammond—a GIS professional working in Glenorchy City Council in Tasmania—based on his previous experience in Maroochy Shire Council. Data cleansing is an interesting subject that provides an example of what local governments (and NRM groups) are working towards. The procedure is still in the planning phase and Graham has kindly provided the following example to demonstrate the ideas behind this increasingly important process.

What is data cleansing?

Data cleansing relates to the basic cleaning of spatial data and attribute data (things like removing gaps, overlaps, checking field names and data spelling, etc.).

At Glenorchy we are in the very early days of developing a data cleansing policy.

This process is long and costly. When a council starts looking at what data they have it becomes a very large job. We will probably only extend our cleansing to datasets regularly used, and then cleanse specific datasets as needed. The risk of litigation of not having clean data, and/or at least associated metadata describing their use and accuracy coupled with a licence agreement saying how they will be used, is getting greater, so most people need to bite the bullet, or accept the limitations of not doing it. Below you will find a draft on how we might proceed.

Data cleansing procedure (Draft Version 0.1)

1. ***Cleansing spatial data:*** (a little platform specific)—basic cleaning of spatial data and attribute data, removing gaps, overlaps, checking field names and data spelling, etc.
2. ***Directory structure and naming convention***

   (The important thing here is a 3-tiered process):

   a. Working directory—where you work on copies of data that will be cleansed to become the new data
   b. Validation and areas where the data are elevated to so the data steward can sign off on them being correct to the best of their knowledge.
   c. Repository—an area where completed data are located—this is where data should be used from (mapping or intranet/internet mapping). These data should be 'read only' to all but a small number of people.
3. ***Constructing metadata***
4. ***Assigning a data steward and custodian department***—a department or person who is responsible for the data. As most GIS people are just constructing or editing the data, the department who owns the data should be the steward. This means visually appraising the data and signing off that they think them correct.
5. ***Data maintenance plan***—no point cleaning them if no plan for maintenance. I envisage a procedure to allow for timely review of datasets, i.e. cadastre may need to be maintained weekly when other data can be archived and not maintained.
6. ***Data licensing***—each cleaned dataset must be covered by a licence agreement if used offsite.

MODULE 3

MODULE 3: Interpretation and Visualisation of Data - An Introduction to Spatial Information Systems

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Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

One of the prerequisites for natural resources management (NRM) involves the establishment and maintenance of a good database of information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making/planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis, standards, and communication are key components.

Under current arrangements, funding for NRM projects is increasingly being channelled from government agencies to regional groups, such as catchment management authorities and resource information centres.

In many situations regional groups are faced with the need to purchase spatial (or geographic) information system software. A spatial information system (SIS) is a computer system for capture (input), storage (management), analysis and display of spatial data, i.e. data that can be referenced according to location. Although an SIS is often thought of as a single piece of software, in reality, to be effective it should be considered as part of an information management system including procedures, operating personnel, data and hardware. In this context, an SIS is a computer system which facilitates the phases of data entry, management, manipulation and analysis and presentation.

Module 3: Interpretation and visualisation of data – an introduction to spatial information systems provides background material to assist regional groups obtain an understanding of spatial information systems and the visualisation of spatial data.

Actions

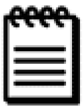
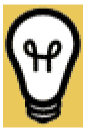
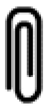
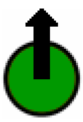
Managers should be aware of the basic operations of SIS applications and how they can support the management of natural resources. In addition, managers should be aware that a complete range of software is now available, starting with free-viewing applications (with limited functionality), through to high-end professional systems and web-based applications. As such, it is now possible for the whole community to have access to spatial data on desktop computers. An understanding of the basic functions of SIS will enable managers to more fully appreciate the benefits that can be realised from a fully integrated information solution incorporating SIS and spatial visualisation tools. In this sense, the whole community is now in a position to capitalise and leverage the benefits obtained from access to natural resource data, and the enrichment those geospatial data can bring to their profession. Numerous services are available to support this process, e.g. the Australian Natural Resources Atlas, the Australian Natural Resources Data Library, and various state-based clearing houses or data portals that enable access to spatial datasets.

Acknowledgements

This module draws heavily on material produced by the United States Geological Survey (USGS) especially as it relates to the text and graphics included at Sections 3.2 and 3.3. The source of this material is duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

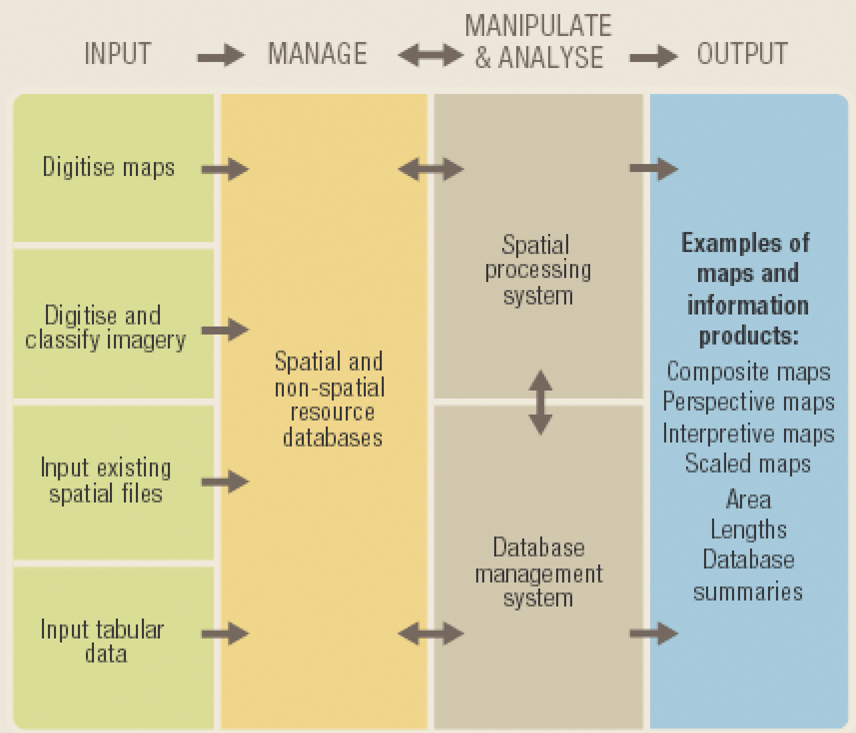
	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

3.1 Introduction

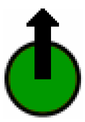
3.1.1 What is a spatial information management system?

A spatial information system (SIS) is a computer system for capture (input), storage (management), analysis and display of geographic data, i.e. data that can be referenced according to location (Figure 3–1).

Figure 3–1 Theoretical schematic for a spatial information system.



The use of a thematic layer approach makes it possible to organise the complexity of the real world into a simple representation to help facilitate an understanding of natural relationships.



Key staff and/or departmental sections demonstrate an understanding of spatial information systems, and their application to key NRM processes.

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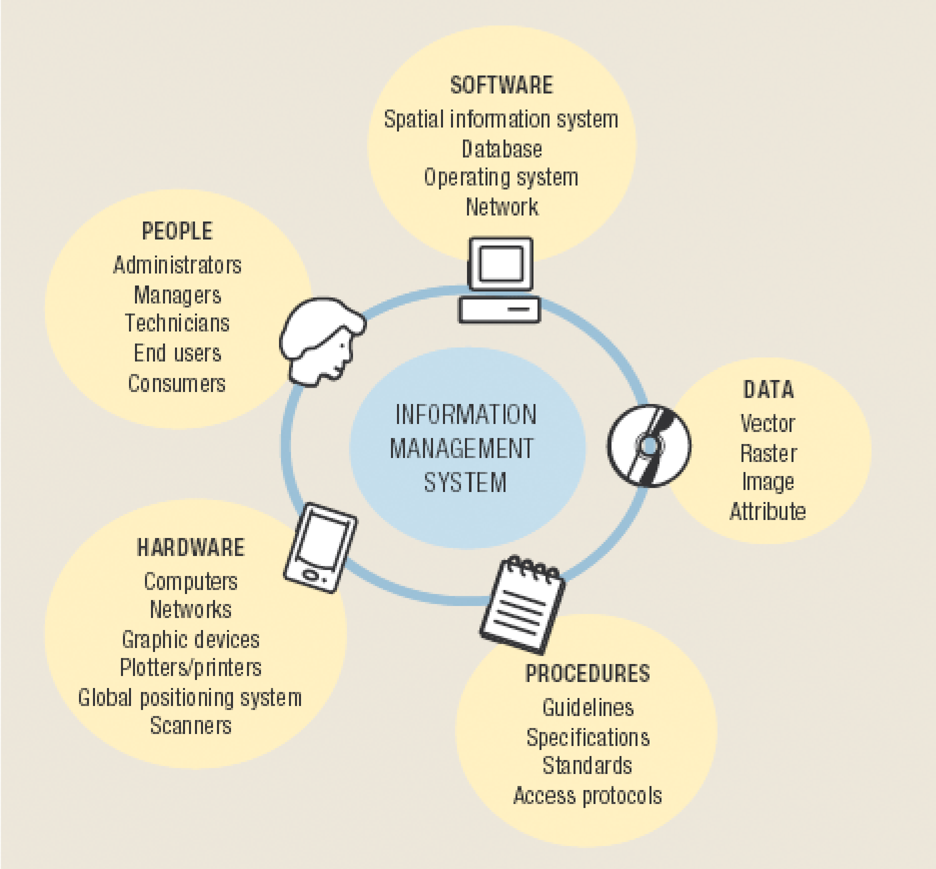
Although an SIS is often thought of as a single piece of software, in reality, to be effective it should be considered as part of an information management system including procedures, operating personnel, data and hardware. In this context, an SIS is a computer system which facilitates the phases of data entry, management, manipulation and analysis, and presentation.

Figure 3–2 Framework for an integrated information management solution.



One of the major strengths of an SIS is its ability to link numerous databases of information within a system, making it possible to visualise and view data in a spatial context. **In this sense many datasets contained in simple external spreadsheets or large regulatory databases, which were previously only used within a discrete domain of an organisation, can be integrated into an SIS to generate an additional level of information and analysis that was not previously possible.** Once within an SIS it is also possible to produce mapped outputs which are often very useful to assist managers in the decision-making process by being able to visualise relationships.

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From a senior level down the organisation or NRM group demonstrates its understanding of spatial information systems and their relevance to core business activities. Such commitment may be illustrated by the use of spatial information products in the support of decision-making processes and the formalised support of tools, technologies and resource allocation.

3.1.2 Spatial data and geoinformation

Many practitioners often use the terms *data* and *information* interchangeably, without the risk of being confusing. There are occasions however, where it is important to distinguish them. In general:

Data are statistics, facts, concepts or instructions organised in a formalised manner suitable for communication or processing by humans or computer.

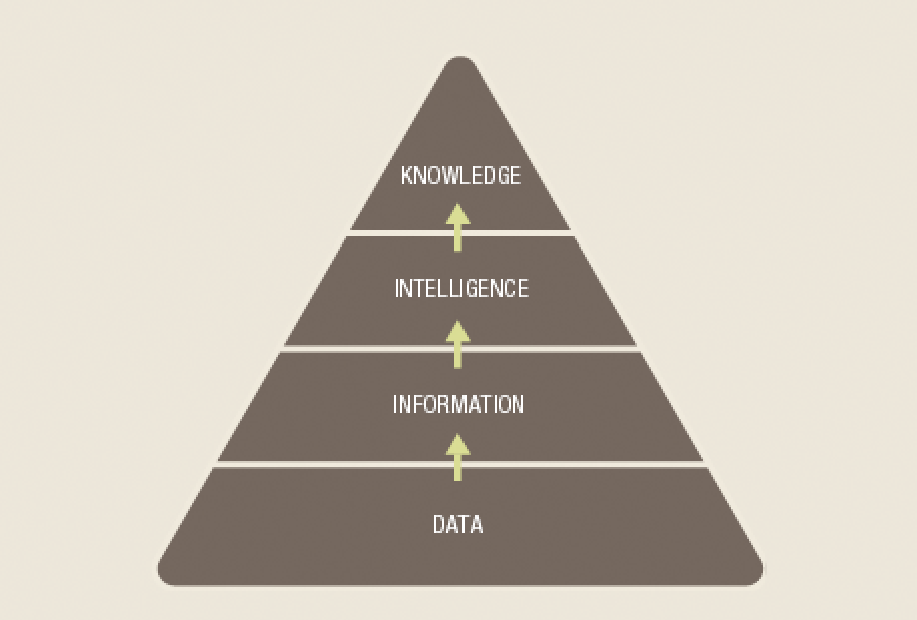
Spatial data are data that have positional values related to them. In some situations the term geospatial data is used as a further refinement—this refers to spatial data that have been georeferenced. (Note: Strictly speaking spatial data that are not georeferenced can have positional data that are not related to the earth's surface. For example, in an industrial engineering design, the parts of an engine may be defined relative to each other as opposed to their location relative to the earth's surface).

Information is data that have been value-added, processed and interpreted.

Geoinformation is a specific type of information which involves the interpretation of spatial data. It has been argued that it is the transformation of data to decision making which brings a level of understanding and knowledge, and the ability to make informed interventions to improve the management of natural resources.

A schema for this concept is illustrated at Figure 3–3.

Figure 3–3 Schematic illustration of the progression of data into knowledge.



The goal of information systems is to convert data into information. Data are considered to be the 'input' to a process where information is created. For example, daily rainfall recorded over long periods can be used to produce a monthly mean average for a particular location.

An SIS is used in NRM to provide the elements of measurement, mapping, monitoring, and modelling which facilitates improved management decisions.

3.2 How does an SIS work?

3.2.1 Relating information from different sources

The power of an SIS lies in its ability to relate different layers of information through the same location, and to derive conclusions about the relationship. It has been estimated that 80% of data have some form of graphical component, and can therefore be referenced to geographical locations such as points, lines or areas. For example, when rainfall data are collected it is important to know where the collection station is located. This is done by using a location system, such as longitude and latitude. Comparison of rainfall information with other thematic data, such as the location of wetlands within a catchment landscape, may reveal that some wetlands receive little direct rainfall and in fact receive most of the their water from streams or underground sources. This may indicate that these wetlands could be severely impacted if the underground water table level dropped due to excess pumping for irrigation, or if streams feeding the wetlands are diverted for irrigation projects further up in the catchment area. Such information can assist in determining the most appropriate decisions on how to manage the resources wisely.

SIS technology is widely used in the management of natural resources to reveal new information that ultimately leads to more informed decision making. Strategies for their improved management can then be developed with the results monitored as part of an overall system.

Many datasets produced by Australian, state, territory and local governments, private companies, universities, international and non-profit organisations available in spreadsheet or database format, can be directly entered into an SIS—either as a new data layer or linked to existing data layers. An example of such layers is given in Figures 3–4 to 3–10.

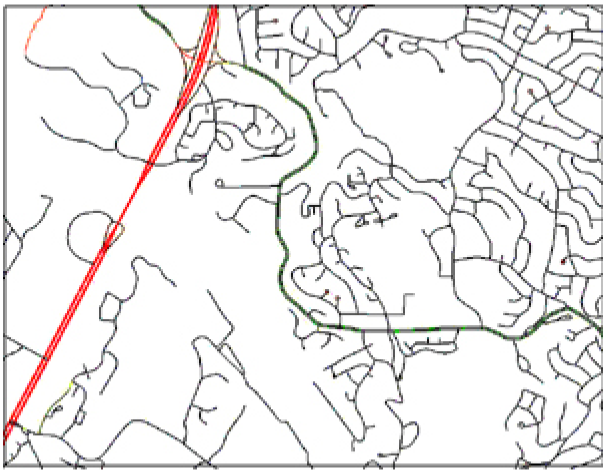


Figure 3–4 Digital line(vector) data for roads

Figure 3–5 Rivers

Figure 3–6 Contour lines

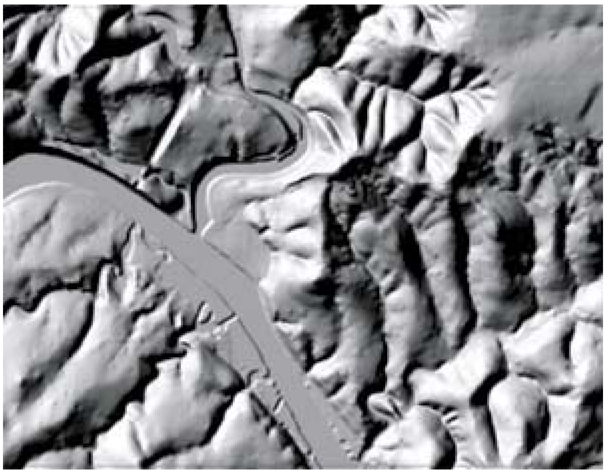


Figure 3–7 Digital elevation model DEM, (raster data)

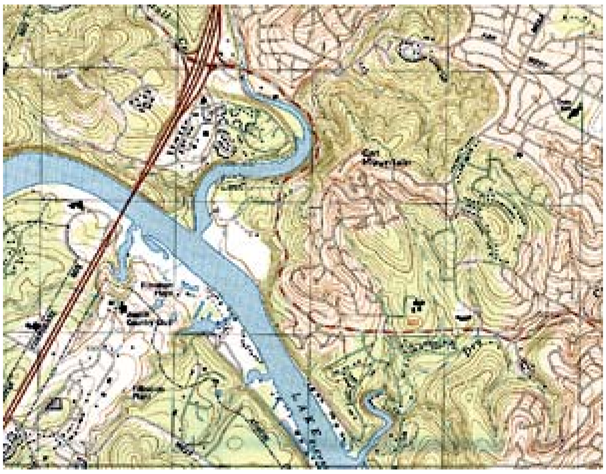


Figure 3–8 Scanned, rectified topographic map called a digital raster graphic (DRG)

Figure 3–9 Digital orthophoto

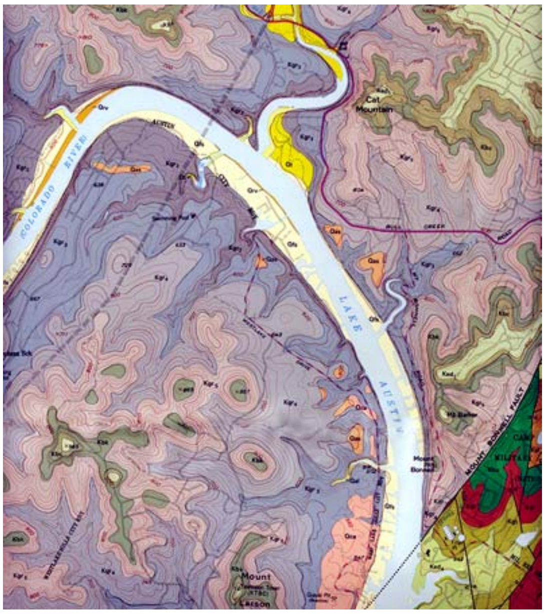


Figure 3–10 Geology map

In addition, an SIS can also import or convert digital data from other sources into a form which can be displayed and used for analysis. Thus, a digital Landsat ETM 7 satellite image may be in the supplier's native data format, e.g. the Australian Centre for Remote Sensing (ACRES) format[1]. This can be imported into the SIS where it can be analysed using specialised remote sensing procedures to produce a digital land use/land cover layer (Figures 3–11 and 3–12).

Figure 3–11 Landsat 7 satellite image from which land cover information can be derived

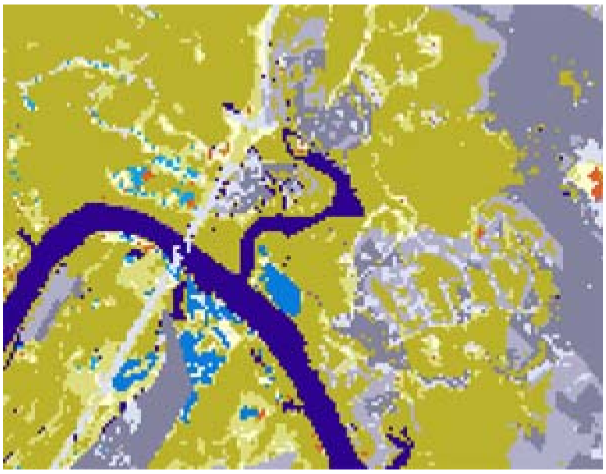


Figure 3–12 Satellite image data in Figure 3–8 have been analysed to indicate classes of land use and cover

[1] Satellite receiving stations often have their own formats in which they ship data. The Australian Centre for Remote Sensing (ACRES) has a specific format for Landsat 7 Thematic Mapper imagery known as TM Landsat-7 Fast-L7A ACRES. Imagery supplied in this format can be imported to enable it to be displayed and used for analysis.

Similarly, census or other tabular data such as hydrological data for a stream gauging station can be integrated into an SIS and displayed as map data (Figures 3–13 and 3–14).

Figure3–13 Part of a census data file containing address and owner information

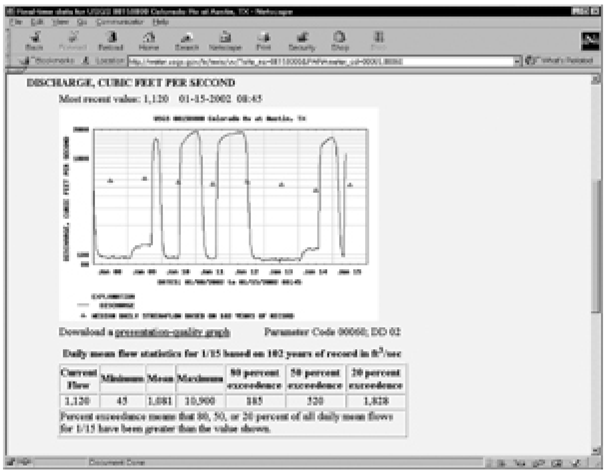


Figure 3–14 Part of a hydrologic data report indicating the discharge and amount of river flow recorded by a particular stream gauge that has a known location

3.2.2 Data capture

For data to be used within an SIS they must be in a suitable format. Various techniques can be used to convert data into a form that can be recognised within an SIS. For example, hardcopy (paper) maps can be digitised by using a digitising tablet to trace and collect the spatial features from the map. Alternatively, the map may be scanned and converted into an image, rectified and then digitised on screen using a mouse—often referred to as 'heads-up digitising' (Figure 3–15.

Figure 3–15 Scanning paper maps to produce digital data files for input into an SIS

Figure 3–16 Collecting latitude and longitude coordinates with a global positioning system (GPS) receiver

In addition, coordinates from global positioning systems (GPS) receivers (Figure 3–16) can be uploaded directly or manually entered into an SIS. GPS surveys can be very time consuming and expensive, and therefore need to be carefully designed and planned to return maximum benefit. A number of issues need to be considered prior to undertaking a GPS survey. Extensive support on GPS surveys, including a technical background to GPS, and best practice guidelines is presented in Module 10.

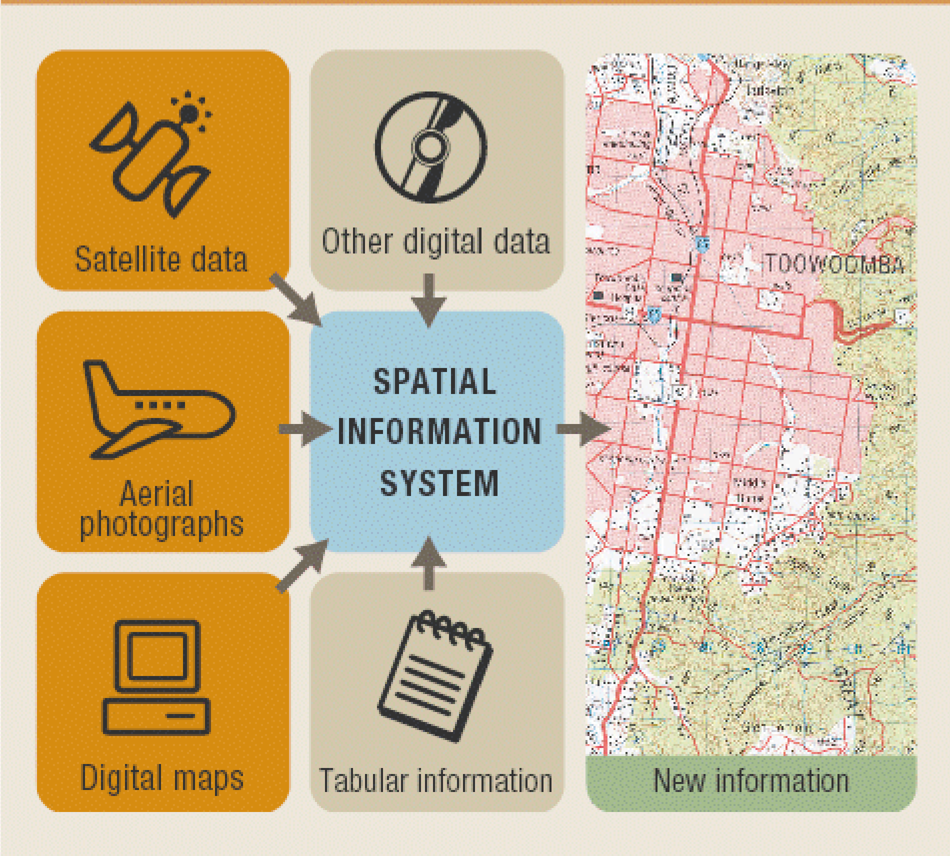
Data capture involves entering an object into the system and attaching the relevant attributes. Spatial relationships (e.g. whether features intersect, or are adjacent to another object) are the key to SIS-based analysis, i.e. an SIS can be used to identify spatial relationships among objects. It is this feature that separates an SIS from other computer-aided design or mapping systems. For example, a computer-aided mapping system may represent a road as a line (in which case the object carries the information, e.g. track as a thin line versus highway as a thick line) whereas in an SIS the road is a line to which the attributes are attached (e.g. track or highway). In addition, an SIS can recognise the road as a line but also as a boundary between wetland and urban development in two local government areas.

3.2.3 Data integration

Using spatial information software it is possible to integrate or link data and information that would otherwise be difficult to associate. For example, imagery from satellites, aerial photography, digital elevation and tabular data can be analysed, and new variables derived as outlined in Figure 3–17. As a result, it is possible to combine agricultural records with stream data to determine which streams will carry certain levels of nutrients due to fertiliser run-off from agriculture fields.

Agricultural records can also indicate how much herbicide was applied to a parcel of land. SIS technology can be used to predict the amount of nutrient run-off in each stream by locating the relevant fields and intersecting them with streams. Where streams converge this process can be further developed to calculate the total loads downstream where the water course enters a lake or wetland area. Further information on the compilation of such data is given in Section 3.3.4 using an example of processing development applications.

Figure 3–17 Data integration is the linking of information in different forms through a spatial system.



3.2.4 Projection and registration

In many cases NRM regional groups encounter situations where a property ownership map may be at a different scale and projection from a soils map. **Map information in an SIS must be manipulated so it registers or 'fits' with the information gathered for other layers.** Therefore, before such datasets can be analysed to determine patterns or relationships within the SIS, they may have to undergo certain manipulations, such as projection conversions to ensure that all datasets being analysed have the same datum and projection.

Projections are an essential component when making maps and undertaking spatial analysis. In simple terms, a projection is a mathematical model which transforms the locations of features on the earth's three-dimensional, curved surface, to locations on a two-dimensional surface such as a computer screen or map. It should be noted that different projections are used for different purposes—some preserve shape, others preserve the accuracy of area, distance or direction. The examples presented in Figures 3–18 and 3–19 illustrate how datasets in different projections can be transformed into a common projection.

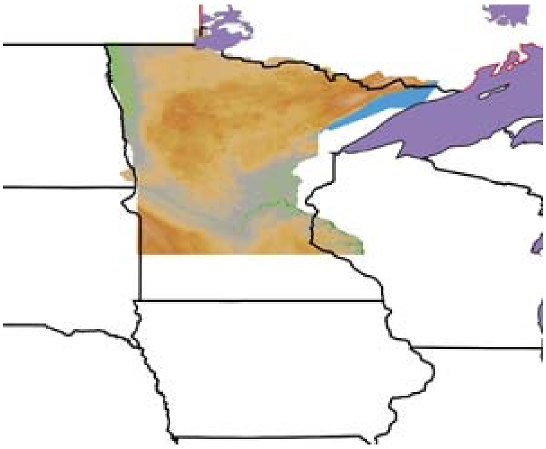


Figure 3–18 A digital elevation model exists in a different scale and projection from the lines on representing administration boundaries

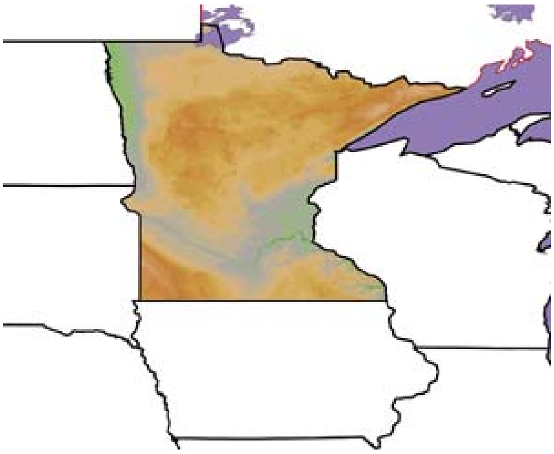


Figure 3–19 The elevation dataset has been reprojected to match the projection and scale of the administration boundaries

In addition, there are often corrections that need to be carried out when inputting data into an SIS due to surveying errors or poor copies being made of original diagrams. These issues are faced daily by SIS specialists within regional NRM groups, who often have established procedures and processes to handle such situations.

Module 9: Map production guidelines discusses the use of different projections depending on the particular need.

3.3 Data structures

An SIS stores two types of data—vector and raster.

Vector data are captured as points, lines (a series of point coordinates that are connected), or areas (polygon shapes that are bounded by lines) (Figure 3–20). Property boundaries and roads are typically stored in vector format with a corresponding attribute file. Property parcels contain details of owner name, valuation and land use zone, while the road file may contain details such as type (e.g. highway or track).

Raster data files consist of rows of uniform cells coded according to data values (Figure 3–21). For example, a satellite image (which uses a raster structure) can be interpreted using remote sensing tools to produce a land use/land cover map also in raster format. (Figure 3–12). Raster files are generally larger in size than vector files and are sometimes less visually appealing than vector data files. However, raster data systems are very good at evaluating environmental models such as soil erosion, land slide vulnerability, forest management suitability or fire hazard management. They are also valuable for providing backdrops of aerial photography for land use planning and a range of other NRM decision-making processes.

Figure 3–20 Example of the structure of a vector data file.

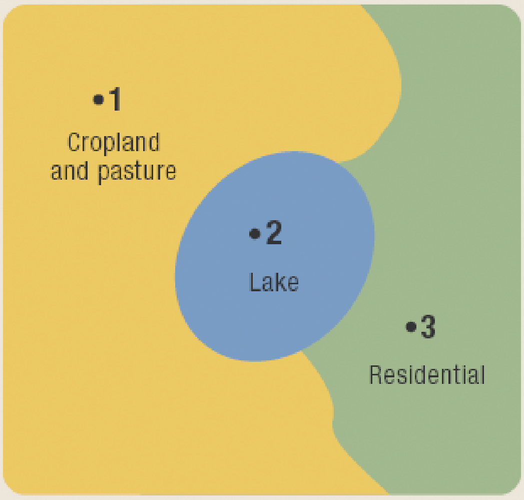


Figure 3–21 Example of the structure of a raster file.

1	1	1	1	1	1	1	3	3	3
1	1	1	1	1	1	1	1	3	3
1	1	1	1	1	1	1	3	3	3
1	1	1	1	2	2	2	3	3	3
1	1	1	1	2	2	2	3	3	3
1	1	1	1	2	2	2	3	3	3
1	1	1	1	1	1	3	3	3	3
1	1	1	1	1	1	3	3	3	3
1	1	1	1	1	1	1	3	3	3

Data restructuring can be carried out using SIS to convert data between different formats, e.g. from raster to vector or vice versa. As a result, an SIS can be used to convert a raster land use/land cover map (interpreted from a satellite image to a vector structure) by generating lines around all the cells with the same classification, whilst determining the spatial relationships of the cell, such as adjacency or inclusion (Figures 3–22 and 3–23).

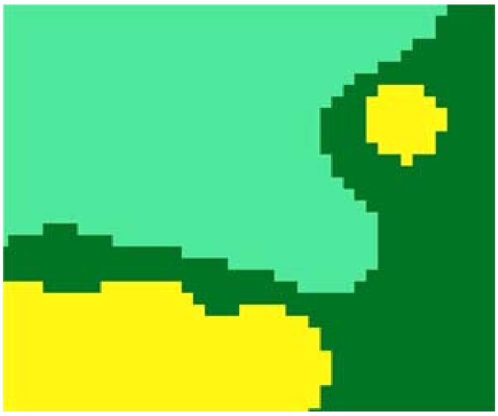


Figure 3–22 Magnified view of the same SIS data file, shown in raster format—previous Figure 3–12

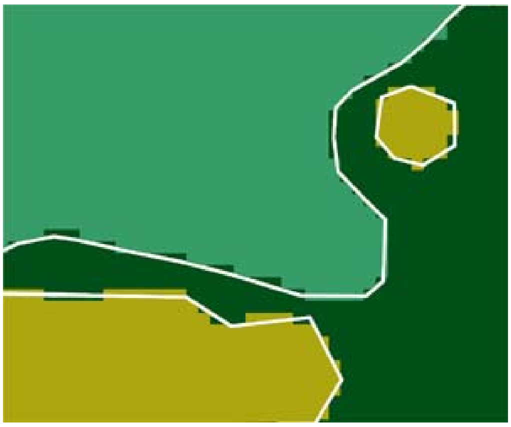


Figure 3–23 Magnified views of the same SIS data file converted into vector format

3.3.1 Data modelling and interpolation

A model is a relationship between located observed values that provides a prediction of the value for un-observed locations, i.e. in effect it can be seen as a method of describing something that cannot (or has not) been observed directly. Given that it is not feasible to collect data from every square meter of a catchment area, models can be used to create simplified representations of reality. Apart from making it easy to process, analyse and combine spatial data, spatial information technology has also made it easy to arrange and integrate spatial processes into larger systems in which thematic layers and their relationships can be modelled using spatial analysis tools.

For example, based on the input of points representing pH results from soil test locations in a paddock, an SIS can quickly generate a map with isolines (or contour lines) representing the level of pH throughout the paddock (Figures 3–24 and 3–25). Such a map can be thought of as a soil pH contour map. Many methods can be used to estimate the characteristics of surfaces from a limited number of point measurements. Two- and three-dimensional contour maps, derived from the surface modelling of soil pH sampling point measurements, can be analysed together with any other map (e.g. soil texture, depth, moisture holding capacity, etc.) in an SIS to determine relationships and investigate other variables such as yield. Much of the current work being done in ‘precision agriculture’ involves investigations of this nature.

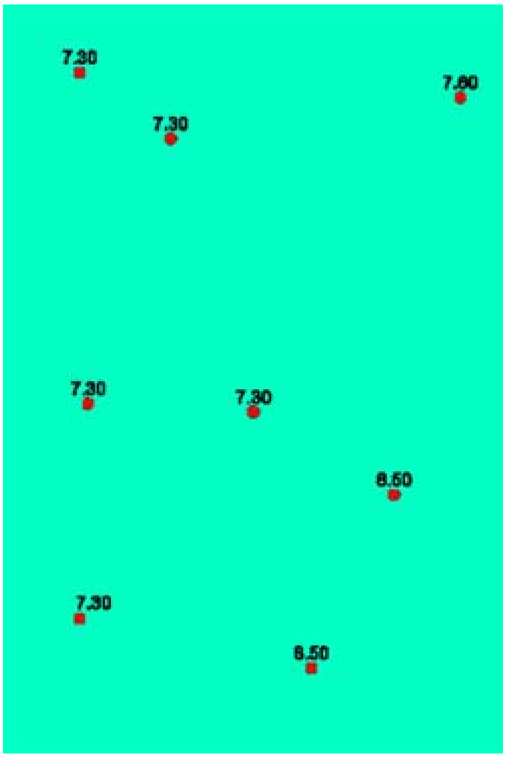


Figure 3–24 Points with soil pH values

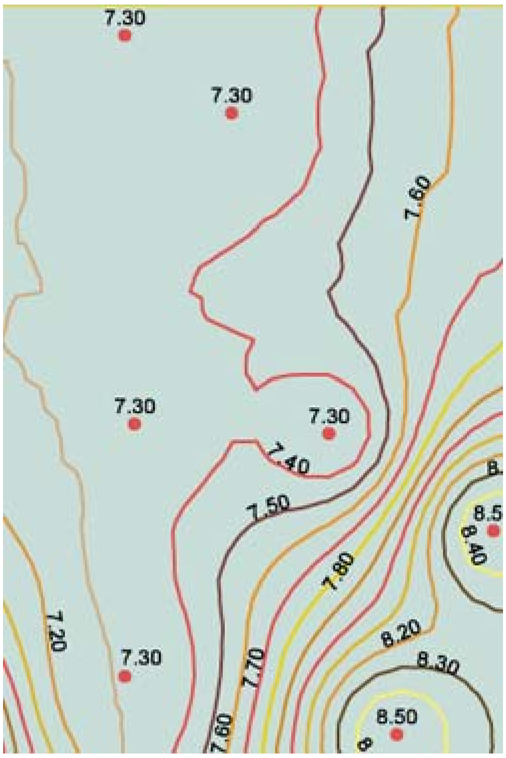


Figure 3–25 Contour map made from soil pH values shown in Figure 3–21

3.4 What is special about a spatial information system?

The way that maps and other data can be stored as layers of information (related by the same referencing system) in an SIS makes it possible to perform complex analyses.

It is the only system that uses location and arrangement of objects as a feature.

3.4.1 Information retrieval

An SIS makes it possible for the user to 'point' to a location, object or area on the screen and retrieve information that is stored as attribute data in some form of database (Figure 3–26).

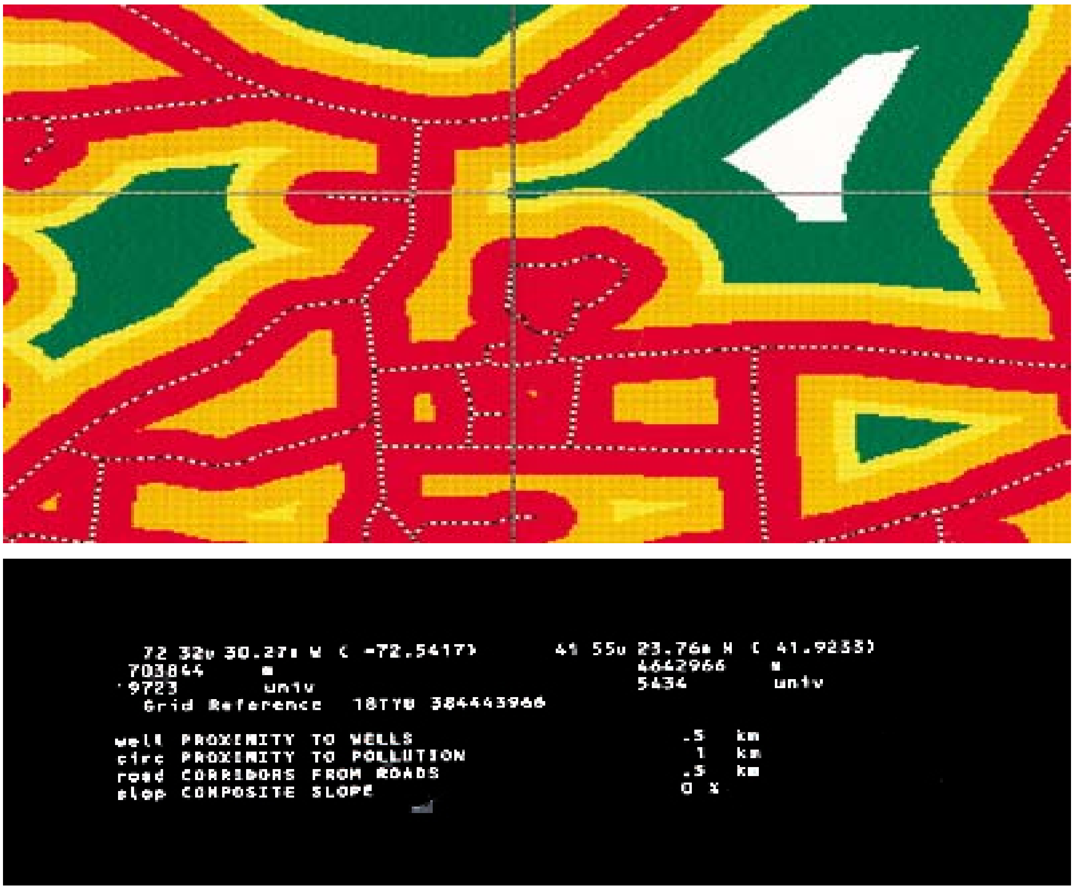


Figure 3–26 The cursor can be used to point to a location stored in an SIS and return attributes about the location such as longitude, latitude, soil type and slope

Using scanned, digital aerial photographs or satellite imagery as a visual guide, it is possible to ask an SIS about the geology or hydrology of an area, or even how close a wetland is to the end of a road. This type of analysis enables natural resource managers to derive conclusions about the wetland's environmental sensitivity.

3.4.2 Topological modelling

Using SIS technology it is possible to identify and analyse spatial relationships among mapped phenomena. Conditions of adjacency (what is next to what), containment (what is enclosed by what), and proximity (how close something is to something else) can be determined (Figure 3–27).

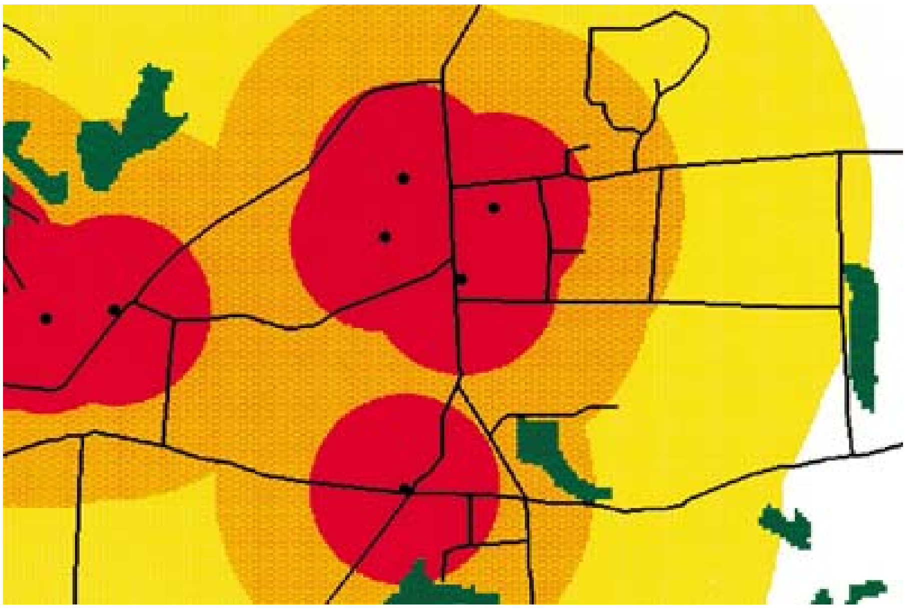


Figure 3–27 Sources of pollution are represented as points—the coloured circles show distance from pollution sources and wetlands are represented as dark green

3.4.3 Networks

When nutrients from vineyards or farmland run off into streams, it is important to know in which direction the streams are flowing and which streams discharge where. This process can be achieved using linear network functions within some SIS software programs. Additional information on water volume and speed throughout the spatial network can assist in estimating how long it will take the nutrients to travel downstream and enter a wetland area (Figures 3–28 and 3–29).

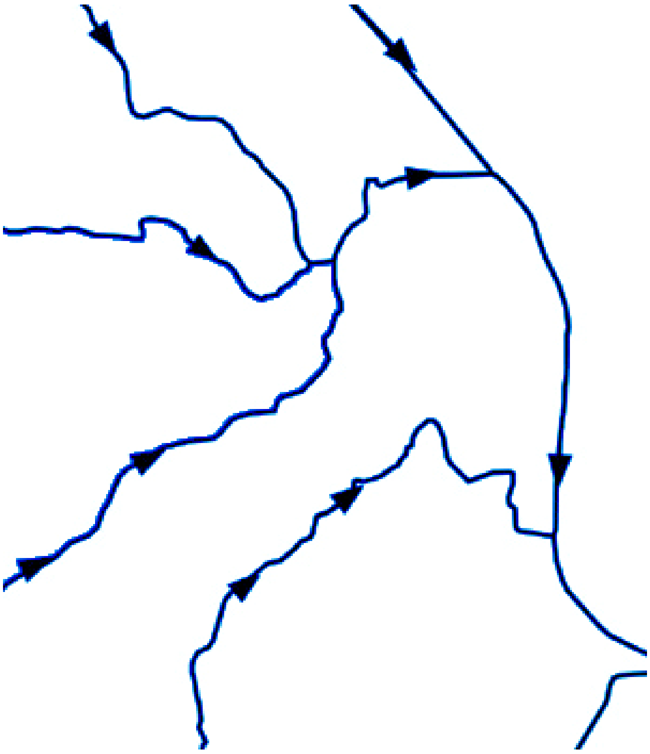


Figure 3–28 An SIS can simulate the movement of materials along a network of lines—these illustrations show the route of pollutants through a stream system

Figure 3–28 Flow superimposed on a digital orthophoto of the area

3.4.4 Overlay

Using the map layers of wetlands, slopes, streams, land use and soils with SIS technology it is possible to produce a new map or overlay that ranks the wetlands according to their relative sensitivity to damage from nutrient run-off (Figures 3–30 to 3–35).

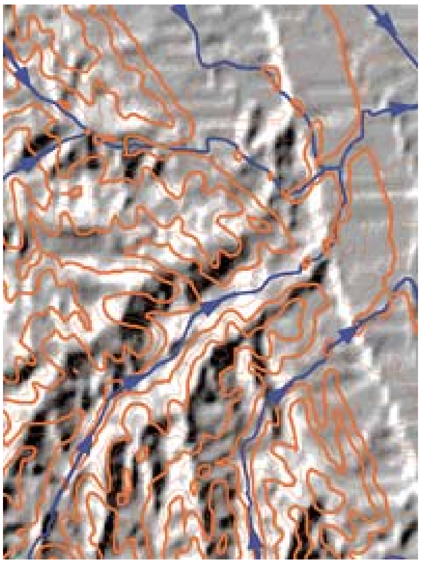


Figure 3–30 Shaded relief map and contour lines generated from a digital elevation model of the study area

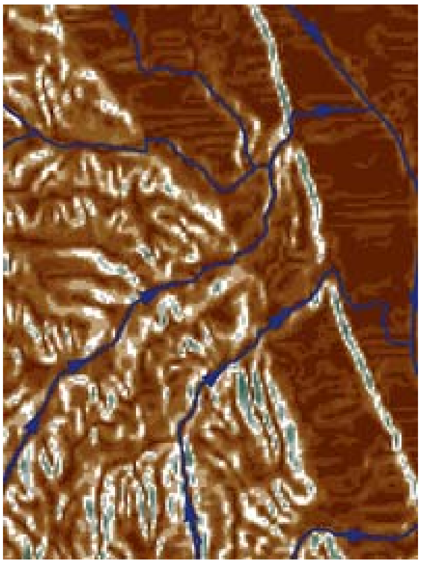


Figure 3–31 Map showing the steepness of slopes in the study area, created from the digital elevation model

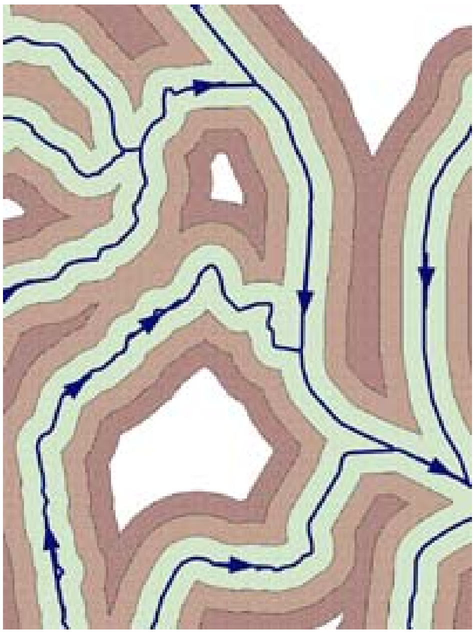


Figure 3–32 Distances to streams as measured by three 200-meter buffers derived from a digital map of hydrography

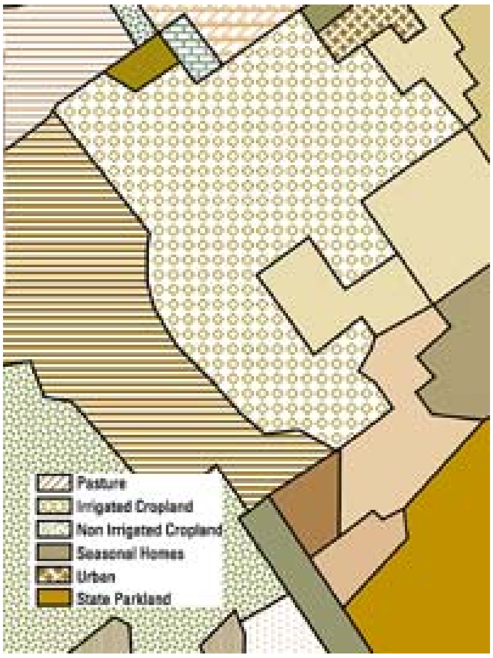


Figure 3–33 Map indicating various land uses in the study area

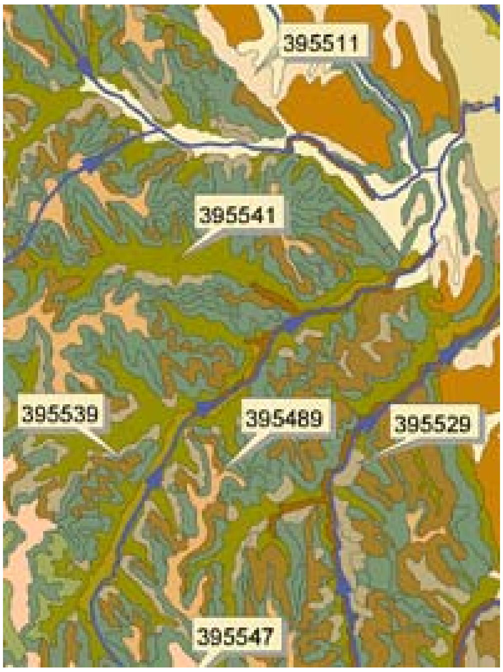


Figure 3–34 A soils map stored in an SIS database—numbers indicate the type of soil

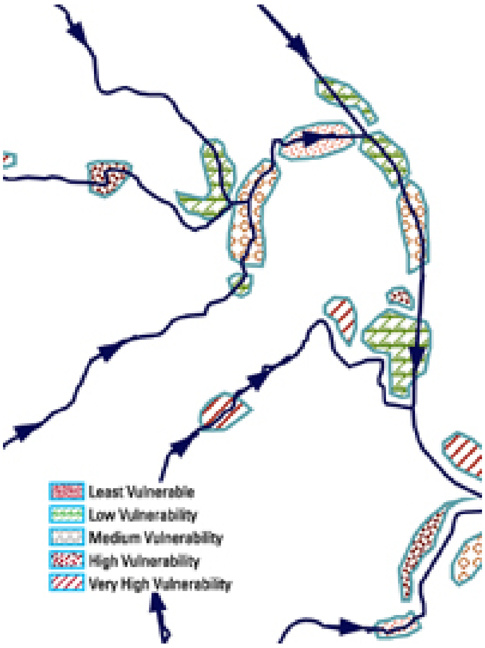


Figure 3-35 Wetlands in the study area ranked according to their vulnerability to pollution on the basis of a combination of factors evaluated by an SIS

3.4.5 Data output

One of the most critical components of an SIS is its ability to produce simple, effective visual representations though graphics, either on screen or on paper, to convey the results of analyses to people who make decisions about resources. A full range of map products covering wall maps, internet-ready maps, interactive maps and other graphics can be generated using SIS technology to assist decision makers in visualising and thereby understanding the results of analyses, simulations or potential events (Figure 3–36). The standards that support the consistent output of SIS are described in *Module 9: Map production guidelines.*

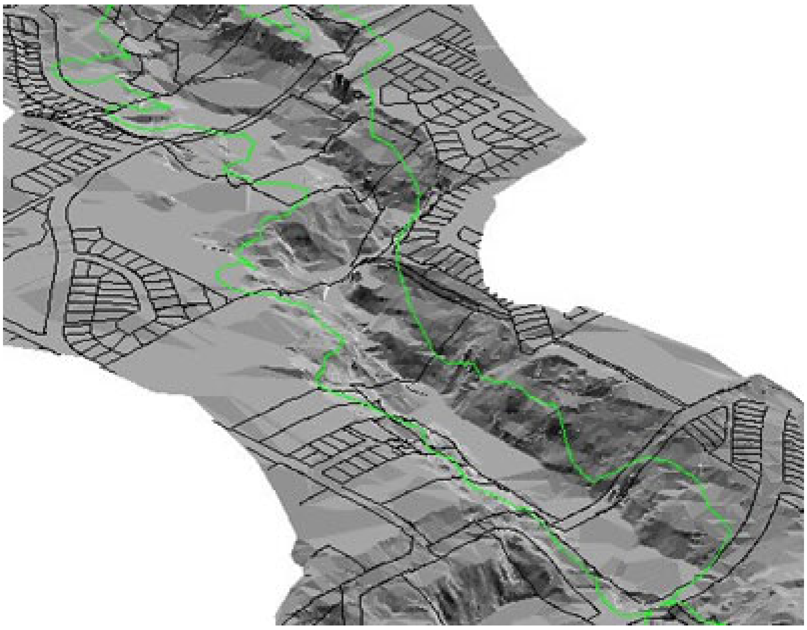


Figure 3–36 A 3-D view illustrating to property owners how a new riparian species protection law will affect them and their neighbours

3.5 Framework for cooperation and the need for planning

One of the additional benefits of introducing SIS technology into an organisation or NRM regional body is that it can encourage cooperation and communication amongst agencies and partners involved in NRM.

The collection or acquisition of data for use in an SIS is very costly and may require specialised equipment and technical expertise. Careful planning is required to ensure collection activities are well coordinated and, where possible, data can be collected once and used many times by different groups.

To be successful an SIS should not be viewed simply as a computer system but rather a tool in which the components of hardware, software, data, people and methods combine to make the system work.

A successful SIS operates according to a well-designed implementation plan and business rules, which form the models and operating practices unique to each organisation**. As with all organisations and NRM regional groups dealing with sophisticated technology, new tools can only be used effectively if they are properly integrated into the entire business strategy and operation.** This is achieved using relational databases which, once connected to geo-locational data, enable the display of data stored in external databases and spreadsheets. Many organisations have large spatial relational data holdings such as thematic datasets with address locations. In this scenario it could be possible to link the thematic data from the external dataset to an SIS layer based on address locations.

To do this properly requires not only the necessary investments in hardware and software, but also the training and/or hiring of personnel to utilise the new technology in the correct organisational context. **Failure to implement an SIS without giving consideration to proper organisational commitment will result in an unsuccessful system.**

It is simply not sufficient for an organisation or NRM regional group to purchase a computer and some SIS software, hire an enthusiastic individual and expect instant success.

Module 11: Partnerships and working together – the potential for collaboration has additional information.

3.6 Additional support

This guideline provides an overview of the issues and functionality of an SIS. The focus is on practical issues aimed at those with limited understanding of spatial information systems. Considerable additional support material is available on all of the issues identified including the following sources and references.

Wiley Publishers: http://www.wiley.com/ has a number of very good SIS/GIS reference books suitable for use in the establishment of regional centres. An example of its collection is a recent publication 'The Design and Implementation of Geographic Information Systems' by Harmon and Anderson, May 2003.

> *The Design and Implementation of Geographic Information Systems provides a unique nuts-and-bolts perspective of enterprise GIS design, a geographic information system that meets the needs of numerous users across multiple units in an organisation. This hands-on guide offers in-depth, up-to-date material on issues of spatial data when designing and implementing enterprise GIS, along with insightful, illustrative examples.*
>
> *From the predesign planning stages dealing with assessment, requirement analysis, organisational issues, and cost analysis, to integrating legacy MIS systems and preparing for future developments in database design, this user-friendly book addresses all the*

fundamental aspects of the design and implementation of GIS, regardless of software or hardware. It offers helpful 'decision trees' to assist in strategic planning, as well as proven strategies for application development, interface design, and enabling web-based access. Numerous case studies and examples from the private and public sectors demonstrate how these strategies and approaches play out in the real world.

As GIS becomes increasingly integrated with traditional MIS/IT database systems, GIS practitioners and MIS/IT managers will find The Design and Implementation of Geographic Information Systems a reliable, go-to resource.

OnWordPress: http://www.onwordpress.com/ also has a number of software specific and general reference SIS/GIS support books. An example of its collection is the publication 'GIS Solutions in Natural Resource Management' by Delmar Publishers.

GIS Solutions in Natural Resource Management enables readers to explore how diverse datasets may be applied to specific areas of study, ranging from sustainability to the incorporation of economic, demographic, and cultural indicators into resource management models. Central to the book are case studies that depict social and life scientists combining efforts to utilise GIS to respond to, and solve, today's socio-political challenges such as: Protecting endangered species, Preventing famine, Managing water and land usage, Transporting toxic materials, Locating scenic trails through public and private lands. Sections I and II introduce a progression of technique developments and requirements for current resource management applications. Section III enables readers to delve beyond these traditional approaches and their requirements to translate GIS resource technology into social and economic terms. Each chapter of the book is written in tutorial style to convey its central ideas. (Keywords: Introduction to GIS)

Other appropriate titles can be discovered by entering GIS in the product search function of the above websites.

Also of interest are a number of web-based newsletter type services that specialise in SIS/GIS activities. The following are examples of such websites:

Geocommunity: http://spatialnews.geocomm.com. This group offers many speciality channels including a book service at: http://search.geocomm.com/search.phtml?query=books

GIS Café: http://www.giscafe.com/

Directions Magazine: http://www.directionsmag.com/.

Similarly, many software vendors have useful reference material and newsletters. A sample collection of material available from bookstores maintained by software vendors can be found at the following locations. The list is provided simply to assist regional centres to discover information available from software vendors and is not meant to be comprehensive. Note: Listing of any company does not constitute an endorsement of that company.

MapInfo: http://www.mapinfo.com.au/

Intergraph: http://www.intergraph.com/au

ESRI: http://gis.esri.com/esripress/display/index.cfm

ESRI Australia: http://www.esriaustralia.com.au/ .

MODULE 4

MODULE 4: Spatial Data Priorities, Standards and Compliance

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

One of the prerequisites for natural resources management (NRM) involves the establishment and maintenance of a good database of information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making/planning processes are very closely related to the quality and completeness of the information, and the manner in which it is made available. In this respect data access, management, integration, analysis and communication are key components. Within all these components the need for standards is critical.

In recent times best practices have evolved to assist data-related tasks in NRM projects. Successful projects have generally adopted an integrated information management solution, combining leadership, people, technology, applications and data within a framework that ensures tools, procedures and standards are in place to maintain and transform data into useful information products that support operations and the decision-making process.

Most NRM agencies and regional bodies are both information providers and clients. This means they collect and use data for their own purposes, as well as making them available to other users. Standards form a key ingredient underpinning the management of data and information. Benefits of standards for data include:

- increased data sharing
- higher quality data
- improved data consistency
- increased data integration and interoperability
- better understanding of data
- improved documentation of information resources
- improved control over data updating activities and development of new versions of datasets
- improved data security.

Module 4: Spatial data priorities, standards and compliance is a guideline providing background material which will enable practitioners to appreciate the importance of standards, and some of the elements involved in their development. Such an understanding should also assist practitioners to ask the right questions when searching for data, planning their own data capture programs, or negotiating technical support for provision of data services.

Actions

Managers should focus on the need to develop standards, and to ensure they are widely communicated to, and adopted by, the user community.

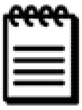
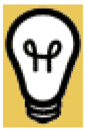
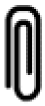
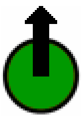
Within most jurisdictions, each state, territory or discipline (e.g. land resource assessment) has its own overarching policies and standards for data collection, maintenance and classification criteria, etc. Managers need to be aware of these standards, and oversee the development of guidelines and assessment criteria (or score sheets). This will enable new datasets to be evaluated, and existing datasets assessed to ensure their appropriateness, fitness for purpose and compliance.

Acknowledgements

This module draws heavily on material produced by the Audit, Environment Australia, Bureau of Rural Science, the Herbert River Resource Information Centre and Spatial Knowledge Engineering, Incorporated (SKE, Inc www.skeinc.com). These sources are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

4.1 Introduction

Each year throughout Australia, government agencies invest very large amounts of resources, including time and money, collecting and maintaining natural resource data. Despite this investment, different agencies (particularly in the natural resources area) often use different standards to collect, store, document and provide access to data. The resultant inconsistencies create major inefficiencies and limit effectiveness.

Inconsistent data increases the time, effort and cost to assimilate datasets which enable area comparison, solve cross-region issues or analyse trends in the status and condition of natural resources over time. These problems occur at all scales, whether working in a local catchment or undertaking a national assessment.

As more information becomes available, organisations and communities want to compare information across regions. Users of natural resource information are demanding:

- consistency between related data (e.g. the location of stream gauging stations should match the location of streams in the database)
- seamless maps not interrupted by artefacts such as map sheet boundaries, regional boundaries or state/territory borders
- consistent descriptions of similar features so that a feature is defined the same way across Australia.

Best practice procedures are available to ensure data are developed that facilitate consistency, interoperability and fulfil the minimum requirements of certain national or international standards (e.g. the Australian Spatial Data Infrastructure). This ensures agencies and the community can achieve maximum value from their investment through multiple use.

The peak body involved in the promotion and coordination of standards for spatial data in Australia is ANZLIC – the Spatial Information Council.

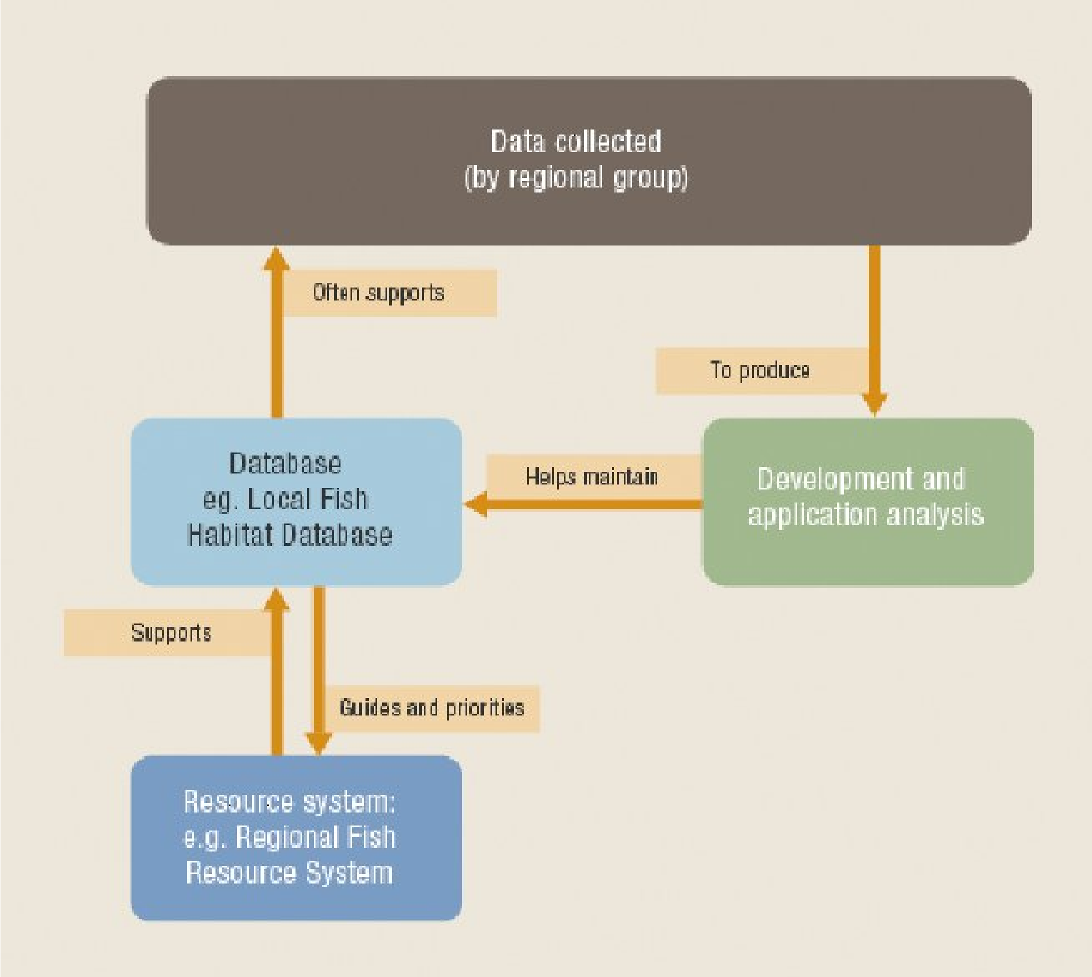
Note: The criteria by which datasets can be assessed to determine their compliance with standards for the Australian Spatial Data Infrastructure (ASDI) are currently being updated. In addition, each state or territory jurisdiction may have its own overarching criteria to which regional bodies should conform.

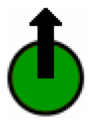
4.2 Determining priorities for data

Data are the most expensive component of any information management system. As a result, there is never enough money available to conduct all the data collection and preparation that might be required to support the management of natural resources. This means that priorities need to be set, and following are some of the parameters/considerations that may assist in determining such priorities:

- an understanding of key information needs and business drivers. How urgent is the need? What decisions are supported? What datasets are required to produce the required information products? (Figure 4–1)
- opportunities for partnership
- opportunities for management and maintenance
- data collection and storage systems
- practical data collection issues—availability of expertise, terrain, outside forces like weather, timing
- potential costs and available budget
- data availability, integration, sources, standards, priorities, use
- metadata and clearing houses—standards, sources, current state-of-the-art interoperability
- applications—current data collection/input tools, access tools, publishing tools, sharing, priorities
- organisational fitness—leadership, vision, resource centre, training requirements and plan, partners and participants, current and future information policy requirements (e.g. partnerships, sharing, access, usage constraints)
- technology infrastructure—network, software, computers, Internet opportunities
- key information products required/used/available.

Figure 4-1 Example of a business process supporting data maintenance.





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Individual people, departments, or NRM bodies have documented spatial data management standards, processes, policies and procedures. Document the parts of the business processes that require spatial information and cross reference to general data management requirements outlined in *Module 2: Data management principles*.

4.2.1 Data publishing considerations

Information publishing and access needs to be addressed when implementing a spatial data infrastructure or integrated information management solution. This includes ensuring that *the published data actually makes sense, is useable to those accessing it, and suitable documentation is available so users can determine whether the data may be useful and pursue steps to access them*. While this might seem obvious, the internet today is rife with examples of organisations that have focused on the system to get their data published and forgotten about their audience and its need to interpret the data. As a result, data often lack descriptive headings, legends, or they have poor metadata/documentation and contain other inconsistencies. In its document 'Australian Natural Resources Information 2002', the Audit reported results of a review of the Australian Spatial Data Directory (ASDD). These results showed that more than 20% of the records had no information about when the data were created and less than 50% had sufficient information about the quality of the data, in turn, making it difficult for users to determine whether they may be useful.

4.3 Data standards

A wide range of support material is available on the development and application of standards as they relate to NRM datasets.

> ANZLIC has produced a series of policy documents and support material on standards (e.g. Policy Statement on Spatial Data Management and Model Data Access and Management Agreements) which serve as useful templates for regional groups. All are available from the ANZLIC website.
>
> '**Australian Natural Resources Information 2002',** produced by the Audit, also provides useful background material. This report is available on the following website:
> http://audit.ea.gov.au/anra/data/docs/national/Data_Contents.html
>
> In addition, each state/territory jurisdiction has protocol and policy documents on data standards. Regional groups should refer to these whenever they are available.

An important goal in the development of an integrated information management solution is to facilitate the development, publishing and acceptance of data standards. Such standards are a key ingredient for all users and producers of data and information. They are particularly important in any co-management, co-maintenance or partnership where data and information need to be shared or aggregated.

Data standards describe objects, features or items that are collected, automated, or affected by activities or the functions of organisations. In this respect data need to be carefully managed and organised according to defined rules and protocols.

Within any spatial information system project, there are normally a number of standard themes of data common to most NRM projects. These include elevation, soils, land use, cadastre, transportation, etc. which need to be organised according to a system that makes them useful to the broadest community.

Fitness for purpose and point of truth

Fitness for purpose and point of truth are key elements of data standards.

- Prior to using any dataset it is recommended that the user undertake an assessment to determine the appropriateness of the dataset (fitness for purpose) for the intended use. This involves assessment of such criteria as:
  - scale
  - resolution
  - accuracy
  - classification system
  - integrity of the dataset.
- Where possible (especially where more than one version of a dataset exists) users should obtain clarification from relevant state or territory jurisdictions to determine the authoritative (point of truth) dataset. Problems in using outdated or unofficial datasets can lead to major problems in analysis, confusion and a lack of interoperability and integration with other datasets.

Benefits of data standards

Benefits of data standards include:

- increased data sharing
- higher quality data
- improved data consistency
- increased data integration
- better understanding of data
- improved documentation of information resources
- improved control over data updating activities and new versions of datasets
- improved data security.

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An organisation or NRM group has developed a comprehensive suite of metrics for understanding the impact of spatial data management on their core business activities. These metrics incorporate standards, process performance, and how well the group's spatial information management operations compare with recognised Australian best practice.

4.3.1 Metadata standards

Spatial metadata is information that describes spatial datasets (i.e. the data about the datasets). This provides a consistent approach to allow the storage and retrieval of information about a particular dataset. An analogy may be the labelling of food on supermarket shelves or historical information about a motor vehicle in a second-hand car yard.

Metadata can be accessed using database and internet technologies that automate search and retrieval capabilities. This is facilitated by the ASDD (available online at: http://asdd.ga.gov.au/asdd/).

ANZLIC has developed a metadata standard, which sets out minimum requirements for metadata published in the ASDD—see http://www.anzlic.org.au/infrastructure_metadata.html#standards

For the ANZLIC Metadata Guidelines Version 2, February 2001 see: http://www.anzlic.org.au/download.html?oid=2358011755). Updated information is available from the ANZLIC Metadata Project http://www.anzlic.org.au/metadata_project.html with additional technical information available on the ASDD website: http://asdd.ga.gov.au/asdd/tech/#metadata.

The guidelines have been widely adopted and are designed for use by data custodians to assist them in creating, storing and distributing core metadata elements. The document includes introductory information on metadata, their use and management. References include sources of more detailed information that users may require as they become more experienced with metadata and their use as an aid to data management within their own organisations. Several online metadata entry tools now exist (more details are available from your jurisdictional Spatial Data Infrastructure coordination bodies).

For additional information about the ANZLIC Metadata Guidelines, the ANZLIC Metadata Entry Tool (MET) or any other metadata related issue NRM regional bodies should contact their jurisdiction's metadata contact. Details are available on the ANZLIC website:

http://www.anzlic.org.au/metadata_project.html.

4.3.2 Principles for developing standards in a multi-user environment

To an outside person, data standards often appear vague or difficult to understand, as they usually reflect the business uses and requirements of the person (or NRM regional group) that developed the dataset and not the multiple needs of different users and data collectors. When involving multiple business interests and/or parties (as is often the case in the development of regional NRM programs) the development and acceptance of data standards must be carried out in an environment of trust and 'agreed-to' principles. The following guidelines should be kept in mind when developing standards.

> ANZLIC policy, as it relates to the development of standards, may be summarised as follows:
>
> - Where possible adopt the following in order of priority:
>   - international standard
>   - national standard
>   - regional standard

    - local standard
- Where possible adopt a minimum standard—less is better than more
- Give consideration to a particular version of a standard as they are constantly being updated.

A Standard is accepted when it is broadly used

There is no merit in referring to something as a 'standard' if it is not used and adopted. Good standards are developed in an inclusive process, are well communicated and widely used. Use is facilitated by access so improving access to data will increase adoption of standards.

Standards evolve

Standards often change in parallel with changes in technology and business processes. A process with built-in continued participation and review is important so that standards evolve, rather than drop out of favour as parties find new individual approaches.

Most data are already collected to some standard

By definition all data contained in a database conform to some standard. A good 'standards' exercise begins by identifying what already exists (i.e. the 'standards' currently associated with the dataset).

Standards reflect a business need or circumstance

Datasets and their related standards exist to support business requirements. Understanding those requirements is key to broad acceptance.

A standard won't meet all business needs

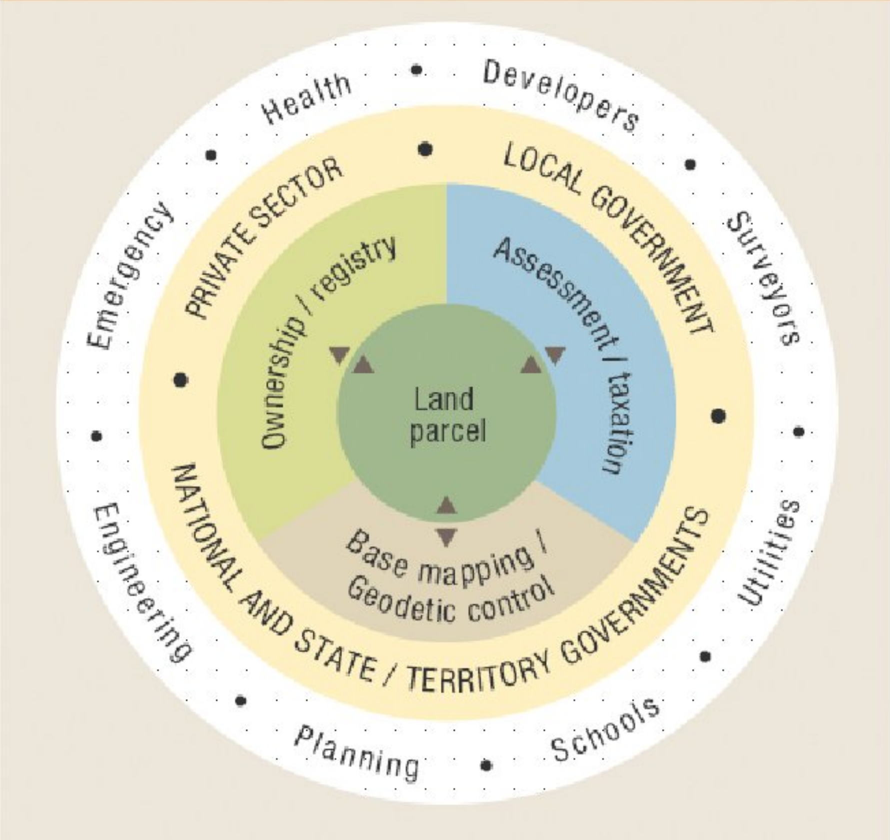
Any one standard may not meet all the business requirements for the dataset. For example, a dataset might be satisfactory for broad-scale local government land-use zoning purpose, but not accurate enough for site-specific evaluation.

Look for a 'minimum standard' or key common components

Due to the range of requirements associated with various business needs, it is often feasible to achieve one broadly accepted standard for a dataset. It is often recommended that standard components (e.g. access, distribution, scale, accuracy) of the various related datasets are included in the standard.

Once adopted, these standards then become broadly accepted and form the basis of a *minimum standard*. Other users are free to add business-specific elements to the data for their own use, while sharing a minimum set of core data elements. Business processes involving multiple partners or participants should support the maintenance and development of the dataset. In the diagram presented in Figure 4–2, the minimum standard components of a land parcel database are supported through the activities of a number of different business processes.

Figure 4–2 Business processes and components in a land parcel database.



The realisation of the need for data sharing and partnerships to address NRM issues has placed increased importance on standards, and emphasised the need to streamline cooperation and communication between parties. Communication is critical to the success of a data standard and the use of the data.

4.4 Data standard components

4.4.1 Spatial standards

A number of standards are involved in spatial datasets used in a spatial information system project to support NRM activities. These include standards associated with map projection, datum, the coordinate system in which the dataset is stored, and the scale and accuracy of the dataset. Such standards are needed as datasets can be rendered useless without them. For example, satellite images or vector road layers cannot be used in a spatial information system unless they match the projection and coordinate system adopted for use in the spatial information system.

The following is a list of various data standards that practitioners need to be aware of (or may encounter) when managing or searching for data.

Map projections

A *map projection* may be described as a mathematical model that transforms the spatial relationships of features on the earth's three-dimensional surface to locations on a flat map or two-dimensional surface. To achieve this, some method must be used to depict a map in two dimensions. However, a flat map does not accurately reflect the shape of the earth. For this reason, many different map projections have been developed and used in spatial analysis and mapmaking activities. Some projections preserve shape, while others preserve accuracy of area, distance or direction.

Datum

In reality the earth only approximates a sphere. For small-scale maps, such as an atlas, which often represent large areas (e.g. a country), map makers treat the earth as a sphere. For large-scale maps (which reveal far more detail for a given area compared with small-scale maps) the earth must be treated as an ellipsoid or spheroid. A *datum* is a set of parameters and control points that are used to accurately define the three-dimensional shape of the earth.

Coordinate system

A *coordinate system* provides a reference to measure horizontal and vertical distances on a map. Coordinate systems are usually defined by a map projection, a spheroid reference, a datum, and a number of other parameters (e.g. standard parallels, a central meridian and possible shifts in the x and y directions). The two most common coordinate systems in Australia are geographic and the Map Grid of Australia (MGA).

Scale and accuracy

The term *scale* refers to a statement of measure. It is often the ratio of the distance on a map as related to the true distance on the ground. In general, maps with smaller scales are less accurate and show less detail. This is also the case for spatial information system datasets, which are often derived from maps or images at given scales. Spatial information system software functionality enables the user to zoom in closely on a dataset and print it at very large scales. Please note however, that enlarging a map beyond the scale at which the data were captured does not make the map more accurate.

When considering scale and accuracy, there is also the need to distinguish between accuracy and precision for both raw and derived data. *Accuracy* is associated with the reliability of the data to a given standard and a lack of bias. In contrast, *precision* involves the ability to make fine distinctions.

Recommended spatial standards

An example of a standards document is presented in the National Land & Water Resources Information Management Manual (Version 2.0, March 2000). Adoption of these standards will ensure compatibility with projects being undertaken with funding from the Audit.

Regional groups are encouraged to contact their respective state and territory jurisdictions to obtain information on the most appropriate spatial standards.

Additional information on purchasing spatial information software that ensures compliance with key standards, including the OpenGIS® Consortium, World Wide Web Consortium in the Australian Spatial Data Infrastructure (ASDI) (as mandated within the national Interoperability Framework initiative) is provided in *Module 7: Guidelines for selecting spatial information systems software and hardware*.

A collaborative case study in the development of spatial data standards between local governments in Victoria was that coordinated by the Municipal Association of Victoria (MAV). The new international standard (GDA, the Geocentric Datum of Australia) was officially adopted in Australia on 1 January 2000 superseding the AGD66 standard. The GDA provides compatibility with satellite navigation systems, national mapping programs, and is a single standard for the collection, storage, and dissemination of spatial information at global, national and local levels. It thus allows for the efficient exchange of data.

Some states/territories have passed legislation mandating adoption of the GDA as the new standard.

There are benefits to NRM groups in coordinating the adoption of the GDA, including the following:

- reduced data translation costs
- increased use of GPS by mobile applications
- reduced risk of error and possible litigation
- reduced confusion
- better coordination between agencies.

The following plan has been proposed to assist the implementation of the GDA by local governments in Victoria:

1. distribution of a video (already available) to all councils to raise awareness
2. formation of a steering committee to oversee the transition
3. preparation of a detailed GDA conversion plan/road map at four local government associations (LGAs) using the most common systems (this road map includes the conversion steps, resourcing/costs and identification of issues). These road maps lead to preparation of a generic report, with example LGA road maps collated, which would be used as a resource for all LGAs
4. the provision of a two-day audit and planning process (facilitated by external providers) at participating councils to enable the development of an action plan for conversion to the GDA
5. scheduling of regional or vendor workshops to accelerate the sharing of knowledge between councils, as well as standard letters and general support
6. facilitation of collaboration between councils in relation to aerial photography data conversion methodologies to enable a sharing of costs.

In addition to the above approach, the MAV also provides an indication of potential costs for the GDA conversion for inclusion in Victorian councils' budget planning cycles.

4.4.2 Non-spatial standards

A number of non-spatial standards are involved in many datasets. The following provides a brief overview.

Data acquisition/collection standards

Data acquisition or collection standards include process standards for survey, collection and data capture methods. Data collection standards are the methods and processes for the collection of new data, or conversion of existing data. Numerous groups are established internationally and nationally that deal with specific standards for data acquisition or collection.

Database structure and content standards

Database structure and content standards relate to the organisation, representation and contents of database files and data elements. Data content standards provide semantic definitions of a set of objects which may be organised and presented in a data model, such as an entity-relationship model.

Data processing standards

Data processing standards are standards to which data are subjected for the purposes of data manipulation and conversion into information products.

Data quality standards

Data quality standards include, but are not exclusive of, the following:

- accuracy
- precision
- resolution
- reliability
- repeatability
- reproducibility
- currency
- relevance
- ability to audit
- completeness
- timeliness.

Database maintenance standards

Database maintenance standards relate to the process and timing of updates to datasets. This includes additions, changes and deletions to datasets. It should be noted that it is an accepted practice for organisations to have an official version of a dataset that they have released for general use while they are in the process of updating or modifying the same dataset in order to produce a new version.

Data usability standards

Data usability standards describe how to express the applicability or essence of a dataset of data elements and include data quality, accuracy, and reporting or documentation standards.

Data dissemination standards

Data dissemination standards include standards for data and information access, dissemination processes and products (e.g. maps and reports), and consideration regarding copyright, privacy and freedom of information. The Audit's Information Management Manual is an example of a document containing data dissemination standards.

Terminology/symbology standards

Terminology and symbology standards include terms or symbols which must be used or adhered to. Data symbology or presentation standards define graphic symbols.

Presentation standards

Presentation standards are the methods for displaying and formatting information from a dataset or data standard.

Quality control and assurance standards

Quality control and assurance standards are used to achieve a specified quality and to check the quality of an existing dataset. Details for accuracy and precision are often included in these standards.

Checklists and scorecards are often used to assess compliance of a dataset to a particular standard as part of quality control and assurance processes. An example of a compliance checklist can be found in the Audit's Australian Natural Resources Information 2002 report: http://www.anra.gov.au/topics/publications/national/index.html.

Compliance of the 1996/97 Land Use of Australia Map with standards for the Australian Spatial Data Infrastructure

Access

√ ***Are the data easily accessible?***

- Land use data are available free of charge over the Internet through the Australian Natural Resources Data Library.
- Data may be mapped through the Australian Natural Resources Atlas Map Maker. Detailed regional summaries of land use for each river basin are available through the Australian Natural Resources Atlas.

√ ***Are the data documented?***

- Summary documentation is available through the Australian Natural Resources Data Library and the Australian Spatial Data Directory.

Supply

√ ***Are licence arrangements in place to ensure the information is accessible, while protecting copyright, intellectual property, privacy and confidentiality?***

- a licence agreement has been agreed between the Audit and ANZLIC and is supported by Australian, state and territory government agencies.

Quality

√ ***Do the data meet national guidelines or standards?***

- Data meet the following national guidelines:
  - Spatial data are available in the Geocentric Datum of Australia (GDA94)
  - Attribute data use the *Australian Land Use Management Classification* Version 4, October 2000. The Executive Steering Committee for Australian Land Use Mapping monitors compliance with the classification.
- Download of data from the Australian Natural Resources Data Library is subject to an agreement with licence conditions.

Maintenance

√ ***Are there national coordination arrangements in place to help ensure that data are being assembled, maintained and delivered in a nationally consistent way without duplication of effort?***

- The Australian Government Department of Agriculture, Fisheries and Forestry coordinates the Executive Steering Committee for Australian Land Use Mapping with representation from national, state and territory governments.

√ ***Are custodians of the data maintaining the data according to national guidelines or standards?***

- The Australian Government Department of Agriculture, Fisheries and Forestry maintains the data according to the *Australian Land Use Management Classification*.

Source: National Land and Water Resources Information 2002, National Land & Water Resources Audit.

As mentioned earlier, the criteria by which datasets can be assessed to determine their compliance with standards for the Australian Spatial Data Infrastructure are being updated. Further, each state or territory jurisdiction may have its' own overarching criteria to which regional bodies should conform.

Data classification standards

Data classification standards provide groups or categories of data that serve an application, e.g. a land use or soil classification. Several groups are currently involved in determining classification methodology standards which outline the procedures to be followed when implementing a data classification standard. They describe how data are analysed to produce a classification, and the processes that are followed to achieve data precision.

Examples include:

Salinity Mapping Methods in the Australian Context: User Guide available from at:
http://www.nrm.gov.au/publications/salinity-mapping/index.html

Guidelines for land use mapping in Australia:
http://adl.brs.gov.au/mapserv/landuse/nat_scale_tec.html

Surveying and Mapping Nationally Significant Weeds:
http://www.affashop.gov.au/PdfFiles/pc13456.pdf

Storage procedure standards

Storage procedure standards address the mechanisms and schedules for archiving or backing up data. When appropriate, storage procedures also address the storage media, e.g. streamer tape, CD or DVD—in some cases these are mandated by law.

Data analysing standards

Data analysing standards include methods for computing, comparing, contrasting, assembling, or evaluating a dataset for an application or specified product.

Data transfer standards

Data transfer standards are independent of technology and applications, and facilitate the moving of data among systems, without the prior specification of the intended end use of the data. Some transfer standards are specific to a technology, e.g. the File Transfer Protocol (FTP) as used on the internet.

4.5 Best practice for standards

Best practice procedures for information management involve the development of guidelines which detail the specific requirements an agency or organisation should adopt in relation to standards. In many cases, most of the data standard elements listed above are incorporated into a document which outlines the organisation's data principles and management guidelines.

An example of such a document, from the Herbert River Resource Information Centre, is available for download at:

http://www.hric.org.au/hric_site/hric_info/Policies/Data_princ/Data_princ.asp.

The Herbert example addresses the following areas:

- data acquisition (including flow diagrams for data acquired from both joint and non-joint venture partners, data request forms and custodian licence agreements)
- data storage (including directory naming conventions and structure, and version control)
- data capture
- data distribution (including a data distribution flow diagram)
- data licence agreements (including a flow diagram for selecting a data licence agreement)
- metadata (including a metadata template).

Other best practice procedures include the development of compliance criteria (including scorecards), and the development of guidelines for standards other than spatial data, e.g. reporting requirements, etc. The Audit's Information Management Manual (Version 2, March 2000) is an example of this type of document providing guidelines for projects funded under the Audit. Additional draft templates to assess compliance are available from ANLIC.

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Business process review for ensuring compliance with spatial data management standards, processes, policies and procedures.

4.6 Additional support

As mentioned earlier, the criteria are available by which datasets can be assessed to determine their compliance with standards (e.g. for the Australian Spatial Data Infrastructure). In many cases each state or territory jurisdiction may have its own overarching criteria to which regional bodies should conform. In order to promote the adoption of such standards most jurisdictions have material related to data policies and standards available on their websites.

The following web sources, while not exhaustive, provide a starting point to assist regional users in the location of information relevant to their jurisdiction.

State and territory material on standards

Queensland: http://www.qsiis.qld.gov.au

Western Australia: http://www.walis.wa.gov.au/

New South Wales: http://www.canri.nsw.gov.au/policies/

Tasmania: http://www.dpiwe.tas.gov.au/

ACT: http://www.actpla.act.gov.au/tools_resources/maps_land_survey

Victoria: http://www.land.vic.gov.au/land/lcnlc2.nsf/childdocs/-418EED712A81C5AE4A256A0A0015CDC1-F31E2DE1F7D75F504A256A4F0017DA3E-B3B667568E6561444A256A5700195F0E?open

Northern Territory: http://www.ntlis.nt.gov.au/

South Australia: http://www.environment.sa.gov.au/mapland/sicom/sicom/index.html

Additional general information

Technical: http://asdd.ga.gov.au/asdd/tech/#metadata

General: For additional information about ANZLIC Metadata Guidelines, the ANZLIC Metadata Entry Tool (MET) or any other metadata related issue, NRM regional bodies should contact their jurisdictional metadata contact. Details are available on the ANZLIC website:

http://www.anzlic.org.au/metadata_project.html

MODULE 5

MODULE 5: Spatial Data Discovery and Access

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

One of the prerequisites for natural resources management (NRM) involves the establishment and maintenance of a good database of information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making/planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis and communication are key components.

In recent times best practices have evolved to assist data-related tasks in NRM projects. Successful projects have generally adopted an integrated information management solution combining leadership, people, technology, applications and data within a framework that ensures tools and procedures are in place to maintain and transform data into useful information products that support operations and the decision-making process. A key component of an integrated management solution (and the development of a data infrastructure) involves the development of clearing house or dissemination mechanisms to enable searching, viewing and accessing of data.

The combination of an increasing number of agencies, universities and other groups developing spatial data in GIS-ready formats, coupled with the development of simple desktop spatial visualisation applications and improvements in information technology, is enabling an increasingly larger audience to distribute, publish, share and use datasets that were previously only available to specialists.

Worldwide, the demand for easy and timely access to accurate data is increasing as more NRM organisations and agencies begin to appreciate the value of using spatial information to solve their problems. The intent of this guideline is to provide background information on what data and information currently exist, and the issues involved in discovering and accessing them.

Actions

Important elements in capacity building activities to assist in the improved management of natural resources involve the following:

- establishment of networks of people
- process of data gap analysis
- training in the assessment of ‘fitness for purpose’ for existing datasets and the identification of ‘point of truth’ or authoritative datasets.

Managers need to be aware that services are available for finding data for use in NRM, and that the same services are often available for publishing and disseminating the results of data collection activities. The philosophy underpinning the creation of a number of these services (e.g. the **Australian Natural Resources Data Library**, the **Australian Natural Resources Atlas**, and

Australia's Resources Online) is that the development of datasets is a very expensive activity, and datasets accrue far greater value if they can be readily accessible to a very wide range of users.

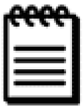
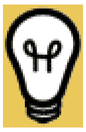
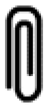
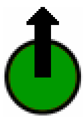
In addition, managers should be aware that accessing and publishing data is carried out within a controlled framework to protect the rights and responsibilities of data providers and data receivers. A number of model frameworks exist for regional groups to develop similar protocols, etc. In this respect, managers should also be aware of the **'Policy Statement on Spatial Data Agreement'** and the **'Model Data Access and Management Agreement'** prepared under the sponsorship of ANZLIC. These can be accessed at: http://www.anzlic.org.au/.

Acknowledgements

This module draws heavily on material produced by the Audit, Environment Australia, Bureau of Rural Science, Geoscience Australia, and ANZLIC. These sources are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

5.1 Background

Access to data and information in a timely fashion, and in a suitable format is critical to decision-making processes related to NRM.

A review of requirements to support regional and local project planning carried out in 2000 produced the following findings.

GIS users were struggling to:

- find appropriate GIS groups in order to get access to their data
- do their own work and efficiently develop their own databases and spatial datasets—consistency and interoperability were also identified as issues requiring attention
- edit existing data to make them more accurate—based on local knowledge.

Regional staff members seek access to spatial datasets and information to:

- undertake their own GIS analysis
- develop their own capacity for printing and overlay work
- develop a sound understanding of what data and information exist and their limitations
- have an input into what data are collected and the level of accuracy and scale.

Regional staff members also requested to know:

- what data and information are available—what they are, how appropriate are they, scale, resolution, etc.
- which agency/organisation has the data
- if they have to pay for the data
- how they feed back local edits and new information into datasets held at a corporate level.

Source: Caroline Michalski (2000), Evaluation of Regional GIS Needs – Workshop and Feasibility Study Overview Information Support for Regional and Local Project Planning. Report for PISA, Land Information Group.

5.2 Access to consistent Australia-wide natural resource data

In recent times, considerable resources have been devoted by governments, education groups and private industry to improve community access to data and information, and the development of consistent Australia-wide natural resource data. As an example, the Audit adopted the following principles to improve community access to data and information products, and increase their usefulness for integration into the decision-making process.

To ensure data from Audit projects remain comparable and consistent where required, all data are:

- developed and maintained to **meet agreed international or national guidelines or standards** for the management of information as endorsed by ANZLIC or through national coordination arrangements.

To help users easily find access to the data from Audit projects, all data are:

- **documented** in the Australian Spatial Data Directory—the documentation provides enough information for users to determine whether the data are suitable for their purpose
- **easily accessible** to all sectors of the community in formats, location, cost and under conditions that promote their wide use.

To protect the rights of all contributors to the data, all data are:

- accompanied by a licence, when transferred, which clearly sets out the conditions under which the data may be used, the rights and responsibilities of the data provider, and the rights and responsibilities of the data receiver. Licence arrangements ensure map information is accessible, while still protecting copyright, intellectual property, privacy and confidentiality. Rights relate to both individuals and governments.

Individuals have the capacity to know where to look for existing spatial data either within their own organisation, NRM group or from external organisations, including clearing houses and peer-support networks.

1⏩2

User groups and stakeholder reference panels provide structured feedback mechanisms to ensure organisations' or NRM regional bodies' spatial information systems are accessible and align with business drivers across NRM regions.

3⏩4

5.3 What data and information exists

A wide range of data and information products that support NRM are currently easily available, *viz* spatial GIS datasets and imagery, reports, documents, tables, videos, posters, photos, and maps.

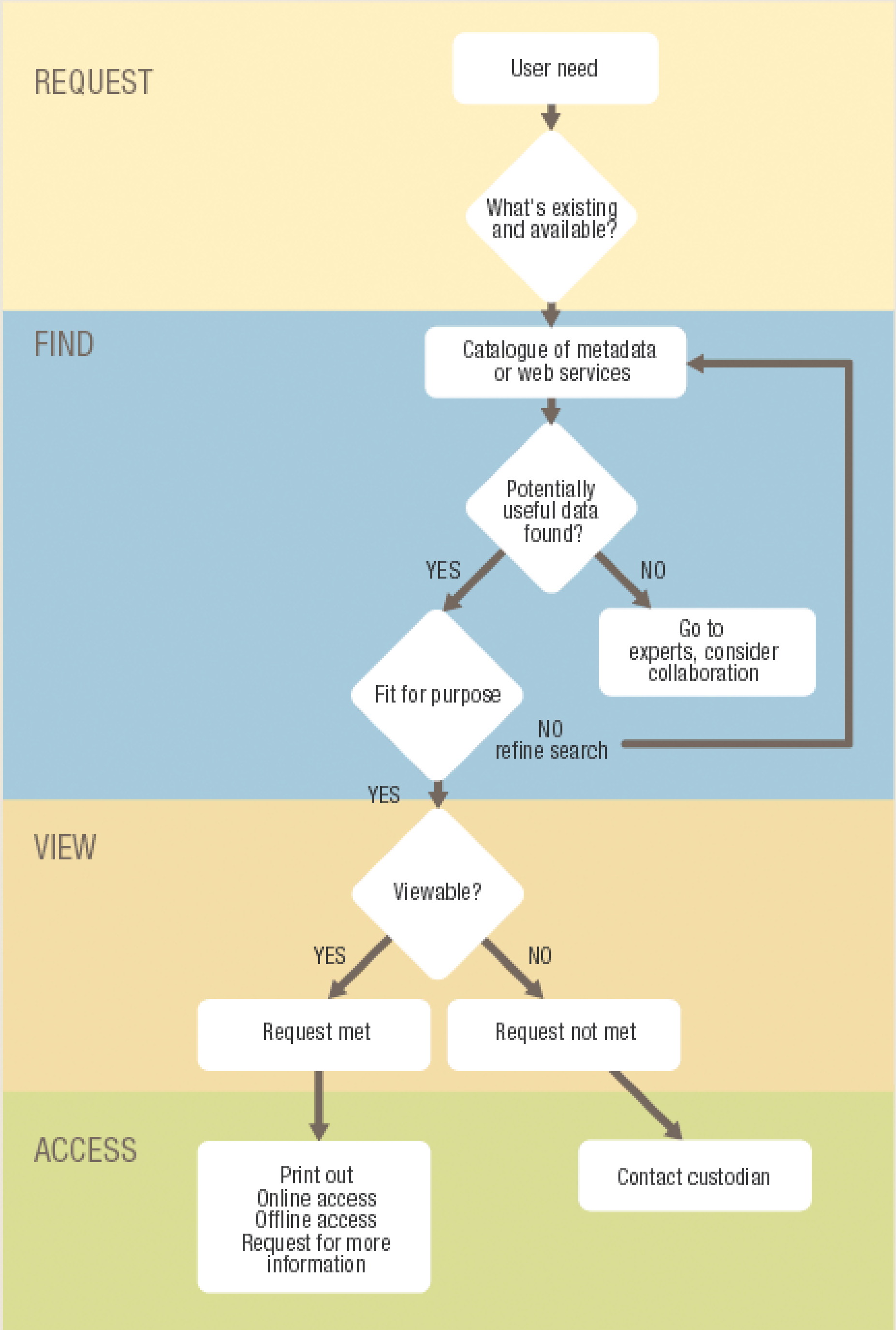
The Audit has been involved in the development of a suite of products to meet a broad range of requirements. These include:

- assessment reports providing national summaries of natural resource issues
- summaries of the assessment reports outlining key findings
- compact discs with map data, technical reports and documentation
- paper maps
- online information services—the Australian Natural Resources Atlas, the Australian Natural Resources Data Library, Australian Resources Online—which provide access to national and regional scale data and information products.

5.4 Finding data for natural resource management

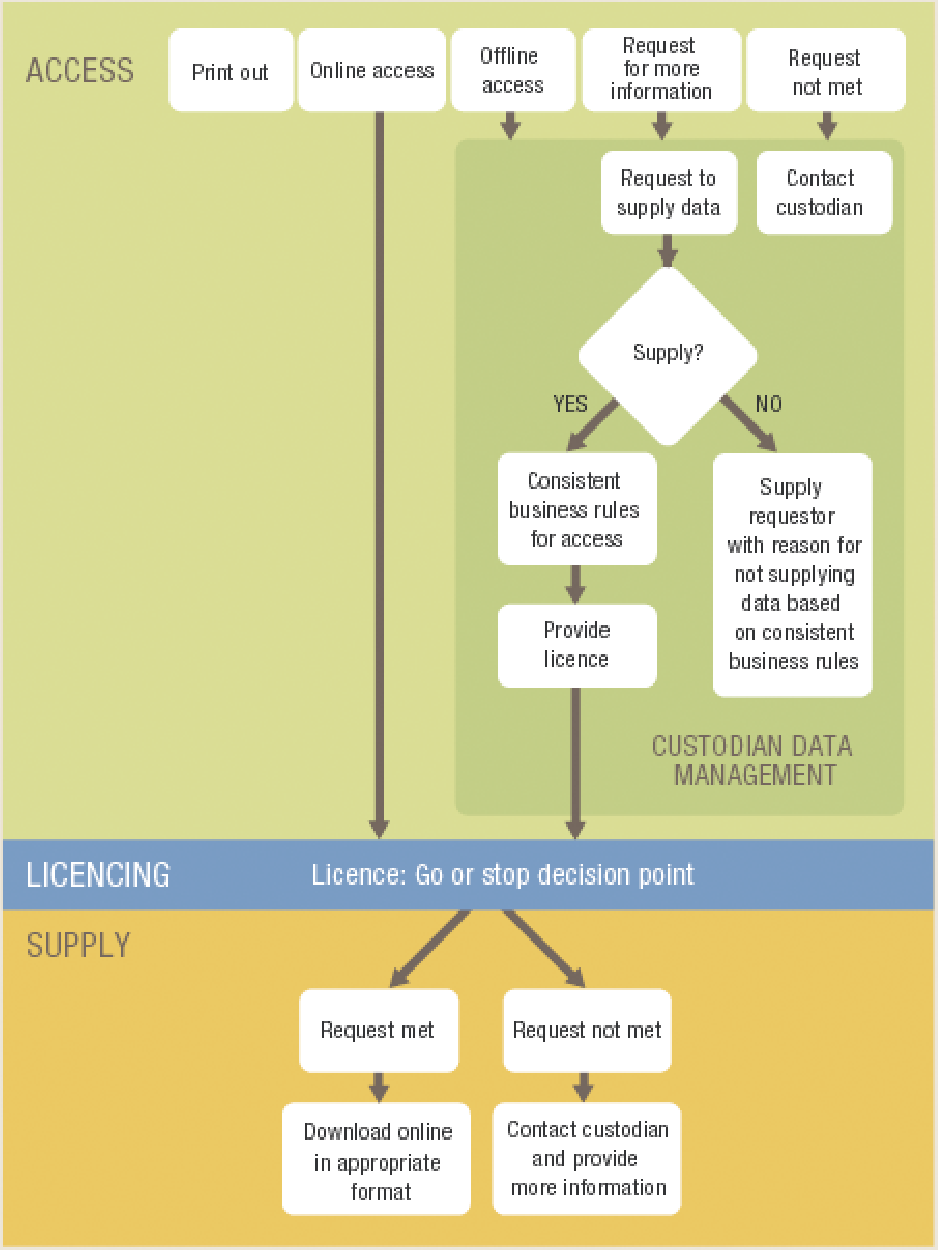
The process of acquiring data (often referred to as data discovery) involves a number of steps carried out within a controlled framework, e.g. searching to determine the data actually exist, viewing and assessing their fitness for use, accessing licence agreements, and supply or delivery. This process is illustrated in more detail in a flow diagram at Figure 5–1: parts (i) and (ii).

Figure 5–1(i) Flow chart for discovering and accessing spatial data and information: a user's perspective.



(continued)

Figure 5–1(ii) Flow chart for discovering and accessing spatial data and information: a user's perspective.



5.4.1 Australian Spatial Data Directory

The Australian Spatial Data Directory (ASDD) is a national initiative that was launched in 1998. It is supported by all governments under the auspices of ANZLIC. **The aim of the ASDD is to improve access to spatial data for the benefit of the wider community— industry, government, education, and general users—through effective documentation, advertisement and distribution.** The directory comprises government and commercial nodes in each state/territory, and spatial data from agencies within the Commonwealth Government.

> A key objective of the ANZLIC Strategic Plan is to promote the development of the Australian Spatial Data Infrastructure (ASDI) which will improve access to, and the availability of, nationally consistent spatial datasets. The ASDD is an essential component of the ASDI and incorporates information about datasets (metadata) from all jurisdictions.

To assist users in searching for and assessing the ‘fitness for purpose’ of datasets, and to ensure that the existence of data producers is widely promoted, all data contain summary documentation or ‘metadata’.

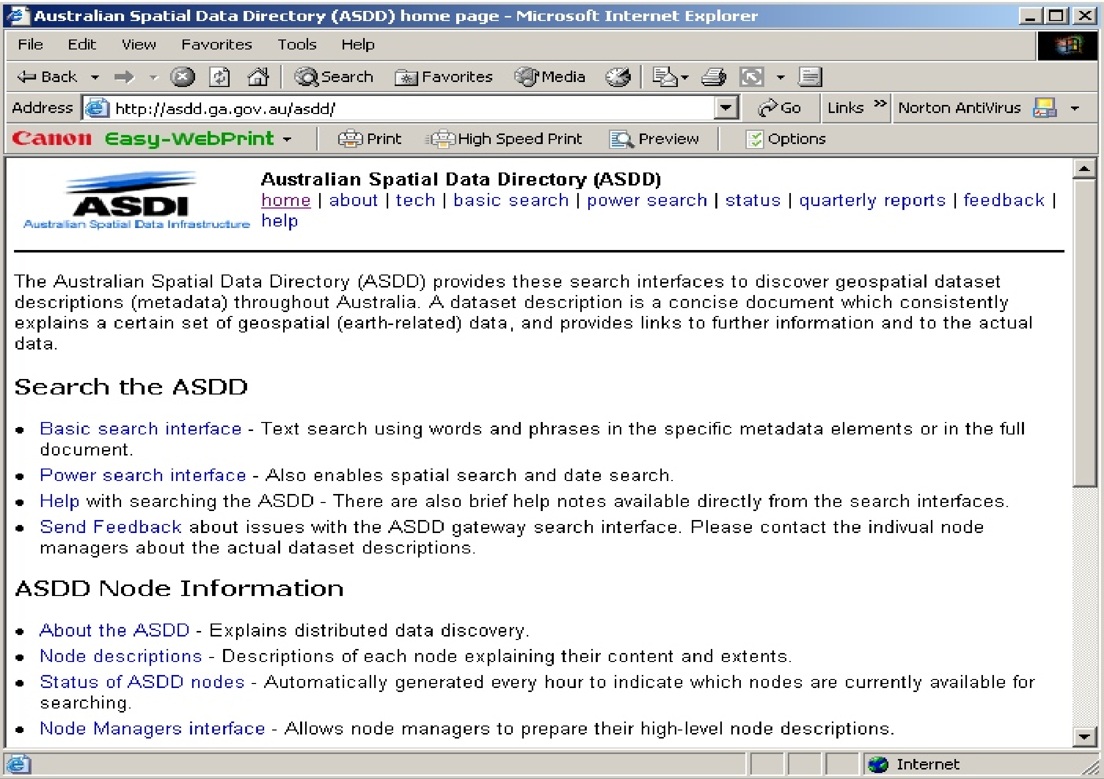
The following information is provided as part of the metadata documentation for each dataset in the ASDD:

- a description of the data
- the location of the data
- details of quality including accuracy and currency
- how the data were developed and any modifications—lineage
- who to contact to obtain access to the data
- conditions of access.

The gateway to the ASDD is maintained by Geoscience Australia on behalf of ANZLIC.

Figure 5–2 Homepage for the Australian Spatial Data Directory

http://asdd.ga.gov.au/asdd/



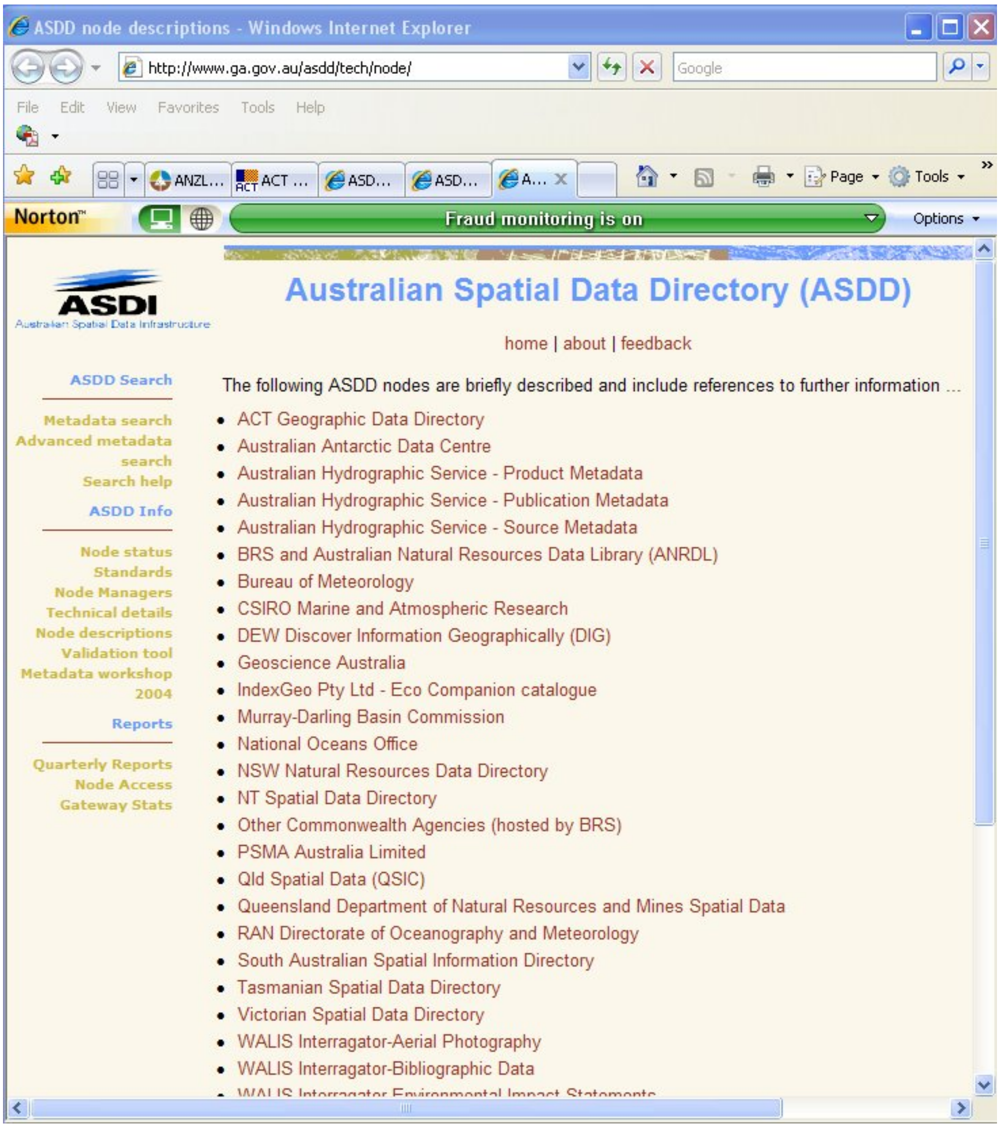
Additional information about the ASDD, metadata management and standards and protocols is available on the ASDD website at: http://asdd.ga.gov.au/asdd/tech/#metadata.

> In addition to the ASDD website, further information is also available on the ANZLIC website at::
> http://www.anzlic.org.au/infrastructure_ASDD.html#connect.

Responsibility for the maintenance of the individual nodes lies with the relevant government and commercial organisations. Anyone can establish a node on the ASDD, but agencies with small holdings are encouraged to use the hosting services of one of the existing nodes.

There are now very good coordination mechanisms between state/territory spatial data systems throughout the Australian Spatial Data Directory, as outlined in Section 5.4.7. The current list is shown below.

Figure 5–3 ASDD node descriptions: http://asdd.ga.gov.au/asdd/tech/node/



5.4.2 Australian Natural Resources Atlas

Governments and the Australian public are able to access a comprehensive range of data and information about Australia's natural resources through the web-based 'Australian Natural Resources Atlas' (ANRA) or 'the Atlas.

The Atlas provides an interface to the data and information prepared by the Audit and its partners, and serves the following functions:

- providing ready access to data and information about the status and trends in Australia's natural resources
- linking and integrating data and information by geography and topics—users of the Atlas can navigate through the Audit's data and information by selecting a topic (e.g. surface water quantity) and geography (e.g. river basin)
- providing a dynamic query and mapping facility for the preparation of user-constructed reports and map-based products
- linking to data and information services to ensure that users have easy access to the most up-to-date data and information.

An overview of Australia's natural resources information is presented in the Audit's report 'Australian Natural Resources Information 2002', and a copy is available on the Atlas website: http://www.anra.gov.au/topics/publications/national/index.html.

This report provides useful information on **'Finding Data for use in Natural Resource Assessments'**, '**Community Access to Information'**, and the development of a '**Consistent Australia-wide database for Natural Resources Management'**.

Note: A flow diagram for accessing data within a distributed network of natural resource information systems taken from the above report is shown at Figure 5–4.

Figure 5–4 A distributed network of natural resources information systems

(Source: Australian Natural Resources Information 2002):
http://audit.ea.gov.au/anra/data/docs/national/Data_Contents.html

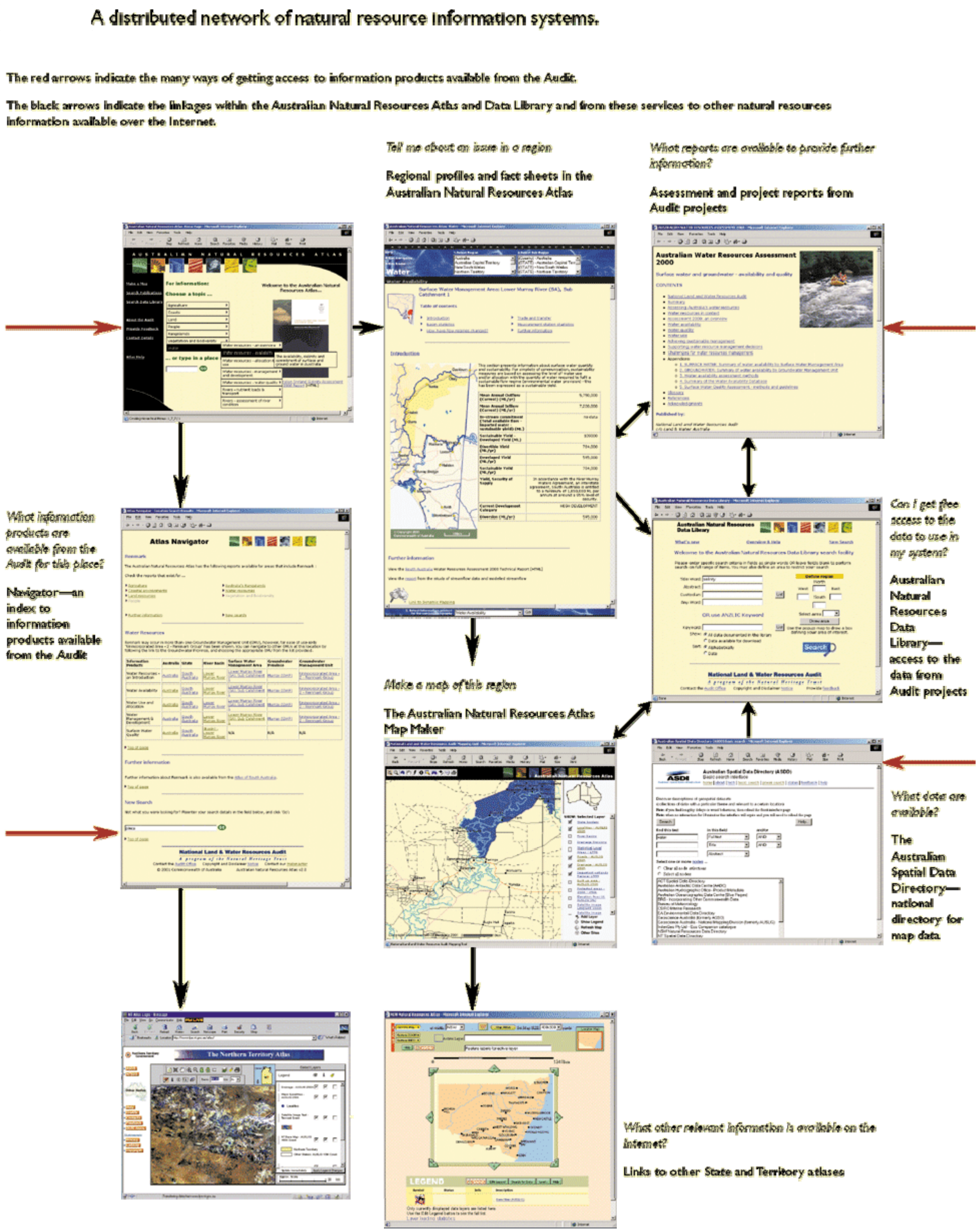


Figure 5–5 Homepage for the Australian Natural Resources Atlas

http://www.anra.gov.au/index.html

5.4.3 Australian Natural Resources Data Library

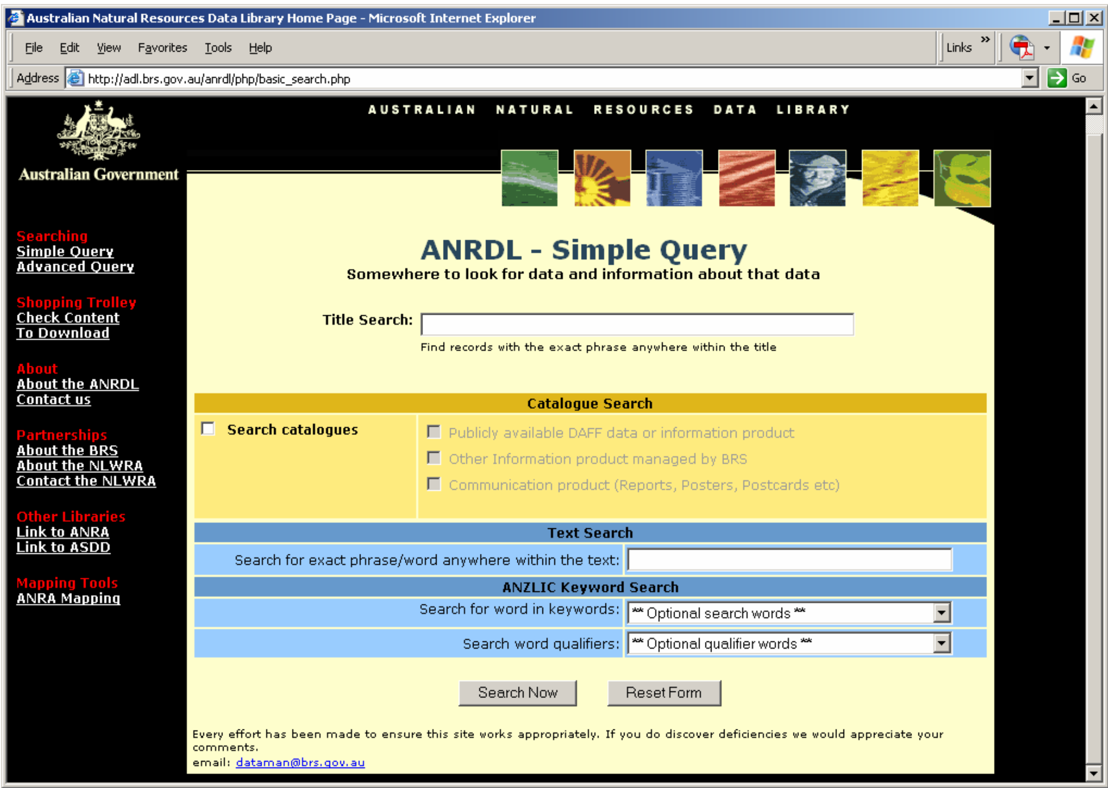
The Australian Natural Resources Data Library, (ANRDL) or 'the Data Library', provides a mechanism for searching and downloading digital data products for free.

The Data Library (a node of the ASDD), involves a broad cross-section of government and private sector groups interested and working in NRM issues. **The Data Library is currently being enhanced to support the full range of data and information products, *viz* spatial datasets (in GIS format), documents, reports, posters, photos, video material, etc.**

> The philosophy underpinning the creation of the Data Library is that datasets, developed by projects carried out under the various themes of the Audit, accrue far greater value if they can be readily accessible to a very wide range of users.

The Data Library can be accessed and used by managers, community groups, students and academics to help in their planning, management and research activities. Additional enhancements, such as simple viewing tools to assist in determining whether a dataset is appropriate for users' needs, are also currently being developed for inclusion.

Figure 5–6 Homepage for the Australian Natural Resources Data Library
http://adl.brs.gov.au



Data custodians are encouraged to make data from Audit assessments available online free of charge.

The Data Library includes large amounts of natural resources data and information collected through Audit projects. Integrated with this documentation are data distribution services and management tools. Much of the data in the library are an extension of that portrayed in the Atlas, often providing additional detailed technical information. Interfaces provide functions to securely download, manage and distribute data.

Spatial data in the Data Library can be used in GIS and spatial modelling tools.

Public Access to Data

The Data Library provides free and direct access to data from Audit projects. This allows users to:

- find Audit data and information products
- find out detailed technical information about Audit data and information products
- download Audit data for use in their own systems where permitted by owners/custodians of the data.

The internet provides direct access to data and information and the marginal cost of transfer is effectively zero, however, there are limitations for groups without access to a broadband connection.

5.4.4 Australia's Resources Online

The Australia's Resources Online (ARO) is a dynamic application enabling generation of a custom report on the condition and trend of the land, water and biological resources in Australia against the Natural Resource Management Monitoring and Evaluation Framework indicators. Reports can be generated for national, state or NRM regional level.

Refer: http://www.anra.gov.au/aro/

The intent of ARO is to provide up-to-date information to accompany the comprehensive theme assessment reports which are still available through the Atlas via the Natural Resource Topics.

5.4.5 Australian Agriculture and Natural Resources Online

The Australian Agriculture and Natural Resources Online (AANRO) is an integrated knowledge discovery tool containing agriculture and natural resources data and information including research, publications and web resources.

Refer: http://www.aanro.net

5.4.6 Discover Information Geographically

The Discover Information Geographically (DIG) is a tool which provides a mechanism for discovering data within the Australian Government Department of the Environment and Water

Resources (DEW). Current entries cover data and publications, but are to be extended to incorporate map services and printed maps. All DIG entries are related to a geographical location, and most of the data are available for download and use within a GIS. Data are mostly available at a national (rather than regional) scale, though they do contain many useful holdings such as protected areas, etc.

How to Use DIG

A search is conducted using keywords, categories or by defining a geographical area. A brief overview of each entry matching the criteria is displayed with links to the full entry and a simple map displaying the approximate geographic location of the data. Alternatively, it is possible to use a 'Browse' tab to navigate through all the metadata entries which are organised in topic folders. Note: Some datasets may not be available for download due to access/use constraints, however, relevant contact details are included with every entry. Where datasets are available for download a simple licence agreement is included. Refer:

http://www.environment.gov.au/metadataexplorer/explorer.jsp

5.4.7 Environmental Reporting Tool

The Environmental Reporting Tool (ERT) is a system developed by the Environmental Resources Information Network (ERIN) within the Australian Government Department of the Environment and Water Resources (DEW). It provides a mechanism for generating custom reports containing information on threatened species, important wetlands, heritage sites, pollutant emissions and other environmental themes based on user-defined areas or NRM regions, NAP regions, local government areas and postcodes.

Refer http://www.environment.gov.au/erin/ert/index.html

5.4.8 State/territory based initiatives

In addition to the services mentioned above, it is possible to access a considerable range of spatial data from nodes and natural resource sites hosted at a state and territory level. Often these data may be at a more detailed scale than those available from a national dataset and are therefore potentially more appropriate for use in analysis at a regional scale.

> When searching for data (especially for NRM programs) it is recommended that users contact their state or territory facilitators and coordinators. A listing is maintained on the NRM website: http://www.nrm.gov.au/do/facilitator.html

Additional state/territory contacts (for spatial digital data) are available on the websites below. These contacts should also be able to assist in providing support in the process of assessing 'fitness for purpose' and location of 'point of truth' or 'authoritative data sources'.

Information on State/territory ASDD and Atlas sites

Queensland: http://www.qsiis.qld.gov.au and http://www.information.qld.gov.au/

Western Australia: http://www.walis.wa.gov.au/ and http://www.atlas.wa.gov.au/

New South Wales: http://canri.nsw.gov.au/nrdd/ and http://www.nratlas.nsw.gov.au/wmc/savedapps/nratlas

Tasmania: http://www.thelist.tas.gov.au/

ACT: http://asdd.ga.gov.au/asdd/tech/node/act-1.html and http://www.gim.act.gov.au/actLocate/index.dwt

Victoria: http://www.land.vic.gov.au and http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/vrohome

Northern Territory: http://www.ntlis.nt.gov.au/ and http://www.ntlis.nt.gov.au/imfPublic/imf.jsp?site=nt_atlas

South Australia: http://www.asdd.sa.gov.au/ and http://www.atlas.sa.gov.au/

5.5 Additional support

A number of additional websites are available which contain spatial data and information. By way of example the following is provided to assist regional groups.

The Australian Government NRM Site http://www.nrm.gov.au/data/index.html has **links to numerous atlases, sources of spatial data and reporting tools.**

The Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA), Environmental Resources Information Network (ERIN) site http://www.ea.gov.au/erin/ contains an **information services section for decision making** with numerous links to various information service sites on the internet. For example:

- the Land Cover Change and Condition Database
- the Australian Heritage Database
- the Australian Wetlands Database
- the Collaborative Australian Protected Areas Database

Refer:http://www.environment.gov.au/erin/index.html

Geoscience Australia's: **GIS Data and Imagery**—free downloads: http://www.ga.gov.au/products/

Free satellite imagery (from 1990 and 2000) is also available for the whole of Australia from the NASA Global Landcover Project at: https://zulu.ssc.nasa.gov/mrsid/docs/GeoCover_circa_2000_Product_Description.pdf

Image downloads available from https://zulu.ssc.nasa.gov/mrsid/mrsid.pl Note: You may receive a certificate of trust warning to enter this site.

Datasets are often updated. It is recommended that users always check to ensure 'point of truth' or 'authoritative data sources' are being used.

MODULE 6

MODULE 6: Project Management and Justification - Lessons Learnt, Pitfalls and Best Practice Procedures

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

Many organisations throughout the world have invested heavily in SIS software and data capture programs. However, in many cases the implementation processes have not operated in an effective or efficient manner, and the anticipated benefits have not been realised. Many projects have run over budget or not delivered on time. Considerable knowledge of the reasons for failure is becoming increasingly available to assist managers in the design and implementation of projects.

It is acknowledged that each state and territory jurisdiction has its own implementation arrangements for NRM projects. The intent of this guideline is to provide an overview of lessons learnt from previous GIS and IT projects, along with resource material that supports 'best practice' for project management, e.g. the development of regional NRM plans, and monitoring and evaluation activities. It is hoped that such material will be generic enough to be useful to all NRM projects.

Actions

Managers should be aware of the experiences and lessons learnt from other organisations to ensure their projects are designed and implemented to achieve maximum benefit. There are many examples where an integrated management solution has been successful in NRM projects, however, there are also examples of projects that have failed to return any measurable benefit to the organisation.

Following are a number of tips for the successful implementation of SIS projects:

- Understand the problem before jumping to a solution.
- Always include key stakeholders in the feasibility process.
- Carefully assess internal development capabilities.
- Define requirements clearly.
- Distinguish the problem from the symptoms surrounding it.
- Resolve political issues.
- Anticipate change during the life of a project and put systems in place to manage it including a risk management plan.
- Make sure effort invested in project management fits the budget, duration and complexity of the project.
- Evaluate the project at various stages, and at the end, to make refinements and help future project implementation.

The key to justifying expenditure on spatial information management processes and projects is to be clearly focused on the benefits to your organisation or NRM body. Where possible these benefits should be considered positive outputs, however they can also include potential risks and/or costs to the organisation or NRM body if investment is not made in its spatial information infrastructure.

Managers should also refer to material provided in the following guidelines:

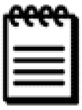
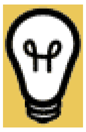
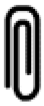
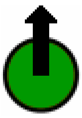
- Module 1: Information management and the sustainable development of natural resources
- Module 2: Data management principles.

Acknowledgements

This module draws heavily on an article produced by Mr David Hamil which has been included with his permission. Additional material has been sourced by the State Government of Tasmania, the University of Tasmania and the NSW Government Natural Resources Information Management Strategy and other NSW Government Department guidelines. Selected material has also been sourced from the ANZCLIC – Local Government Toolkit. These sources are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

6.1 Background

Many organisations throughout the world have invested heavily in GIS software and data capture programs. However, in many cases the implementation processes have not operated in an effective or efficient manner, and the anticipated benefits have not been realised. Projects often run over budget, or are not delivered on time. An understanding of why such failures occur is becoming increasingly available to assist managers in the design and implementation of spatial information projects of all sizes, budgets and complexity.

In most cases the software was not the problem, but rather some of the essential ingredients that comprise an integrated management solution were not addressed in the correct manner, e.g. leadership, management, planning, etc.

Fortunately, considerable literature is now available on the implementation and management of GIS projects, and a stand-alone guideline on Information Management and the Sustainable Development of Natural Resources has been prepared as part of this Toolkit series.

The intent of this module is to provide an overview of some of the pitfall and lessons learnt (best practice) from previous experiences in implementing GIS projects, plus support material on project management and best practice procedures for regional natural resource projects.

6.2 Pitfalls, lessons learnt and best practice in managing IT and GIS projects

The following material, included with the permission of Mr. David Hamil, provides a clear overview of the pitfalls and issues in managing GIS and IT projects.

Your Mission, Should You Choose To Accept It: Project Management Excellence

BY David L. Hamil, PMP, MESA Solutions, Inc.

Project failure is endemic in the geo-spatial information systems (GIS) industry. A recent study performed by KPMG Information Technology, a Toronto-based professional services company, showed that of the projects that failed, 87% went more than 50% over budget, 45% failed to produce the expected benefits, and 86-92% went over schedule. Do you know why 85% of all projects fail to meet all of their critical measures of success? Do you know how to avoid the pitfalls and mistakes that can cripple your projects and derail your career? If you answered no to either of these questions, then your projects may be in trouble. This paper presents the top 4 factors that have a direct bearing on the success or failure of a GIS project, and the strategy for substantially achieving project management excellence.

Web Link – This article is available at http://spatialnews.geocomm.com/features/mesa1/

6.3 Introduction

Technology projects worldwide are costing companies billions of dollars more than they budgeted for, and almost half don't live up to the clients' expectations. Newspapers and business dailies trumpet few project successes but a massive number of failures. As projects grow larger and more complex with every passing year, their outcomes - both successes and failures - become fodder for the media and our competition. Unfortunately, project failures tend to predominate as they not only make sensational stories but also are far more common.

What are the odds that your next information systems/information technologies (IS/IT) project will be delivered on time, within budget, and to user expectations? Pretty grim, unfortunately, if you dwell on the news propagated by IS industry analysts. META Group estimates that half of all new United States software projects will go way over budget (META Group, 2000). The Standish group says 53% of IS projects overrun their schedules and budgets, 31% are cancelled, and only 16% are completed on time and on budget (Standish Group, 2000).

The mismanagement of projects to develop the geographic information systems that companies use to run their businesses has been going on for years and the situation has not improved. "The management of projects is still treated in a very amateurish way," said Nigel Kelly, a partner in KPMG's IT practices.

For its study, KPMG surveyed the chief executive officers of 1,450 public and private sector organizations across the U.S. and Canada, and analysed more than 100 failed IT projects. A project is considered a failure, according to IS industry analysts, if it was cancelled or deferred because it wasn't delivering its planned benefits, or if it had a budget or schedule overrun of more than 30 per cent. Bottom line is that there is an astonishing waste of money here. The GIS sector of the IS/IT arena is no exception - project failure, sadly to say is as prevalent in our business, also. Wow, what a project "horror scope" for you and I. However, the real message for you and I is not that a project fails, but rather why it fails. In analysing these cautionary tales, business leaders can draw on these "lessons learned" to prevent similar fates in their own project ventures. An analysis of project failures, both publicized and unpublicized, shows that the principal causes for project failure can be distilled down to 4 fundamental reasons: 1.) Poor planning, 2.) Lack of corporate management support, 3.) Poor project management, and 4) Lack of customer focus and end-user participation.

6.3.1 Poor Planning

GIS evangelists frequently tout the cost savings, improvements in productivity and services, and market-share increases that GIS can bring to an organization. Why then, have some organizations that have gone down the GIS road found the process frustrating and the benefits elusive. According to Dr. Roger Tomlinson, who is widely recognized as the "father of GIS," "one culprit is often to blame - poor planning (Tomlinson, 2001)."

Proper planning is a key project driver for success. The success of any organization's GIS implementation depends on thoughtful planning. Dr. Tomlinson states," without such planning, a GIS implementation can easily run over budget and still not provide any measurable benefits to the organization." Thus the formula for a successful GIS is to focus on strategic business needs and know, going into it, what you want to get out of your GIS.

GIS project planning must occurs at two distinct times - at feasibility study time and during project implementation time.

6.3.1.1 Feasibility Study Planning

A feasibility study typically is the response to some client-identified problem or opportunity. It reveals what is required to build a solid business case, allowing management to make an informed decision about funding or cancelling the project. "To be, or not to be?" is the primary question a feasibility study answers. This primary question can be decomposed in three supporting questions: What is this project all about? Should we do this project? How should we go about this project?

6.3.1.2 What is this project all about?

One primary reason for project restarts, or outright failure, is the lack of a project mission, which at this early point means a careful analysis of the problems or opportunities and their possible impact on the organization. Team members, customers, and other stakeholders need a good understanding of the project's fundamental components - goals, objectives, scope, problem statement, constraints, and vision.

A good test of whether or not a project is understood is to walk around and ask various participants what they think it's all about. A crisp, business-oriented, non-technical answer usually means the project's groundwork is well established. The answer could be what we refer to as a project objective statement: a short, concise, high-level summary of the project. For example, 'To identify and deliver a production-ready, state-of-the-art geographic information system to include online service provisioning and assurance subsystems by July 9, 2002."

6.3.1.3 Should we do this project?

The second major question answered by a good feasibility study is whether or not the project should proceed. The very name "feasibility" indicates one possible outcome is not to proceed. A significant portion of the multi-billion losses on software projects comes from projects that should never have gotten past the feasibility stage, but got caught up in corporate egos and politics. Once the problems and opportunities have been identified, the next task of the feasibility study is to define the criteria for an acceptable solution. Feasibility (acceptability) incorporates political, economic, technical, and organizational components. For example, if the senior vice president of engineering demands that a particular project to be done, why spend weeks coming up with a detailed cost/benefit analysis? In this case, the "should" question is fairly easy to answer. It is more effective to spend the remaining time answering the other feasibility questions.

The second phase of answering the "should" question is to identify the alternatives and recommend one. The alternative of not continuing the project should always be thoroughly considered. Table 1 shows key signs of an unfeasible project.

Table 6-1 Signs of an Unfeasible Project

Reasons "Not to Be" (Signs of an Unfeasible Project)
1. Major political issues are unresolved by the feasibility study.
2. Key stakeholders won't participate in the feasibility study (and therefore the project).
3. Risks (probability of adverse consequences) are too high (technical, economic, organizational).
4. Cost and benefit ratio isn't favourable enough, especially when benefits are "soft."
5. Internal staff's experience and training is insufficient for the project.
6. Requirements are unclear, or keep changing radically during the feasibility study.
7. Risk and reward ratio is unfavourable. High risks usually need a high reward to be worthwhile.
8. Clients (in a multidisciplinary project) can't agree on exactly what the problems or objectives are.
9. No executive wants to be the project's sponsor.

iii. How should we go about this project?

A good feasibility study says more than "do it." In addition to defining the project objectives and deciding whether or not to proceed, it provides a broad outline of how to proceed. This involves preparing an initial, high-level project plan that provides a gross project sizing, identifies major milestones, and estimates resource needs. A plan of action serves two purposes: it gives the follow- up team a direction, and it forces the feasibility study team into thinking about critical implementation issues up front. Figure 6-1 depicts six simple steps for feasibility analysis.

Figure 6–1 Steps in a successful GIS project.

The success or failure of a project is often decided very early. To pull off an effective feasibility study, you must have the right attitude and the right approach. Having a good feasibility study process without the proper commitment from management and staff to listen to the answers doesn't work well - it results in substance without form. Having a commitment to listen, but without the substance of a reasonable feasibility study process isn't much better. Doing a feasibility study takes time up front, and it will likely result in a later start date for a software project. The potential benefit you'll receive from starting slow, however, is a quality product finished on time and within budget. Table 6-2 shows several tips for a successful study.

Table 6-2 Tips for a Successful Study

Tips for a Successful Study
1. Understand the problem before jumping to a solution.
2. Always include key stakeholders in the feasibility process.
3. Carefully assess internal development capabilities.
4. Define requirements clearly.
5. Distinguish the problem from the symptoms surrounding it.
6. Resolve political issues.

6.3.1.4 Project Implementation Planning

The solution to successful project implementation planning is to develop an understanding of the full scope of the GIS project. Using the results of the feasibility study as a basis, you must achieve answers to the following questions: What you're building? Why you're building it? What are your requirements? Who your customer is? Who's in charge of the project and who are the key or required staff? What are the risks? What are the benefits? What are the major milestones and target dates for each? And of course, it's also important to understand what your project isn't. A project that tries to meet everyone's objectives likely will please no one.

The answers to the above questions, along with many others, should be documented in a formal, approved document, called the "Project Plan," which is used to manage and control project execution. The project plan is a single document or collection of documents that should be expected to change over time - a "living" document - as more information becomes available about the project. A solid project plan is a blueprint, or a game plan, that charts the entire project's course. For example, the risk assessment portion of the plan should help to minimize the cost of rework by anticipating and addressing problems early in the project. According to the Project Management Institute (PMI, 2000), "there are many ways to organize and present the project plan, but it commonly includes all of the following:

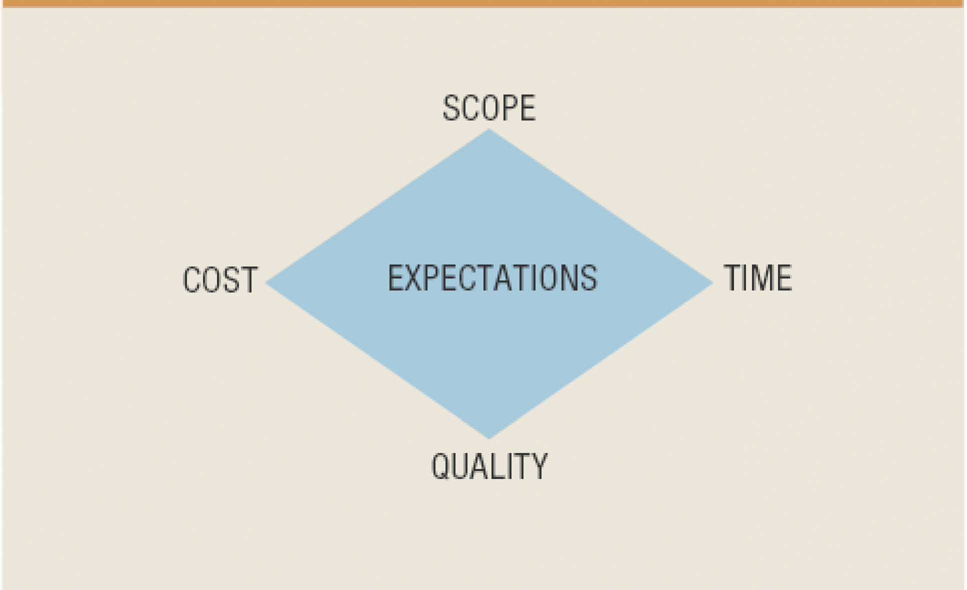
- project description and overview
- a description of the project management approach or strategy
- scope statement, which includes the project deliverables and the project objectives
- work breakdown structure ("WBS") to the level at which control will be exercised

- cost estimates, scheduled start dates, and responsibility assignments to the level of the WBS at which control will be exercised
- performance measurement baselines for schedule and cost
- definition of project success criteria
- major milestones and target dates for each
- subsidiary management plans, including:
  - risk management plan that identifies key risks, including constraints and assumptions, and planned responses for each
  - resource management plan
  - schedule management plan
  - cost management plan
  - quality assurance/quality control plan
  - communications plan.

6.3.1.5 Project Planning Summary

The fundamental premise of achieving excellence in project management states that the project manager's greatest challenge is effectively balancing (or juggling) the components of time, cost, scope, quality, and the expectations for each. Figure 6-2 shows the project diamond, which signifies this balance.

Figure 6–2 Project diamond.



The components of the project diamond have a symbiotic relationship. For example, when a user requests an additional report that wasn't agreed on in the requirement specifications, the project's scope and quality change. This will change the other project components as well. As a result, the diamond's shape will be skewed, graphically depicting a project out of control. The challenge is managing change while keeping the diamond's shape intact. Project planning defines the diamond, while effective and efficient change and expectation management lets you manage it throughout the project's life cycle.

Effective project planning is not conducted in a vacuum. It must be carried out in coordination and cooperation with all appropriate stakeholders. The project manager must manage their expectations throughout the process. The project manager must constantly look for opportunities to create win- win relationships by negotiating work that must be accomplished. A project manager who declares, "this can't be done in the time frame allotted" will meet with stiff resistance from client management. On the other hand, a project manager who can defend this statement with a solid understanding of the project's scope, backed by a logical work breakdown structure; thoughtful estimate and project schedule; and concise risk analysis will be met with a response like, "Maybe you're right. Help me to understand what you understand." This is effective expectation management and proper development of win-win relationships. Once your project plan is in place, it's much easier to manage your project diamond.

6.3.2 Lack of corporate management support

Does your project have the full cooperation and support of corporate management? If not, then you're project is likely doomed to cancellation or cutbacks. Your project is not the only game in town. Make sure you have a dedicated sponsor who will support your project from its inception to completion, such as a project manager who communicates resource needs early and often to his or her senior management.

A project succeeds only when senior leadership makes it a top priority and broadly communicates their sponsorship across the organization. Organizations respond when leadership emphatically communicates their commitment to the project. All levels, from the bottom through the middle to the top, must remain sensitive to the needs and priorities of the project.

Without the commitment of our upper management, then our projects may suffer in any one or more of the following areas:

- Inadequate Staffing - Your team cannot set and maintain direction if key positions are left unfilled or inadequately filled for a long period. This is where the inner-company politics come into play. The project manager must aggressively seek out talent. They must identify the critical skills and characteristics needed for success in an open position. They must organize a selection process that leaves little question about what team members can do and how they would fit within the project team.

- A project manager is only as good as his or her team; don't let your ego distract you from your project's goal. Work with your senior management to assemble a talented team, provide resources and ground rules, and let the players take ownership of the target solution. You've probably heard the statement, "80% of management is picking the right people, and the other 20% is getting out of their way." A good project manager must create an environment where the "right people" can perform optimally. You have to work hard to fail if you have the best people.
- Unfulfilled Commitments - The project manager should always engage in good-faith commitments with customers and managers about what is realistically achievable. In spite of this, if the project manager loses, or never fully obtains support from his or her senior management, then even such commitments as funding, staffing availability, and hardware and software needs may be unachievable.
- Inadequate Funding - It almost goes without saying that a project is "dead" if funding is insufficient or if funding is cut. Corporate management will put their money where they believe they will receive the most benefits. If you, as the project manager, truly believe in your project and can communicate both its short- and long-term benefits, then you must be that "champion for the cause" to keep your project funded.

6.3.3 Poor project management

Project management can be subdivided into two categories - the software development process, and the role and responsibilities of the project manager.

6.3.3.1 Software Development Process

GIS projects, like a project for constructing an automobile, must have an ordered set of steps for taking what started as a concept in someone's mind to a real product that is usable by the client. Without a sound software development process, GIS projects can easily run astray. Many organizations that undertake a GIS project do not fully embrace a defined, repeatable, and predictable software development process. The consequence of this behaviour usually is a significantly increased risk to the project in predicting and controlling the critical factors of schedule, cost, scope, and quality.

According to Neal Whitten, a world-renowned project management author and lecturer, "an organization may have currently defined processes, but those processes are ineffective for one or more of the following reasons (Whitten, 1995):

- not comprehensive enough: they do not already define all of the activities that apply to all new projects,
- overly complex: they require too much time and skill to comprehend and apply,
- not flexible: they are not easily tailored to meet the unique needs of new projects,
- not "owned": there is weak or no buy-in from the project's members,

- not continuously improved: lessons learned from past projects are not used to improve the current processes, and
- not enforced: the guidelines are there, but the project leadership lacks the discipline to enforce them.

Even worse is the situation where a software development process is not followed because a process has never been defined and documented fully. Having no software development process, or not following a defined process, is indicative of an organization that, albeit perhaps unintentionally, lacks the vision and discipline to become or maintain a world-class position in the fiercely competitive software industry. A software development process offers a framework from which to plan a new project, avoid repeating mistakes of past projects and improve on things that went well. Whitten defined eight steps to define a software development process (Whitten, 1995). The top three of these steps are:

1. Identify the software model - The first step in defining a software development process is deciding on the software process model that best fits the needs of your organization and the type of project you are implementing. There are numerous models and variations of models from which to choose. Most models are derived, at least in part, from one or more of the following basic models: Code-and-Fix Model, Waterfall Model, Incremental Model, and Iterative Model.

2. Identify the Activities_- Once the software model has been selected, the next step is to identify the primary activities that need to be implemented to satisfy it. A representative list is as follows: Requirements Definition, Functional Design, Detail Design, Test Plans/Procedures, Code, Unit Testing and Incremental Deliveries, Integration Testing, Regression Testing, System Acceptance Testing, Software Packaging and Delivery, Training Plans/Procedures and Training

3. Identify the Relationships Among Activities - With the activities defined, now identify the relationship between related activities. This can be achieved by listing the entry and exit conditions for each activity

Let's look at the entry and exit conditions for the Functional Design activity.

Entry Conditions: The approved requirements, as set forth during the Requirements Definition, are distributed for review.

Exit Condition: The GIS functional specifications are reviewed and approved prior to proceeding on to the Detail Design activity.

6.3.3.2 The Role and Responsibilities of the Project Manager

KPMG's Kelly stated, "The management of projects is still treated in a very amateurish way." Although some of the blame can be placed on the software development process, or a lack thereof, the primary place to "point is finger" when poor project management comes into play is a failure by the project manager to "manage the project."

Simply put, the project manager is "the" individual with the responsibility for managing the project. To get results, the project manager must relate well to: the people to be managed, the tasks to be accomplished, the tools available, the organizational structure, and the organizational environment, including the customer community.

I have identified six key competencies of a "top gun" project manager:

1. Education and Experience in Project Management - Organizations that undertake the management of very diverse projects must possess thorough knowledge of project management and implementation. Along with up to date formal training, the project manager should be an apprentice "on the job" before he or she is placed solely in control of managing a project. Remember, project management and implementation is a craft, not a science - you can't quantify all of it. At some point, you'll have to rely on your own intuition and experience to substantially ensure success.

   All in all, the project manager must possess the skill set to be able to manage their project, from inception to completion, using the organization's software development process.

2. Negotiation and Communication Skills - Another of the key competencies of a "top gun" project manager are his or her ability to effectively negotiate and communicate with senior management, direct reports on the project team, the client, supporting organizations, and other stakeholders who have a vested interest in the success of the project.

3. Planning and Organization Skill - Recall the number 1 reason for project failure is poor planning. The project manager has direct control over this and can setup the necessary measures to "build the proper foundation" that will be a stepping-stone to project success. Coupled with proper planning, the project manager must be a good ringleader who minimally organizes the following: meetings, schedules, deliveries, financial statements, and various other plans to substantially ensure his or her project is targeted for success.

4. Effective Problem Solver_- Due to the complexity and diversity that may exist within a project (e.g., a GIS data migration project), the project manager is often called on to analyse problems and make timely, strategic decisions that can have a profound affect on the project - whether good or bad. The project manager should be skilled at being able to isolate the root cause of a problem at any given moment in a project, and if necessary enlist the help of his or her project team to "buy into" the solution.

5. Leadership Ability - The best leaders spend much of their time just watching and taking it all in. They avoid jumping to conclusions or leaping to premature judgments. They try to understand what is needed and why. They are constantly learning from minute to minute as well as from year to year.

Never forget that every leader is always being watched. Set the standard with your own attitude and performance. If you demand thoroughness, practice it. If you expect openness to new ideas, listen and consider. If you want to promote teamwork, be a team player. If you want good communication, communicate well. Sure it's obvious, but it can be darned hard at times to practice what you preach.

6. Aims for Excellence in All Work - Although I believe much of how a project manager functions in his or her daily work is characteristic of their very nature, the project manager can learn to aim for no less than the best. The project manager, of all people on the project team, must strive for excellence in "all" project work, and expect no less than the same from his or her project team. Achieving excellence in a couple of areas, but missing the mark in others is not acceptable. For example, if the team meets a particular software delivery date and kept the expenditures within budget, but what the team delivered does not meet the quality expectations, as defined by the client, then we have missed the mark on achieving overall project excellence. It's a tall order, but one that we should strive for.

All in all, seasoned project managers are good ringleaders. They know they must balance four elements of expectations - quality, schedule, cost and scope - at all times. Quality shouldn't be sacrificed to adhere to a rigid schedule or a tight budget. Nor should a schedule be tossed aside because of an obsessive focus on quality. Yet in even the most well managed project, sometimes it makes sense to ease up on a deadline, a budget or a quality-control process. But these slips shouldn't simply happen. They should come from conscious decisions made by project managers who understand their objectives and know that project management is a balancing act.

6.3.4 Lack of customer focus and end user participation

Are your users involved in the system requirements definition process, the system design process, and throughout the project's implementation and testing phases? If the customer loses focus or is never fully engaged in the project, then you're faced with the situation where the project deliverables likely will not meet the client's expectations.

User involvement is a key driver for a successful project. It is absolutely imperative that the customer, including the end-user of the GIS, be proactively involved throughout all lifecycle phases of the project. The end users are powerful and are only becoming more so. Their power can work for you, or against you. To have their power work for you then make sure the client's users are a part of the project team, and that you involve them during requirements gathering, application design, prototyping, testing, and incremental acceptance. If you, as the project manager, do not include the very users who will be using the GIS, then you may not achieve buy-in to the new system. Far too often, lack of buy-in by the true GIS users causes the system to be "shelved." Oh yes, the system may satisfy every requirement, pass every acceptance test procedure, and receive signoff by the client's project manager. However, it could fail to pass the most important test - user acceptance.

The client involvement, and in particular the end-user participation, can "make" a project. Reminder, the end users are probably the most powerful organism in the client's organization. Let's ensure that they're playing on our team.

6.3.5 Summary

Considering that billions is spent each year on IT software development in the U.S. and Canada alone, the KPMG and Standish findings painted an alarming picture of project mismanagement in both private and government sectors. There's a buyer beware message to the extent that the clients need to understand what they want, what they are getting, and go after it with a vengeance. Clients need to be able to quantify and qualify project benefits, have it planned initially, managed properly, and its status monitored early, often and closely.

Remember, all software projects run into snags - no project is immune from failure. The potential troubles are well known: missed deadlines, blown budgets, unmet expectations, and internal resistance - the list goes on and on. How teams respond to problems determines the project's eventual success or failure. Avoid past mistakes by responding effectively to problems as they arise. The trick is to manage a project in a proactive way, preventing some problems and minimizing the effects of others. With proper planning, support of senior management, sound project management, and active client involvement, a GIS team can bypass many common mistakes.

While there are essentially 4 principal reasons why projects fail, as I have documented here, it only takes one of them to make the difference between success and failure. While avoiding the mistakes of the past, never forget to stop and celebrate successes, even the small ones. GIS technology is taking organizations places they've never gone before. So when you get somewhere that you've never been, be sure to have your team "pull over" to take in the view. Then push on together.

6.3.6 References

META Group. 2000, http://www.metagroup.com/, META Group, Stamford.

Standish Group, 2000, http://www.pm2go.com/, The Standish Group International, West Yarmouth.

Tomlinson, R. 2001, Planning for a GIS, Environmental Systems Research Institute, Redlands.

Whitten, N. 1995, Managing Software Development Projects, John Wiley & Sons, New York.

6.4 Being consistent in managing IT and GIS projects

Many of the pitfalls and lessons learned outlined in the previous section can be addressed by using a consistent approach to managing IT and GIS projects. Many organisations, including local governments, state/territory and Australian government agencies and private companies, now employ full-time staff or hire consultants to set up and run a project office. A project office is the centre of excellence within the organisation to provide support for those involved in projects (including project managers, members of steering committees or those involved in a project team) to better understand their roles and responsibilities.

The good news is that all organisations and NRM regional bodies can benefit from the consistency in approach to project management used by those in the project offices of large organisations. Some of these resources include:

- **PRINCE (Projects IN Controlled Environments)**—developed and extensively used by the UK government and widely recognised and used in the private sector, both in the UK and internationally. PRINCE, the method, is publicly available and offers non-proprietary best-practice guidance on project management.
- **Government of Tasmania Project Management Guidelines**—structured set of tools, techniques and support resources for managing all kinds of projects in government. The resource has been constantly evolving since 1996 and now provides a consistent approach to managing all projects, including IT and GIS projects, in Tasmania and beyond.
- **Australian Standards on Project Management (AS 4915-2002)**—formal set of approaches used in some federal government agencies.

Use one of the standardised project management approaches for selected projects with formalised project documentation and process. Link these selected projects with individual/departmental level business cases.

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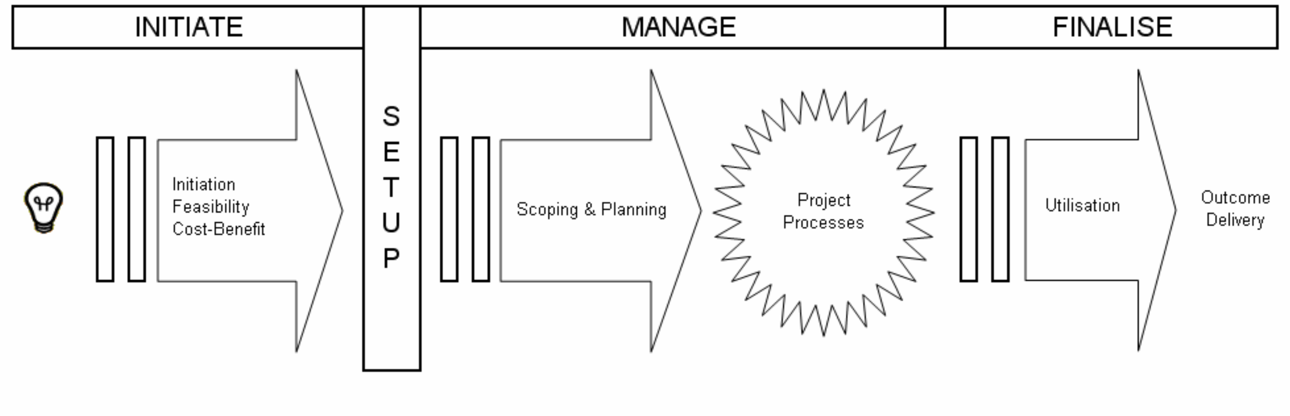
These approaches, along with most other structured project management methods, focus on:

- a controlled and organised start (initiation), middle (management) and end (finalisation)
- regular reviews of progress against the project plan and what the project is meant to achieve
- telling management when projects are forecast to exceed pre-defined tolerances (like time and/or cost)
- good communication channels between those working on a project, its managers and senior staff.

For example, the phases and key elements of the Tasmanian approach is shown in Figure 6–3.

Figure 6–3 Tasmanian State Government generic life of a project



The Tasmanian State Government project management approach is currently being used by numerous organisations including NRM regional bodies and local government.

An important part of these project management methodologies is that they allow the development of a common language within an organisation. What can seem like a daunting set of project management jargon can quickly become broken down into a simple, useable lexicon, e.g. the Tasmanian approach has an online glossary. So being consistent can mean ensuring that many projects within one local government are managed consistently, or that single IT and GIS projects can be managed in a way consistent with project management best practice. Thus, specialised GIS projects, which often only happen once every few years, or have never happened before, can have a much better chance of success.

6.5 Project justification

One of the major benefits of following a consistent approach to project management within an organisation is that staff begin to talk a 'common project management language'. Technical and managerial staff can then use this common language to talk about the requirements for new spatial information projects (including upgrades) and ongoing recurrent expenditure requirements as part of an organisation's or NRM regional body's funding and programming cycle. More importantly, project justification is streamlined within standard business processes—project management should be viewed within this context.

For example, the Tasmanian State Government project management system defines a Project Business Case as:

> *A one-off, start-up document used by corporate management to assess the justification of a proposed project, or to assess the development options for a project that has already received funding. If approved, it confirms corporate management support and/or funding for a recommended course of action.*

The Tasmanian system uses two different styles of business case documents, for small and large projects, that can be downloaded from their website (see Section 6.5).

Importantly, when defining justifications to support the development of spatial information projects, there are some specific issues to consider. For example, Geldermans and Hoogenboom (2001) believe:

> *The content of the GIS business case is in general the same as those of usual information and communications technology projects. However, for a few aspects the GIS business case is fundamentally different, in particular in the field of assessing the long-term value of the GIS data, which must be seen as the enabler of any GIS.*

Elements of a GIS business case include:

- What is it about? (purpose of project, description of functionality of application)
- What are the costs? (people, data and software)
- What is the financial impact? (decrease of costs, increase of profits, and improvement of market position)
- How long will it take to develop the system?
- How long will it take to gain advantages?
- What is required to make any of the advantages permanent?

By addressing these six issues the management of the organisation is able to make an educated decision on the viability of a GIS initiative. Furthermore, the description ensures that the short-term investments are put into perspective with the long-term benefits and the required intermediate improvements of the GIS to keep it up to date. In fact, the GIS business case is one of the key documents describing not only the first implementation of a particular GIS, but also the expected lifecycle of the GIS. This point, the lifecycle description of a GIS, is a key issue in the GIS business case, as GIS initiatives are seldom a one-time-only thing and any benefit from a GIS implementation will evaporate over time if not upgraded periodically.

The critical component of the project justification is to clearly state what the benefits are for the required expenditure. Put simply, what do we get for our money? This can be a very complex question to answer, especially if the benefits are not concrete (or tangible) as is often the case with spatial information projects. Generally there are two approaches to this issue: first is to attempt to develop economic cost/benefit arguments; and second is to develop qualitative assessments of benefits, often by comparing the benefits in relation to one another. This distinction is used in the Tasmanian State Government guidelines with large projects requiring cost benefit analysis, while small projects require relative assessment of the benefits of different project options.

For example, budget planning and project justification within the City of Perth is integral to the organisational planning cycle. When planning new projects it is important to anchor your projects into the business unit's business plan and ensure sufficient funds are available. The earlier the planning the more chance it has of being assessed within a timely manner. For the City of Perth the budget cycle commences in October with the preparation of pre-budget submissions and four-year forecasts for inclusion in the business plan, together with draft capital expenditure proposals. The review process aligns these submissions with the City's strategic objectives and identifies the key results areas.

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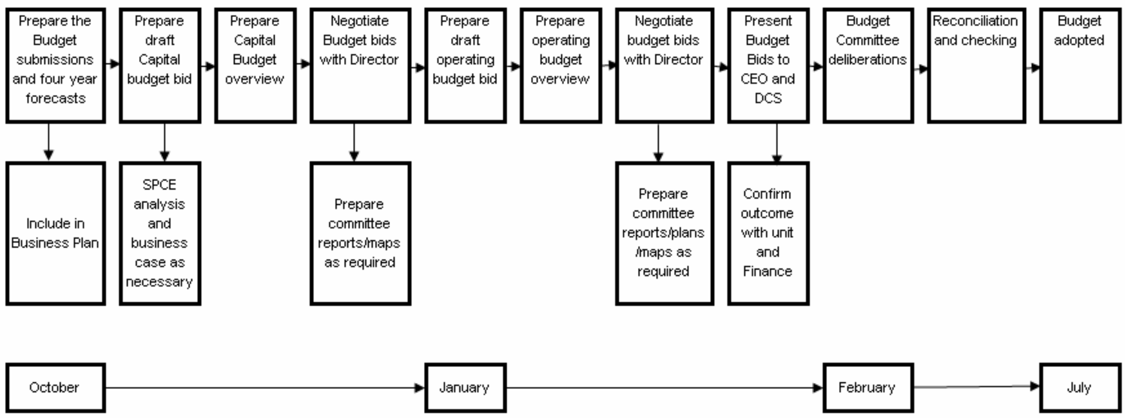
Those organisations or NRM regional bodies with well established project management and project justification frameworks, based on estimated project benefits, can consider internal benchmarking and quantitative process improvement methodologies. These can be used to provide measurable efficiencies to the organisation's or NRM regional body's service provision with the introduction of enhanced spatial information systems.

Figure 6–4 City of Perth's budgetary process overview



An example of a business case dealing with spatial information systems is presented in Attachment 6–1. Additional material on business case development for ICT projects is available from the NSW Government Department of Commerce which has developed guidelines, templates and cost/benefit tables: http://www.oict.nsw.gov.au/pages.asp?CAT=764&ID=771

6.6 Project management guidelines, methods and project justification support

Project management system, Tasmanian State Government

The project management system of the Tasmanian State Government is available online and provides an excellent set of resources for anyone working in project management—from beginners to experts. The resources have been refined since 1996 and are widely used in Tasmania and by many other Australian government agencies:

http://www.egovernment.tas.gov.au/.

The resources available online include:

- Tasmanian Government project management guidelines—includes the key elements of project management that need to be considered, regardless of the size or complexity of a project
- project management glossary—explains project management terminology
- project management templates—to support the Tasmanian Government project management guidelines which are available through this website. The templates include instructions on the 'what',' why', 'when' and 'how' applicable to each document. A registration process is required each time a template is downloaded
- project management knowledge base—a collection of examples from Tasmanian State Government agencies, reference material and related links
- project management fact sheets
- project management frequently asked questions (FAQs)
- proformas—a collection of useful tools for managing a project
- project management roles and resources—a self-directed learning tool
- project management resource kits for managing small projects (including fact sheets for members)
- an internet mailing list for sharing ideas and experiences about project management
- interactive project sizing calculator
- booklet—a quick guide to project management
- project management forum presentations
- project services newsletters
- project management games, crosswords and cartoons.

6.5.2 University of Tasmania project management guidelines

The University of Tasmania's project office has developed a range of documents (guidelines and templates) to assist university staff in their management of projects, drawing on the Tasmanian Government resources outlined above. The guidelines have been tailored to the university context but are nevertheless useful for local governments and are constantly reviewed and updated. They are available at:

http://www.utas.edu.au/major_projects/.

6.5.3 Setting up for Success: A guide for designing, managing and evaluating projects

This guide has been developed by the National Landcare Program Evaluation Coordinators and is available from the Australian Government Department of Agriculture, Forests and Fisheries website at:

http://www.daff.gov.au/natural-resources/landcare/publications/setting_up_for_success.

6.5.4 NSW information to support sustainable management of natural resources – Information Management Framework

The Information Management Framework focuses on the delivery of useable content (business-driven data modelling, information integration, business intelligence, information compliance, data quality) to ensure a comprehensive and consistent approach to the management of information resources consistent with recognised standards and international best practice. This is a comprehensive site containing guidelines, templates and forms:

http://nrims.nsw.gov.au/policies/imf/index.shtml.

6.5.5 Project justification support

Justification for Spatial Information Systems—considerable justification support information is now available related to the introduction of spatial information systems.

For example:

Packaging the GIS Business Case for the Board Room:
http://www.directionsmag.com/article.php?article_id=2013&trv=1

Measuring the Benefits of GIS: http://www.esri.com/industries/localgov/roi/roi_index.html

A Roadmap to Implementing an Enterprise GIS:
http://gis.esri.com/library/userconf/proc01/professional/papers/pap315/p315.htm

Project Management System—Tasmanian State Government to download business case templates for small and large projects: http://www.egovernment.tas.gov.au/

An example of a GIS Project Business Case is presented at Attachment 6–1.

6.5.6 Additional resources and project management associations

See the official PRINCE2 website UK Office of Government Commerce to download project management templates, source training in Australia and where to purchase manuals and other resources: http://www.ogc.gov.uk/PPM_Resources_prince_2_c2.asp

The Australian Institute of Project Management has chapters in all states and territories:

http://www.aipm.com.au

The Project Management Institute has chapters in Canberra, Melbourne, Sydney, Brisbane, Adelaide and Western Australia:

http://www.pmichapters-australia.org.au/home.asp

6.5.7 Monitoring and evaluation for NRM projects

Throughout Australia all state, territory and Commonwealth goverments, along with industry, community groups and landholders, are investing considerable funds to improve the sustainable management of natural resources.

A number of documents and guidelines have been prepared as part of monitoring and evaluation programs for NRM programs, including a 'Framework for Natural Resource Management Standards and Targets', and a 'National Natural Resource Management Monitoring and Evaluation Framework'. In addition, a 'Users Guide' has been developed providing background information to assist in the interpretation of the national frameworks. Additional information and the actual documents are available from the Australian Government Department of Environment and Water Resources (DEW) website: http://www.nrm.gov.au/me/index.html.

Note: Each state and territory jurisdiction is responsible for developing its own monitoring and evaluation implementation plans.

6.5.8 Regional NRM support services

A number of jurisdictions have established support service facilities for NRM projects. The following is a list of such websites.

Queensland: http://www.regionalnrm.qld.gov.au/index.html plus http://www.nrw.qld.gov.au/. In addition the Queensland Regional Groups Collective also maintains a website providing NRM support: http://www.regionalgroupscollective.com.au/default.asp

Western Australia:

New South Wales: The NSW Information Management Framework:

http://nrims.nsw.gov.au/policies/imf/storage.shtml

Tasmania: http://www.dpiw.tas.gov.au/inter.nsf/Home/1?Open

ACT:

Victoria:

Northern Territory:

South Australia: http://www.nrm.sa.gov.au/

Contact details for facilitators and coordinators

A listing of state and territory facilitators and coordinators for NRM programs is maintained on the NRM web site: http://www.nrm.gov.au/contacts/agnrm.html#contacts

6.7 Developing a risk management plan

There are always risks associated with a project. The purpose of risk management is to ensure levels of risk and uncertainty are properly managed so the project is successfully completed. It enables those involved to identify possible risks, the manner in which they can be contained and the likely cost of countermeasures. Material presented in Attachment 6–2 is taken from the Tasmanian Government Project Management Fact Sheet to provide background information on developing a risk management plan. Additional material, including templates, checklists and prompts is available from the NSW Department of Commerce, Chief Information Office: http://www.oict.nsw.gov.au/docs/Project_Risk_Man_0904.pdf

Attachment 6–1

Sample GIS Business Case Document

Sourced form the internet on 1st June 2007
https://www.derbyshire.gov.uk/Images/content/DemocraticServices/Reports/DSNet/Cabinet/130503CAB6962.pdf

Derbyshire Partnership Forum Report of the Programme Manager Business Proposal for Spatial and Geographical Information for the Derbyshire

1.1 Background

Information about an object that is geographically located is known as geo-spatial information or "spatial referencing".

A location can mean many things – an address, postcode, administrative area or perhaps an ordnance survey grid reference. The vast proportion of national and local government information can be related to a location and therefore a map.

A GIS is used for capturing, storing, checking, integrating, analysing and displaying spatially referenced information. That is to say any person, place or thing can be displayed at it's location on a digital map and it's position analysed against any other information on the map.

The key to a successful GIS implementation therefore is the quality and accessibility of datasets, and addressing the collection, conversion and long term management of the geo-spatial data must be a high priority within any implementation proposal.

It is feasible to present comprehensive information from Geographic Information Systems (GIS) to the public by way of publishing through the World Wide Web, and this is a key element in the partnership strategy for "joined-up" working. However this objective does require both improved ways of managing the technical information, and additional software functionality.

The local authorities and other organisations comprising the Derbyshire Partnership utilise a number of disparate back office systems, including GIS. In order to deliver

'joined up' GIS services and 'joined up' GIS information, there are two fundamental technical options available for the Partnership.

The first option is to re-engineer all the partner back office GIS systems to provide a fully unified ICT approach, so that each organisation would rely on a central GIS system and equipment.

A second option is to allow participating organisations to use their existing GIS locally to match their own internal service delivery needs, and setting their own pace of development. However there would be a need to set county-wide standards for managing and distributing datasets between partners, which would require a key co- ordination role to be created by the Partnership. The information would then be made available to partners through a web-based front end either via individual web sites or a "Partnership portal".

Such an approach would require the Partnership, or more specifically one authority in the Partnership, to take a lead role in managing the necessary technical architecture and data protocols to enable disparate datasets to be accessed through a standard web front end for public access.

1.2 GIS Benefits

The most difficult question to answer with respect to this project is "Why should you do it?" The business case for this type of project is often initially based around provision of service to the customer with the potential for internal cost savings or business benefits to follow.

1. The ODPM have mandated (through BVPI 157) that 100% of all services that can be made electronic will be made available by 2005. BVPI 157 specifically mentions Provision of information and Application for Services. Some of this information and services can either only be delivered, or can be significantly enhanced, by the use of visualisation of data on a map base. Examples include:

   - Planning history and constraints, where information cannot be shown accurately without the plotting of the planning extents onto a map base or
   - Reporting of pot holes, street lights, abandoned vehicles, fly tipping, etc where information accuracy and hence improved service can be delivered via allowing users to show position directly on a map

   These examples show that there are potentially a number of existing services where visualisation of the information, via partners web sites, on a map base will be an integral part of the service delivery.

2. Providing these services integrated with the CRM and A-Z projects will result in a greater number of enquires being answered at the first point of call, especially on split responsibilities such as planning. This will reduce the need for "Back Office" functions and will provide a more focussed service for the customer.

Such benefits are linked to the Business Case for the E-forms project. The services and information with a spatial nature are to be considered as subset of the overall services and information delivered and can be seen as an essential building block.

3. Provide new services and information by linking up data that currently exists within the partner organisations. Spatial data is currently held in separate databases within individual organisations and cannot be presented together. By linking up this spatial information across internal council departments, across other local authorities and to other local organisations (e.g. Health, Fire, Police, etc) the Partnership can provide new services that will be of significant value to the citizens of Derbyshire and to council staff. For example, footpath diversion application and tree preservation order consent.

These new services could be based around Life Events, for example, if someone is visiting or moving to the Derbyshire area they may want to know the location of local schools, location of doctors surgeries, where the bus stops are (as they might not have transport), location of council services (Libraries, Recycling sites, etc). Then to be able to combine this information so that they can see, for example, if the doctor's surgery is close to a bus route that will take them to this location.

4. Partnership members though could, by pooling the information they hold and using GIS, improve strategic planning and ensure that resources are located in the best place to ensure that the needs of local people are met in the most

   efficient and effective way. Examples could include the location and number of units of sheltered accommodation, location and risk assessment of potential fire or other hazards.

5. The main provider of GIS data to Local Authorities is the Ordnance Survey. Under the latest Local Authority Services Level Agreement data can be freely exchanged with other local authorities signed up to this agreement. Therefore, a central repository of large data sets, such as Master Map, should be created and would benefit the partners in the rapid delivery of data and would centralise maintenance of this data.

The partnership must, in providing new services and information, be careful that they do not just provide information that is available elsewhere, without adding to its value by combining it with other information. There is no case for provision of information where it can be obtained from other commercial sources or government organisations.

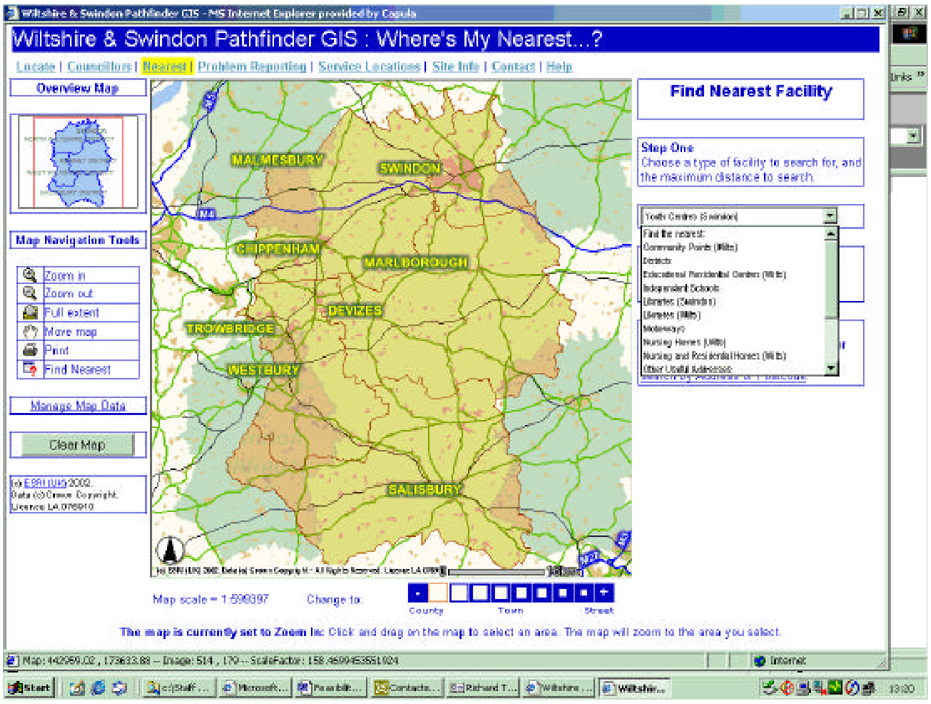
1.3 What can this look like to local people?

Wiltshire and Swindon Pathfinder – Where's my nearest?

This implementation provides users with the ability to find a number of features within a radius of a particular location. Features provided include schools, libraries, recycling points, etc.

The site can be seen at www.wiltshire.gov.uk/environmental

Example screenshot

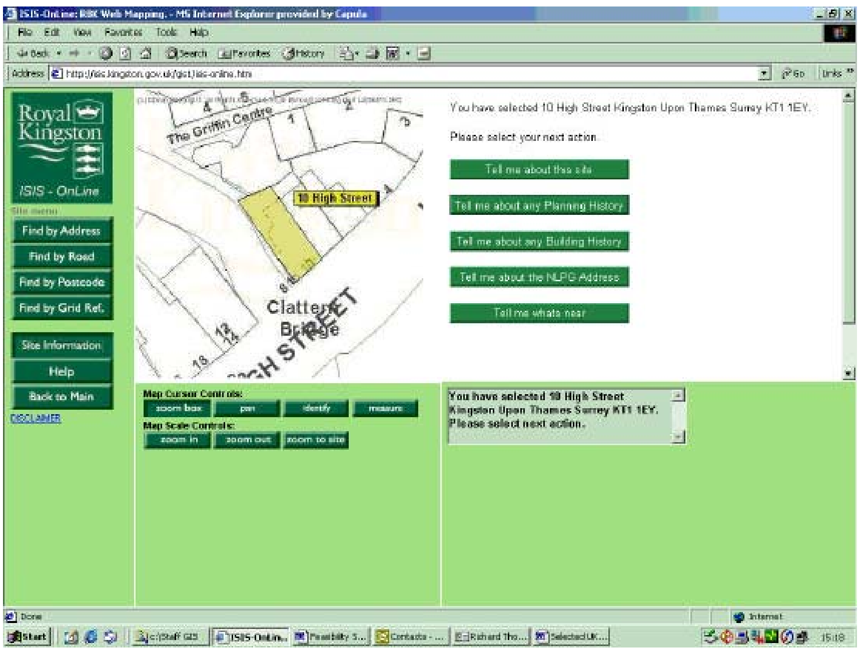


Kinston upon Thames – ISIS

This site was a SOCITM award winner in 2002. It mainly focuses on planning history information but also has a "Tell me what's near" function that shows location of local facilities.

The site can be seen at http://isis.kingston.gov.uk

Example screenshot

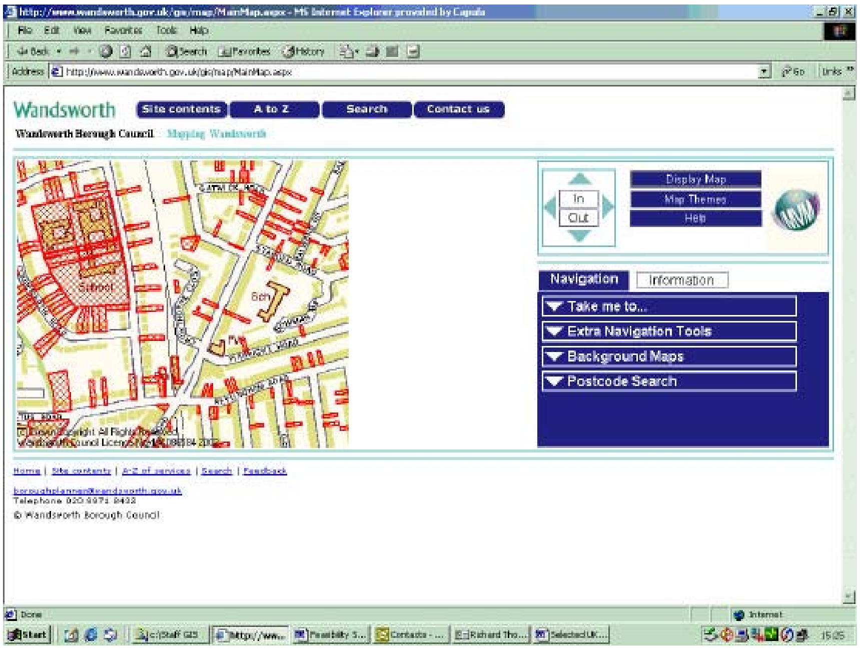


London Borough of Wandsworth

This site has a mixture of local information and planning data. The site can take a considerable amount of time to load when first entering the site.

The site can be seen at: www.wandsworth.gov.uk/gis/map/mainmap.aspx

Example screenshot



Similar screenshots to the above could be made available to call centre operators to enable them to deal efficiently with calls requesting information or services.

1.4 Creating an infrastructure

Derbyshire County Council and a number of the other Partnership authorities predominately utilise the MapInfo product range, it is therefore appropriate to consider a data publishing operation based on the MapInfo products.

In order to handle the substantial volumes of spatial information (e.g. MasterMap, digital aerial photography, and many hundreds of thousands of polygons and associated records), a resilient database will be required to support the data and user queries.

The use of solutions based upon MapInfo proprietary files and Microsoft Access is totally inappropriate for the level of use envisaged, and it is therefore proposed to utilise a major commercial database to provide the solution. It is proposed to make use of Oracle database, which is widely recognised as the leading database for managing geo-spatial data.

In terms of the web deployment of geo-spatial data, a number of solutions are possible :

1. In-house software development using standard programming languages
2. In-house software development using MapInfo's web mapping software development tool - MapXtreme
3. Use of third party web mapping solutions

Options 1 and 2 will require the creation of a development team specifically to create a web front end, which will need to have specialist skills in MapXtreme.

For Option 3, a number of third party technical products are available from a company known as GDC (the leading MapInfo reseller to local government in the UK). These include:

- PlanWeb - GDC's Intranet based web deployment, which makes use of MapXtreme
- PlanAccess- GDC's Internet based web deployment for public access which makes use of MapXtreme
- GeoStore - GDC's implementation of an Oracle 9i spatial database

Products such as PlanWeb and PlanAccess are tools which both simplify the creation and reduce the time to create and modify the GIS front end displays and navigation. Without this investment the Partnership will have to create a development team.

It is suggested that purchasing the tools PlanWeb and PlanAccess as outlined in Option 3, is the most effective solution for cost and time. PlanAccess will also be available for partners to utilise, linking in to Web sites and back office systems.

1.5 Technical Architecture

A fundamental element in the strategy is the creation of a data warehouse facility, which would coordinate and supply all geo-spatial information to the web front end, and would provide a common source of data that was up-to-date and not duplicated. It is proposed that this data warehouse should be Oracle based, and utilise the data management capabilities of GeoStore.

The architecture to facilitate Option 3 (See Diagram) will require two servers - one to run the GeoStore Oracle 9I database, and a web server running PlanWeb and Plan Access, enabling access by the public through a standard web browser. It is suggested that the servers be operated from County Hall on behalf of the Partnership, which will enable them to have security and disaster recovery facilities from the forthcoming Storage Area Network.

This project proposes that data will initially be transferred to the Data Warehouse utilising a Batch process over slow network connections or dial up facility. The Partners could obtain further benefits by investing in high-speed links to the County, where upon partners can utilise the Data warehouse via their intranet for a wide variety of internal GIS applications.(e.g. NLPG)

(See attached diagram Appendix A)

1.6 Organisational Issues

The public would have access to the mapping facility directly or via each partner's web-site. It would have a consistent look and feel and the public would not automatically distinguish changes between partner boundaries (except when the OS watermark changes).

Change Only Updates would be transferred between each partner and the data warehouse on a daily basis making use of XML/GML schemas, which will have to be developed and agreed to support each dataset published.

The rate of developing GIS by each partner will be entirely of their choosing. The model proposed involves the Partnership providing the technical architecture and resources to implement the core system, including the provision of Ordnance Survey, MasterMap and aerial photography, with other datasets being provided by each partner once available to an agreed schema.

The lead partner for GIS is the County Council, and it is proposed that the County Council offers this service on behalf of the Partnership. A degree of supplier & consultancy support will be required in the early days of specification, procurement and configuration. A full time in-house resource will be required to configure the solution, to process and manage the updates to GeoStore and to manage updates from GeoStore to partner systems, and to deal with access & security arrangements.

1.7 Cost Estimates

The following table identifies the potential implementation and maintenance costs associated with the proposed architecture:

Table has been excluded but available in internet version see
https://www.derbyshire.gov.uk/Images/content/DemocraticServices/Reports/DSNet/Cabinet/130503CAB6962.pdf

1.8 Background Papers

Approved County GIS Business Case - Derbyshire County Council

Successful Bid for LGOL Partnership Grant

1.9 Recommendations

The Management Board is asked to approve the following recommendations: -

1. The Partnership supports the principle of a co-ordinated approach to geo- spatial data management and web publishing as proposed in this report.
2. Jeff Wheatley is assigned Project Management responsibility reporting to the Management Board through the Programme Manager.
3. A Project Executive is nominated from the Management Board members.
4. The County Council is nominated to provide the GIS service for the Partnership subject to an approved Service Level Agreement between the County and the Partnership members.

5. It is agreed that a data management regime is implemented based upon Oracle and GeoStore technologies.
6. The budgets and financial costs as described in the report are approved including the recurring revenue charge.
7. The apportionment of the ongoing revenue charge is agreed.

Attachment 6–2

Developing a Risk Management Plan

Attachment 6–2: Developing a Risk Management Plan

Sourced from the Tasmanian Government Project Management website.
http://www.egovernment.tas.gov.au/__data/assets/word_doc/18512/pman-temp-open-risk-register.doc

What is a Risk Management Plan?

A Risk Management Plan summarises the proposed risk management approach for the project and is usually included as a section in the *Project Business Plan*. It is dependant upon the establishment of a *Risk Register*. The Risk Management Plan describes:

- the process which will be used to identify, analyse and manage risks both initially and throughout the life of the project
- how often risks will be reviewed, the process for review and who will be involved
- who will be responsible for which aspects of risk management;
- how Risk Status will be reported and to whom
- the initial snapshot of the major risks, current gradings, planned strategies for reducing likelihood and seriousness of each risk (mitigation strategies) and who will be responsible for implementing them (these are usually included as an Appendix in the *Risk Register*).

What is a Risk Register?

The *Risk Register* records details of all the risks identified at the beginning and during the life of the project, their grading in terms of likelihood of occurring and seriousness of impact on the project, initial plans for mitigating each high level risk and subsequent results.

It usually includes:

- a unique identifier for each risk
- a description of each risk and how it will affect the project
- an assessment of the likelihood it will occur and the possible seriousness/impact if it does occur (low, medium, high)
- a grading of each risk according to a risk assessment table (see *Table 1*)
- who is responsible for managing the risk
- an outline of proposed mitigation actions (preventative and contingency)
- in larger projects, costings for each mitigation strategy.

This Register should be kept throughout the project, and will change regularly as existing risks are re-graded in the light of the effectiveness of the mitigation strategy and new risks are identified. In smaller projects the *Risk Register* is often used as the Risk Management Plan.

Why would you develop a Risk Management Plan and Risk Register?

A Risk Management Plan and *Risk Register* are developed to:

- provide a useful tool for managing and reducing the risks identified before and during the project
- document risk mitigation strategies being pursued in response to the identified risks and their grading in terms of likelihood and seriousness
- provide the Project Sponsor, Steering Committee/senior management with a documented framework from which risk status can be reported upon
- ensure the communication of risk management issues to key stakeholders
- provide a mechanism for seeking and acting on feedback to encourage the involvement of the key stakeholders
- identify the mitigation actions required for implementation of the plan and associated costings.

When would you develop a Risk Management Plan?

Initial risks must be identified and graded according to likelihood and seriousness very early in the project. This initial risk assessment will form part of the *Project Proposal/Brief* or *Project Business Case* for the project. Once the project is approved the Risk Management Plan and *Risk Register* should be fully developed. In the case of smaller projects the *Risk Register* may serve both purposes.

What you need before you start:

- knowledge and understanding of the project
- knowledge and understanding of the Key Stakeholders
- knowledge and understanding of appropriate types of risk management activities, or where to obtain them
- any of the following optional documents – *Project Proposal/Brief*, *Project Business Case*, or *Project Business Plan*.

Optional:

- Departmental Project Management Guidelines
- Corporate/Business Plan for the Department/Business Unit

How do you develop a Risk Management Plan?

The following is one way to develop your plan. It consists of a series of steps that become iterative throughout the life of your project. Firstly:

Step 1: Identify the risks

Before risks can be properly managed, they need to be identified. One useful way of doing this is defining categories under which risks might be identified. For example, categories might include Corporate Risks, Business Risks, Project Risks and System Risks. These can be broken down even further into categories such as environmental, economic, human, etc. Another way is to categorise in terms of risks external to the project and those that are internal.

(Refer to generic sources of risk as described in the Australian Standard for Risk Management AS/NZS 4360: 1999, Appendix D)

For a medium to large project, start by conducting a number of meetings or brainstorming sessions involving (as a minimum) the Project Manager, Project Team members, Steering Committee members and external key stakeholders. It is often advisable to use an outside facilitator for this. Preparation may include an environmental scan, seeking views of key stakeholders etc. One of the most difficult things is ensuring that all major risks are identified. For a small project, the Project Manager may develop the *Risk Register* perhaps with input from the Project Sponsor/Senior Manager and colleagues, or a small group of key stakeholders.

The results of this exercise should be documented in a *Risk Register* for the project. For larger projects, if an outside facilitator is used, it would be expected that they would develop the initial documentation.

Step 2: Analyse and evaluate the Risks

Once you have identified your risks you should analyse them by determining how they might affect the success of your project.

Risks can result in four types of consequences:

- benefits are delayed or reduced
- timeframes are extended
- outlays are advanced or increased
- output quality (fitness for purpose) is reduced.

Risks should be analysed and evaluated in terms of likelihood of occurring and seriousness of impact if they do occur. Firstly, assess the likelihood of the risk occurring and give this a rating of Low (L), Medium (M) or High (H) likelihood. Once you have rated the likelihood, assess the seriousness of the impact of the risk if it did occur and rate at Low (L), Medium (M) or High (H) seriousness.

Using your ratings for likelihood and seriousness you can then determine a current grading for each risk that in turn provides a measure of the project risk exposure at the time of the evaluation.

Table 1 provides a standard method for calculating a grading for each risk based upon the combination of the likelihood and seriousness ratings.

Grade: Combined effect of Likelihood/Seriousness				
	Seriousness			
Likelihood		low	medium	high
	low	E	D	C
	medium	D	C	B
	high	C	B	A

Table 1: Risk matrix for grading risks

So what this means in practice is:

Id	Description of Risk	Likelihood	Seriousness	Grade	Change
1.1	Inadequate funding to complete the project	medium	medium	C	↑
1.2	Lack of technical skills in Client Business Unit	high	high	A	NEW

Key:

Change to Grade since last assessment			
NEW	New risk	↓	Grading decreased
—	No change to Grade	↑	Grading increased

In the case of larger or more complex projects, the matrix should be expanded to ensure an A Grading is automatically assigned to any risks defined as extremely high seriousness.

Grade: Combined effect of Likelihood/Seriousness					
	Seriousness				
Likelihood		low	medium	high	EXTREME
	low	E	D	C	A
	medium	D	C	B	A
	high	C	B	A	A

Depending upon the size and nature of the project, some choose to use numerical scales for this analysis and evaluation.

The resulting grades of risk help the project team to focus on treating the most important risks, once evaluated and prioritised, and to mitigate them before the project progresses much further into the MANAGE Phase.

Step 3: How will you manage or 'treat' the Risks?

Using the Grading Table in Step 3, for your entire Grade A and B risks and those rated Extreme it is really important to have identified mitigation strategies very early in your project. **Risk mitigation strategies reduce the chance that a risk will be realised and/or reduce the seriousness of a risk if it is realised**. Grade C Risks should be continually monitored and have planned mitigation strategies ready to be implemented if appropriate. These plans need to be recorded on your *Risk Register*.

There are two broad types of risk mitigation strategies:

- Preventative - planned actions to reduce the likelihood a risk will occur, and the seriousness if it does occur. In other words, what should you do now?
- Contingency - planned actions to reduce the seriousness of the risk if it does occur. In other words, what should you do if?

Once a risk has occurred, recovery actions to allow you to move on should be built into the work breakdown structure for your project. In other words, what should you do when?

For each action in the *Risk Register*, it is necessary to specify:

- Who will be responsible for implementing each action?
- When the action must be implemented?
- What are the costs associated with each action (for larger projects in particular)?

Your *Risk Register* may now look something like this:

Id	Description of Risk	L	S	G	Change	Date	Action	Who	Cost	WBS
1.1	Inadequate funding to complete the project	M	M	C	↑		Re-scope project focussing on time and resourcing	PM	$$$	
1.2	Lack of technical skills in Client Business Unit	H	H	A	NEW		Develop training plan	Consultant	$$$	

This example is in brief and more detail would be added as required. For example, in larger projects separate documentation might be developed for each major risk providing much more detail regarding mitigation strategies and costings.

(Refer to the Project Management Knowledge Base for examples of a Risk Register)

Step 4: Monitor and review risks

The Risk Register should be visited fortnightly with re-evaluation of the risks occurring on a monthly basis. If your prevention strategies are being effective, some of your Grade A and B Risks should be able to be downgraded fairly soon into the project. Risk Status should be reported to the Steering Committee or Project Sponsor/Senior Manager on an agreed regular basis and form part of the Project Status reporting processes.

(Refer to the Project Status Report template available on www.projectmanagement.tas.gov.au)

Remember - Risk Management is an iterative process that should be built into the management processes for your project. It is closely linked with your Issues Management processes, as untreated issues may become significant risks.

Also remember: Communicate and Consult

Even though you may have done this really well at the beginning and involved your key stakeholders in the identification, analysis and evaluation of risks, it is important to remember to keep the communication going. The communication strategy for your project should build this into the activities.

Who is responsible?

Many people involved in a project will have some responsibility for project risk management, including the project team members, Steering Committee, Project Sponsor, potential business owners and working groups. It is important that they know what they are watching out for, and reporting potential risks is a significant part of their role.

The Project Manager is responsible for monitoring and managing all aspects of the risk management process, such as:

- the development of the Risk Management Plan and *Risk Register*
- the continual monitoring of the project to identify any new or changing risks
- continual monitoring of the effectiveness of the risk management strategies
- regular reports to the Project Sponsor and Steering Committee.

In large projects, the Project Manager may choose to assign risk management activities to a separate Risk Manager, but they should still retain responsibility. It should be noted that large projects are a risk in themselves, and the need for the Project Manager to reassign this integral aspect of project management may be an indication that the project should be re-scoped, or divided into several sub-projects overseen by a Project Director.

Who has ultimate accountability?

While the Project Manager is responsible for the management of risks, the Project Sponsor/Senior Manager has ultimate responsibility to ensure that an effective Risk Management Plan for the project is in place.

Who approves the Risk Management Plan?

Generally, the Risk Management Plan would be approved or endorsed by the Steering Committee/Project Sponsor or Senior Manager, depending upon the size of the project.

Once the Risk Management Plan has been approved, it is important to:

- add the actions into the Project Plan with the appropriately assigned resource(s)
- add the costs for the actions into the Project Budget.

Where to Get Additional Help

1. Refer to the *Risk Register template*.
2. The *Tasmanian Government Project Management Guidelines*.
3. The *Project Management Knowledge Base*.
4. Contact Project Services on email PMInfo@dpac.tas.gov.au
5. Further details and examples are available at: http://www.projectmanagement.tas.gov.au

MODULE 7

MODULE 7: Guidelines for Selecting Spatial Information System Software and Hardware

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

One of the prerequisites for natural resources management (NRM) involves the establishment and maintenance of a good database of information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making/planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis, standards, and communication are key components.

Under current arrangements, funding for NRM projects is increasingly being channelled from government agencies to regional groups, such as catchment management authorities and resource information centres. In many situations regional groups are faced with the need to purchase software. Given that most groups are experiencing increased demands on budgets to support information technology hardware and software it is important that products are chosen that fulfil actual requirements. Selections should always be based on the needs of the organisation or group. The following is a simple 'best practice' guideline:

- Software and hardware should be selected giving consideration to functionality and applications that have been identified based on a needs assessment
- Hardware should be based on software requirements.
- Operating systems should be based on the software products and hardware, and the standards that have been developed as part of the organisation's data policy and standards activities.

It is acknowledged that each state and territory jurisdiction may have its own initiatives related to data collection and information management including governance guidelines and protocols related to the implementation of NRM projects within their jurisdictions. In some cases this may involve recommendations for spatial information system (SIS) software and hardware.

For the purpose of this Toolkit, spatial information systems include geographic information systems (GIS), image processing applications for raster data (e.g. satellite images and aerial photography) and spatially-enabled databases.

Module 7: Guidelines for selecting spatial information systems and hardware provides general material to assist regional groups in the selection of software and hardware with an emphasis on spatial applications.

Actions

Managers need to make judgements and decisions when selecting new SIS software and hardware, upgrading existing systems or evaluating whether to change system providers. This guideline attempts to provide the parameters to assist in the decision-making process.

When dealing with the issue of SIS software, managers need to ensure that it is selected based on the range of functionality and applications needed by an organisation—it is important to understand context, and not be influenced by the loudest voice. If in doubt, get additional support.

It also important to remember that hardware and software are part of an integrated information management solution, and therefore need to be considered in relation to other components, (e.g. procedures—standards and protocols, etc), designed to provide ready access to data and information, and support best practice procedures. As such, NRM regional groups are encouraged to purchase software products that are fully compliant with OpenGIS® specifications, enabling them to interoperate with other information systems.

Best practice guidelines and standards are available to assist in the design and evaluation of spatial information systems. Checklists and templates are included in this guideline to assist in selecting new SIS components, upgrading existing systems or changing system providers.

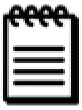
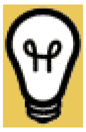
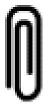
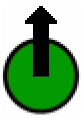
Acknowledgements

This module draws heavily on material from the publication by Harmon and Anderson (2003) 'The Design and Implementation of Geographic Information Systems'.

Material in this module has also been sourced from Spatial Knowledge Engineering, (SKE, Inc www.skeinc.com), Peter Thorpe, of Peter Thorpe Consulting (http://www.planweb.co.uk/tip1.htm), and the Point of Beginning Magazine website (http://www.pobonline.com). These sources are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

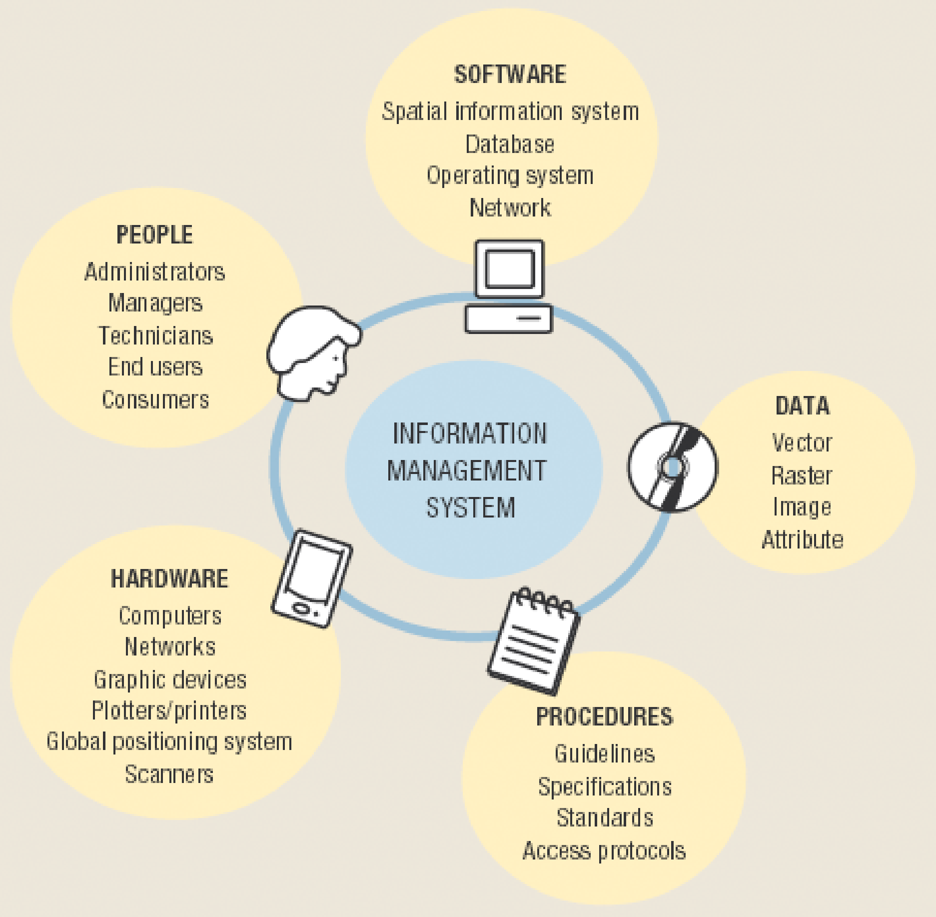
	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

7.1 Introduction

It is important that software and hardware is selected and upgraded based on the range of actual functionality and/or applications needed by an organisation. In recent years there has been a proliferation of SIS software and various related hardware items (computers, plotters, GPS receivers, hand-held devices and digital cameras) that support spatial information systems, and an almost exponential increase in the range of functionality or tools available.

It is also important to remember that hardware and software are part of an integrated information management solution, and therefore they need to be considered in relation to other components (e.g. procedures—standards and protocols, etc), designed to provide ready access to data and information, and support 'best practice' procedures. (see Figure 7–1 and *Module 1: Information management and the sustainable management of natural resources).*

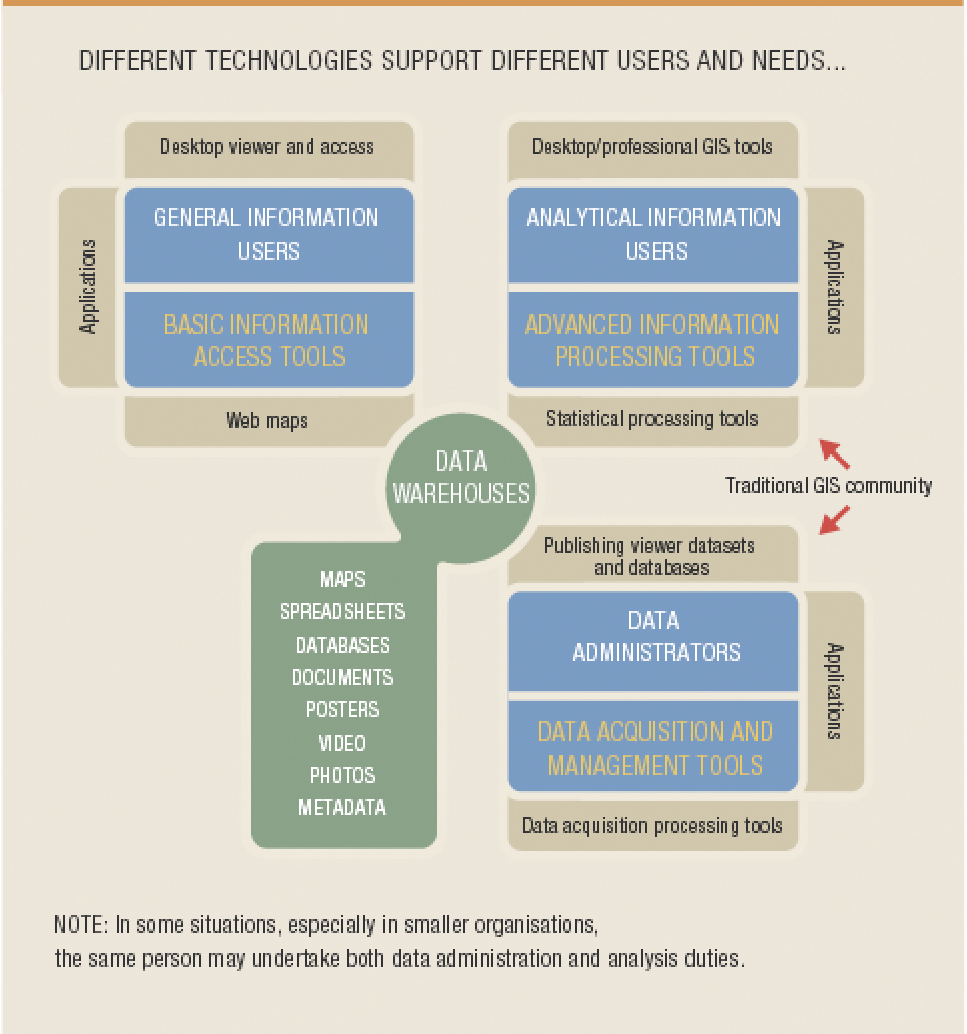
Figure 7–1 Framework for an integrated information management solution.



> Traditionally, the tasks of dealing with spatial data within an organisation or group has been the domain of 'experts' who worked with 'high-end complicated technology' to dictate the business processes, instead of facilitating and supporting the organisation's information needs.

In the context of developing an integrated information management solution it is important to recognise that there is a range of different user groups involved including general, technical and analytical. In addition, with the advent of simple low-cost or free-viewing software and web-based applications, there is now a suite of tools available for casual users to access, query and print spatial data (Figure 7–2).

Figure 7–2 Schematic illustration of different technologies in support of different user groups.



1 ⏩ 2

Spatial information system procurement is driven by documented and justified individual or departmental business needs under the umbrella of a funded and endorsed plan for system procurement and implementation. As a guide, use the selection checklist (Section 7.3) and criteria (Attachments 7–1 and 7–2).

Similarly, developments in hardware technology mean that it is now feasible to have SIS applications operating on the full range of hardware systems such as large mainframe computers and workstations through to desktop computers, notebooks and hand-held devices, (known as personal digital assistants or PDAs) and even mobile phones.

As such, there is an increasing range of software and hardware available that can be used by different user groups.

Selections should always be based on the needs of the organisation or group. The following is a simple 'best practice' guideline:

- Software and hardware should be selected giving consideration to functionality and applications that have been identified based on a needs assessment.
- Hardware should be based on software requirements.
- Operating systems should be based on the software products and hardware, and the standards that have been developed as part of the organisation's data policy and standards activities.

7.2 Elements to consider when selecting software and hardware

When making a decision to purchase hardware and software it is worth keeping in mind a number of key elements, including:

- whether the product has a proven record in the marketplace—avoid outdated and unproven products
- whether good support mechanisms are available—these include manuals, training material, online help and technical backup support from vendors.
- whether staff with appropriate skills is readily available to enable smooth implementation. Employing specialist staff with spatial information skills is an expensive activity. It is recommended that a software and hardware product is chosen for which people with the skill sets are obtainable in the marketplace. The issue of staff turnover and general capacity building need careful consideration
- whether the product has appropriate functionality to suit existing and planned needs for your organisation.

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In preparing for any system development or replacement, undertake formal, documented system audits including user reviews and alignment of spatial information systems to the support of core business. The outcome of this analysis should be a structured business case justification incorporating elements such as total cost of ownership models.

7.2.1 Evaluating Software and hardware

The key to selecting software and hardware is to fully appreciate user or organisational requirements and choose a product that fulfils these criteria.

The main criteria to be evaluated when selecting software involve functionality, performance, scalability, licensing and standards.

Functionality

How well does the functionality of the software and hardware fit the requirements to solve the problem?

Rule of thumb—

- Don't buy more than you need.
- Educate, review and then upgrade.

Functionality is the ability of the product to perform required tasks in a simple and straightforward manner. A number of issues are involved in determining functionality, e.g. an easy to use graphic user interface (GUI). In earlier versions of SIS software, most activities were command driven where the user typed commands into the SIS to execute tasks. This required users to be familiar with a whole suite of command functions to undertake even simple tasks. The command-line era, in part, explains the situation in which SIS technical staff operated in a domain of their own within an organisation (as referred to in Section 7.1).

With advances in technology and improvements in software development, today most software packages incorporate a standard Windows-type interface with menu and toolbars. This reduces the learning curve for users and thereby enables access to spatial data on desktops. It should be noted that in reality the introduction of a Windows-based or internet browser-based interface coincided with an increase in the functionality and tools available on many systems. As a result, the learning curve for users of most professional level spatial information systems is still quite steep. It is this factor, and the demand by the general community for access to spatial data on their desktops, that has seen the development of many free or low-cost applications, often referred to as viewers. These viewers generally have limited functionality.

If SIS software is to be used by novices or those unfamiliar with computer technology it is important that the software has a simple and easy-to-use interface.

A second functionality factor involves the ability of the software to be customised using industry standard programming languages. The degree to which SIS software can be customised varies from product to product. Such applications include:

- stand-alone applications designed to meet a specific need—often referred to as custom applications and developed using specific programming tools
- large professional level SIS software packages with internal programming functions
- entry level applications designed for simple viewing operations. These packages are often 'locked' and have no ability to be customised. They are designed to undertake a simple task and do it well.

The key, when selecting software and hardware, is to fully understand user requirements and choose a product which matches those needs. To assist this process it is recommended that a list is developed detailing the functionality required for each user group that will be accessing and using the spatial data. This information can then be used to produce a matrix which compares user requirements against available products for each functionality issue. Having completed this task it is recommended that, where possible, software or hardware vendors are invited to provide a demonstration of their product's ability to perform the tasks or functionality required for each user group identified in the needs assessment. An alternative is to seek the support of other groups who currently use the software or hardware and have them undertake a demonstration (and make a recommendation). Attachment 7–1 provides a draft list of criteria to consider when selecting SIS software and hardware.

Performance and hardware requirements

The *performance* of software applications is governed by the way it was designed and engineered at the programming stage, and the speed and configuration of the hardware it is running on. Good software applications are optimised to fully utilise the hardware resources available, e.g. dual CPU processors, large amounts of RAM, and high-end graphics card, etc. Most SIS offer more than simple viewing capabilities (such as added functionality to perform certain overlay, merging and analysis tasks) which makes them very complex. Such software requires large amounts of computer resources to operate efficiently. Performance of the software application can be significantly affected if the appropriate level of system resources is not available, and therefore care is required to ensure that the frame conditions comprising CPU speed, memory, graphics display card, and disk type are optimised. The system will only operate as efficiently as the weakest link within this framework.

Most software vendors, and in particular the larger companies, provide minimum and recommended specifications. Information is also available for individual components such as the graphic card performance for a particular piece of software. Minimum specifications can often refer to the absolute minimum requirements to run the system and therefore may not yield good performance. Given that hardware technology is rapidly changing, care must be taken to ensure the specifications listed by the software vendor are not out-of-date. If requested, most software vendors will supply up-to-date specification recommendations, and most of these are also available online.

Scalability

Scalability relates to the ability to expand, migrate/upgrade or 'add-on' increased functionality to a base product in an ordered and structured manner.

- Scalability has to match the skill levels of the organisation or NRM regional body.
- Does the system have the ability to incorporate additional functionality that may be required in the future?
- Does the system have the ability to communicate seamlessly with other programs via connections or interfaces?

Due to competitive market forces and the need to provide increased functionality, almost all software vendors are constantly changing their products. In this respect SIS software and hardware is no exception as updates and patches are continually being released. The contemporary approach to software development for a number of the major SIS and image processing software companies is to provide a suite of software as part of an overall family. Under this scenario, it is possible to purchase a base version of the software and add on additional modules, often called 'extensions' or 'add-ons', to provide increased functionality. It is also important to consider the ability of a system to expand.

Key questions are:

- Does the system have the ability to incorporate additional functionality that may be required in the future?
- Does the system have the ability to communicate seamlessly with other programs via connections or interfaces?

Most large integrated information management solutions have a number of software products which communicate and share data between each other. The ability of software vendors to offer a scalable product enables users to streamline their software purchases and installations to match their own business needs.

To support scalability some software vendors have implemented a special software licensing system in which licences can float within a network to enable users to access increased functionality when required.

Licensing

Most software programs available on the market have a *licensing* agreement, i.e. the terms and conditions the user agrees to during the installation process. In addition, there is commonly a one-off licence fee included as part of the purchase price. Suppliers of the more popular products also offer maintenance programs by which users pay an annual maintenance fee entitling them to free upgrades or new versions as they become available. These are additional on-going expenses that need to be included in operational budgets.

In earlier releases of most programs, the standard licensing agreement meant that software was licensed to a particular machine—known as a single-seat, stand-alone or per-CPU licence. The advent of increasing scalability and functionality of software has resulted in more complex licensing agreements. As previously mentioned, it is now possible to obtain floating or concurrent licences for some SIS software. These licences cover the overall program, and in some cases, the extension or add-on components that may operate on any given computer. To achieve this functionality some of the major SIS and image processing companies have adopted a system that involves installing a separate licence manager program to administer the use of separate software applications within an integrated system. This allows larger organisations with many infrequent users to utilise fewer licences than if they were required to install stand-alone licences on each user's machine.

> It is recommended discussing licensing requirements with vendors to ensure software purchases are appropriately licensed for both immediate and planned future needs.

Standards

The development of an integrated information management solution is dependent on the development of standards for areas such as metadata descriptions, file naming, directory structure conventions and data storage formats. In the context of software programs, standards are also important. For example, is the SIS compatible with the operating system standards used in your organisation or NRM regional body (e.g. Mac, Linux, UNIX, Windows NT/95/98/2000/XP/Vista)?

A further aspect in which standards are important involves the ability of the software to recognise data formats used in other computer systems. Many SIS and image processing applications have unique file formats. This used to mean that the data exchange and transfer protocols were extremely important. In recent times most major packages (while still having their own unique native formats for raster, vector and data attribute information) now have the ability to import and export, and read and write data in many other formats. This is not to say that data formats are no longer important: they are, especially in the area of increasing interoperability (or the ability of different computers and systems to talk to each other and share or access each other's data). Within an NRM regional body, these may include systems for:

- document management
- financial management
- approval processing
- identification and monitoring of significant assets
- environmental management, resource condition assessment and monitoring
- reporting of on-ground works, etc.

In this respect it is important to be aware that standards groups in Australia are currently very active in the development of standards in collaboration with their counterparts overseas. The OpenGIS® Consortium (OGC) is one such group (see www.opengis.org). It is an international industry consortium and currently comprises in excess of 250 companies, government agencies and universities which participate in a consensus process to develop publicly available geoprocessing specifications. According to the OGC, open interfaces and protocols defined by OpenGIS® specifications support interoperable solutions that 'geo-enable' the web, wireless and location-based services and mainstream IT, and empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications. Most of the major SIS and image processing suppliers are members of the OGC, thereby ensuring their software complies with industry standards.

The work of the OGC has also played a part in the recent development of international geographic information standards by the International Organisation for Standardisation (ISO). These ISO standards are published as the ISO 19100 series. Many software companies are now including these standards in their products and, given the global status of the ISO process, this is likely to become an important requirement for local governments. Consequently, NRM regional bodies are encouraged to purchase commercial off-the-shelf software that is fully OpenGIS® compliant to enable interoperability with other regional bodies and local/state/national government information systems at minimal cost.

The ISO geographic information standards can be obtained through Standards Australia (http://www.standards.org.au/ and http://www.standards.com.au). Further information on the development and application of the standards in Australia is available from ANZLIC (http://www.anzlic.org.au/publications.html).

7.2.2 Steps in choosing software and hardware

Evaluation team

A primary task when choosing software for an organisation is to establish a team comprising a mix of technical, general and causal users. Such a team should include motivated staff with the ability to make decisions on behalf of the work area they are representing.

Development of a specification document

The second step involves preparation of a detailed specification document covering the items of functionality, scalability, licensing requirements, performance and standards as described previously. Consideration also needs to be given to capacity building to ensure adequate skills are available to implement the system, and the range of products and services the system will undertake.

> It is often a good idea to consult with other NRM regional bodies of similar size or functional requirement for comparison. Liaison with state/territory bodies, industry groups, the engagement of consultants and consultation with vendors are other options to consider. It should be remembered however, that vendors obviously have a vested interest in their products, and in some cases this situation also applies to private companies and individual consultants. If engaging a private consultant care should be taken to ensure they are objective and free of any vested interest.
>
> **For additional information on choosing a consultant refer to *Module 8: Enhancing capability for using spatial information.***

Develop a procurement approach

Each organisation or NRM regional body will have its own approach to the procurement of goods and services. Factors that influence the procurement approach include value thresholds. For example, procurement of goods and services over a certain limit requires a certain number of written quotations (often called an RFQ or Request for Quotation). Higher thresholds may require open tendering with advertisements placed in newspapers or online (often called an RFT or Request for Tender).

Alternatively, it is possible to prepare what is termed a Request for Proposal (RFP). This approach is often adopted by larger organisations in situations where a number of software programs may potentially fulfil the requirements detailed in the specification. Under this scenario companies are asked to submit a document outlining their proposed approach, experience, fees and timeframe. In some cases, vendors are provided with actual NRM regional body spatial data and asked to provide working solutions to pre-defined issues and problems. Through this mechanism the use of systems in 'real life' can be tested.

It is strongly recommended discussing procurement and tendering requirements with your organisation's purchasing staff and/or senior management in the process of developing a procurement approach. There are often clearly defined legal and probity issues that must be followed.

Development of an assessment matrix

The development of a matrix to enable software packages to be assessed against user requirements or functionality is recommended to provide the evaluation team with a clear overview of the options. An example of a features functionality matrix used in GIS industry surveys is included at Attachment 7–1.

Evaluation

A number of options exist for evaluation depending on the chosen procurement approach. For example, based on the results of the assessment matrix and recommendations from consultants or others, your organisation or NRM regional body may be happy to proceed directly with a purchase. In cases where more than one company is selling the same software it is possible to ask for them to bid on the cost of supplying the software. It is important to note that installation, training requirements and ongoing technical support need to be considered.

Key questions for evaluating vendors' or companies' submissions include:

- Do they have a demonstrated understanding of the applications and needs of your organisation?
- Are they able to articulate what they are going to do in a clear and precise fashion?
- Do they have proven experience in providing similar services to other NRM regional bodies or similar organisations?
- Are they able to meet timeframes?
- Have they recommended a solution that matches your budget availability?

Benchmarking

Benchmarking involves testing the software system's ability to perform a number of tasks or handle a number of issues. In such cases data and information are often provided to suppliers and they are given a set amount of time to undertake the tasks.

Final decision

A number of options exist to reach a final decision. In some cases a two-phased process is used where each member of the team is given an opportunity to evaluate the outcomes of the tasks above. A meeting is then held and the final decision determined. A second option is to reach consensus as a group thus eliminating an extra step in the process.

Either way the evaluation team should feel comfortable with the selection process and assured that the final selection fulfils the requirements.

Rule of thumb

- It is a good idea to define the selection process before the detail becomes known.
- Leave room for evaluating intangibles—some non-cost factors generally relating to functionality include:
    - availability of skilled staff in nearby NRM regions, local government or state/territory agencies
    - skill and availability of an in-house SIS group
    - skill of the service provider.
- Be conscious of where your next technician may come from—skilled SIS professionals can be expensive and often in short supply.

The exact method of the tendering and selection of software and hardware will be determined by your organisation or NRM regional body's purchasing and procurement policies. It is recommended that you talk to your purchasing section (if they exist) before embarking on a software and hardware purchasing initiative.

7.3 Checklist for selecting spatial information system software

General tips and tricks for selecting and implementing spatial information systems are included at Attachment 7–2. The following is a checklist of issues that need to be addressed when selecting SIS software:

☐	**Do you need a spatial information system or a mapping package?** If so, what scale or type—simple desktop viewer, professional workstation, custom application?
☐	**Cost:** Hardware and software requirements (including ongoing maintenance)
☐	**Type of operating system:** Linux, Unix, Windows, Mac
☐	**Format requirements:** Ability to handle raster (pixel data), vector (point, line, polygon data) or both formats
☐	**Support:** Are you going to be able to get help if you have problems?
☐	**Complexity/personnel resources (including staff and training):** For a beginner, it will be important to have a user-friendly SIS, i.e. one with an easy to understand graphic user interface (GUI). Ensure that budget funds are available for initial training and continued capacity building activities for both SIS technical and casual users
☐	**Company, agency or organisation requirements (general and specific):** Develop a needs assessment. Can specific benchmark requirements be met? Does the software fulfil a variety of needs? Does the system have the functions needed?
☐	**Reliability of system and vendor:** Will they be around for the next ten years to service equipment and provide technical support?
☐	**Scalability, maintenance and upgrading:** Does the technology have an update or production development program? Does it offer a migration path or suite of options? Will you need to buy add-ons and are they available?
☐	**Support material:** Is there a pool of people locally or within your organisation that uses your preferred SIS? If so, will it be possible to get help from more experienced users? Capacity building is one of the most important aspects in the successful implementation of an SIS
☐	**Maintenance and licensing:** What maintenance and licensing options are available?
☐	**Interface with other software used and interoperability:** For example, between computer aided drafting (CAD), mapping, image processing, database and web systems
☐	**Open system support:** Does the software support OpenGIS® Consortium specifications and the World Wide Web Consortium within the Australian Spatial Data Infrastructure (as mandated within the national Interoperability Framework Initiative)?

Additional support

Considerable resource materials exist that can support the process of selecting GIS/SIS software. For example, many of the spatial industry news groups and magazines often have information reviewing particular software products, and in some cases providing cross-functionality comparisons.

The following list provides links to some available sources and is not meant to be exhaustive. Note: the inclusion of individual organisations does not in any way promote a particular product.

Choosing a GIS

GIS Strategies and Issues—a complete framework, including needs analysis, funding and choosing hardware and software, from the Louisiana Geographic Information Council: http://lagic.lsu.edu/gisprimer/strategies.asp

How to Choose a GIS (GIS Monitor website): http://www.gismonitor.com/articles/features/how_to_choose.php

Ultimate Map/GIS Directory (GIS Monitor website—links to available mapping and GIS products): http://www.gismonitor.com/products/index.php

Support on system upgrading

A challenge facing many organisations is whether or not to update existing SIS installations and what the best approach is. Several considerations are important and require evaluation to ensure successful updating which provides for the continued effectiveness and efficiency of spatial systems to meet future geo-spatial needs and changes.

Upgrades can originate from existing systems which have been installed for quite some time or upon those systems that have been in place for shorter periods of time.

Upgrade Your GIS: Best Practices for Successful Implementation:

http://www.gisvisionmag.com/vision.php?article=200111%2Ffeature.html

Product reviews

General product reviews (GeoCommunityTM website): http://software.geocomm.com/reviews/

Product comparison (GeoCommunityTM web site): http://www.spatialnews.geocomm.com/reviews/mifav.html

Software surveys

The results of a variety of annual product surveys between 1999 and 2007, including *GIS Software Survey* and *GPS Receiver and Software Survey*, are available from the Point of Beginning (POB) website: http://www.pobonline.com.

Free software viewers and data conversion tools

A number of free viewers and software applications are available online. Free applications and reviews about functionality and file formats are available from the following websites:

Grime website: http://www.grime.net/gistools/

GeoCommunityTM website: http://spatialnews.geocomm.com/features/viewers2002/

Attachment 7–1

Criteria for selecting spatial information system software

The following criteria, sourced from the Point of Beginning website, is a template from which GIS functionality requirements and software products can be assessed. For additional information on software features refer to http://www.pobonline.com

Program name	**GIS *X***
Manufacturer/distributor	Company *X*
Manufacturer's phone number	
Cost per seat	
Date of first release	
SOFTWARE FEATURES	
Operating system/network support	
- Network client/server support	
- Server operating system	
- Client operating system	
- Internet server enabled	
GIS data administration	
- Multi-user edit locking	
- Versioning	
- Metadata maintenance	
Database management	
- Proprietary DBMS	
- Relational database management system	
- RDBMS spatial data warehouse	
Native Graphic Data Structure and Format	
- Vector — spaghetti	
- Vector — topologic	
- Parametric	
- 3-D	
- TIN	
- Grid	

- Raster image	
GIS data import/export utilities	
- Direct import formats	
- Direct export formats	
GIS data entry and editing	
- Board digitising	
- Coordinate geometry/precision entry	
- Electronic survey data import	
SOFTWARE FEATURES	
- Heads-up digitising	
- Vectorisation	
- Map rectification	
- Graphic error check/correction	
- Field data entry	
Map design and composition	
- Interactive map composition	
- Annotation from attributes	
- Global symbol change	
- Thematic mapping	
Geographic query and analysis functions	
- Attribute query and selection	
- Map measurements	
- Address matching	
- Buffer generation	
- Point/line-in-polygon analysis	
- Polygon overlay	
- Network analysis	
- Raster document query and access	
- Direct access to other GIS format	
Terrain data processing and analysis	
- Digital elevation model (DEM) generation	
- Contour map generation	

- 3-D display/profile generation	
- Map draping	
- Slope/aspect analysis	
Raster image capabilities	
- Geometric rectification	
- Orthoimage generation	
- Image enhancement	
- Spectral classification	
Application development language	
- Proprietary application development language	
- Industry standard programming environment	

Summary of GIS software features	
SOFTWARE FEATURE CATEGORY	***EXPLANATION***
Geographic data management	Database administration tools for managing data access by users, locking of data during edit and maintenance of metadata.
Tabular attribute data management	Software environment and capabilities for storing and managing database attributes linked to map features in the GIS database. May involve use of a vendor-proprietary system for attribute storage or a commercial relational database management package.
GIS data import/export utilities	Utility programs bundled with the GIS package for translation of GIS or CAD data to or from another format, including common industry-standard formats such as SHP, DXF, SIF, DLG, SDTS, GRID, ASCII.
GIS data entry and editing	A range of interactive and batch processing functions for entry of map data through such means as board digitising, coordinate geometry entry (COGO), scanning and heads-up digitising, along with capabilities for editing GIS data, performing error checking and resolution, map rectification and transformation of coordinate systems and map projections.
Map design and composition	Interactive capabilities for the design of map plots and displays, automatic creation of thematic maps and legends, and modifying map symbology and annotation for custom map displays.
Basic geographic query and analysis functions	Basic tools for performing attribute or map-based queries and displays, basic distance and area measurements, query and access to scanned documents, buffer generation, polygon overlay operations and other query and analysis functions.
Network analysis	Spatial analysis operations based on linear networks (e.g. road or pipeline systems), including operations such as the shortest path tracing and region allocation. Network analysis capabilities in GIS packages often allow users to design network models based on attributes of network segments.
Terrain and 3-D data processing and analysis	Capabilities for storing three-dimensional data normally in a grid or triangular integrated network (TIN) format with functions for 3-D analysis such as contour mapping, 3-D display, draping of map features over a 3-D display, slope and aspect analysis.
Raster image processing capabilities	Capabilities for the manipulation and processing of raster images (e.g. digital aerial photos or orthophotography, satellite images), including functions for the import and rectification of raw imagery, digital image enhancement and automated classification of multi-spectral imagery.
Application development languages	Programming environment for customising applications accessing software functions provided by the package, including proprietary languages included with the GIS software package or industry-standard tools (e.g. C++, Visual Basic, Python, Delphi) that may be used for application development.

Attachment 7–2

Tips and tricks for selecting and implementing a spatial information system

The following list is a summary of the 'tips and tricks' presented by Peter Thorpe (Peter Thorpe Consulting) at the UK Royal Town Planning Institute's (Planning and Environmental Training) GIS Selection and Implementation Conference at the Cavendish Centre, London on 19 April 1996 (Source: http://www.planweb.co.uk/tip1.htm).

Selecting

1. First develop your **vision** for how GIS will support your business priorities, **then** fill in the details of your requirements.

2. Focus on your **key** requirements, **not** on the GIS technology.

3. Decide the overall shape of your GIS procurement at the outset — Map management? Full GIS? Integrated systems such as Development Control? Land and Property Gazetteer? Links to databases such as Census? Links to existing Council systems such as Land Charges?

4. Identify the first 'showcase' project so as to ensure high visibility and maximum chance of successful implementation.

5. Get commitment from Elected Members, Chief Officers and Senior Managers.

6. Refine your requirements through supplier demonstrations and visits to local authorities which are active in GIS - **but don't get deflected from your own priority needs**.

7. Review the British Standard BS7666 ('Spatial Datasets for Geographic Referencing') and put in place **'home grown'** standards for your geographic data ('streets', 'properties', 'addresses').

8. Consider the Local Government Management Board's GIS Functional Specification - **but treat it with healthy suspicion and don't use it indiscriminately!**

9. Structure your Invitation-to-Tender to ease direct comparison between suppliers - if possible in a way, which can be **quantified**.

10. Call the tune in assessing suppliers and ensure that presentations, demonstrations and benchmarks are carried out to rules that **you** define.

Implementing

1. Set 'benefit targets' in advance as the challenge for implementation.
2. Hand pick the 'Project Leader' (skills in GIS, people management and trouble-shooting equally important).
3. **Dedicate adequate resources** (human and financial) within the Project Team.
4. Keep alive a detailed Implementation Plan and use it rigorously as the basis on which to monitor progress and take corrective actions.
5. Don't skimp on training, which is a fundamental investment without which the project is unlikely to succeed.
6. Administer geographic data as a major corporate asset and put in place procedures to ensure standardised definitions, responsible ownership and quality.
7. Maintain the support of Chief Officers and Members in order to underpin ongoing success.
8. Exploit the opportunities for new ways of working which GIS can offer the local authority.
9. Promote the successes and achievements accruing from the implementation of GIS, in order to sustain and justify continued commitment.
10. Keep it all under review because things never stand still (vision, strategy, implementation plan, benefits, future direction)!

MODULE 8

MODULE 8: Enhancing Capability for using Spatial Information

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

One of the prerequisites for natural resources management (NRM) involves the establishment and maintenance of a good database of information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making/planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis, standards, and communication are key components.

Under current arrangements, funding for NRM projects is increasingly being channelled from government agencies to regional groups, such as catchment management authorities and resource information centres.

Decisions by an NRM regional body to train existing staff in spatial information systems (SIS), hire new staff with existing SIS or hardware skills, or hire a consultant, are no different from any other similar technical issue faced by other organisations, such as local government. SIS software is now in the mainstream of the information technology industry; so SIS expertise (once a very scarce set of skills) is now widespread in Australia. However, as with specific IT skills, they may generally be more difficult to obtain in rural and regional Australia than in metropolitan centres.

It is acknowledged that each local government may have its own initiatives related to data collection and information management, including governance guidelines and protocols related to the implementation of information technology initiatives. These may include a list of recommended consulting firms and panel contracts. There are also likely to be constraints on local government procurement resulting from state/territory requirements.

Module 8: Enhancing capability for using spatial information addresses the options available to raise the capability for using SIS technology in NRM regional groups. In particular this module focuses on staff development, recruitment and the issues surrounding the hiring of SIS consultants.

This module links closely with many other modules in the Toolkit, given that the issues with the collection, storage and dissemination of spatial information focus on raising the overall SIS organisational capacity of NRM regional bodies.

Actions

In many cases an organisation or NRM regional body may need to raise their SIS capacity by training present staff, recruiting new staff, or hiring specialist consulting firms to provide guidance, recommendations, specific software development or data analysis tasks.

There is a range of sources of SIS training available, from short courses and training linked to software purchases, through to dedicated courses up to degree level. The number and scope of these educational opportunities has increased rapidly in recent years.

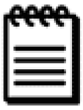
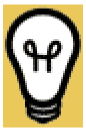
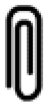
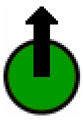
Managers should be aware that best practice guidelines are available to assist in determining when a consulting firm is required and what to look for when choosing one.

Acknowledgments

This module draws heavily on a two-part article by Marshall Payne published on the Directions Magazine website—*Part 1: How Do You Know When You Need One?* and *Part 2: What to Watch Out For* by Marshall Payne. Material has also been sourced from the ANZLIC – Local Government Toolkit. These sources are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

8.1 Introduction

This module addresses the options available to raise the capability for using spatial information within an organisation or NRM regional body. In particular this module focuses on staff development, recruitment and the issues surrounding the hiring of SIS consultants.

8.2 Train, recruit, or hire a consultant?

Decisions to train existing staff in SIS software, recruit new staff with existing skills, or hire a consultant are no different from any other similar technical issues within an NRM regional body. GIS and SIS software are now in the mainstream of the information technology industry; so GIS/SIS expertise (once a very scarce set of skills) is now widespread in Australia. However, as with specific IT skills, they may generally be more difficult to obtain in rural and regional Australia than in metropolitan centres.

Consequently, the processes that apply in your organisation or NRM regional group when faced with decisions on staff development, recruitment of new staff or outsourcing, also apply in the case of SIS skills. Factors that influence these options include:

- matching current capability with planned SIS requirements—do you have a thorough understanding of skill needs for both short- and long-term deployment of your SIS?
- consideration of the SIS resources available in your region—is it possible to work with your neighbouring NRM regional body or local government to share resources?
- time constraints—do you need an SIS system urgently or can you progress this more slowly?
- long-term planning—a long-term vision for SIS in your organisation or NRM regional body will require consideration of the sustainability of SIS and how a staff/consultant mix will be maintained.
- budget—whether training, staffing and consultant budgets are consolidated or segmented will affect how the mixture of capacity-raising options is approached.
- linkage with purchasing—there is often a strong linkage between SIS software and hardware purchasing decisions with the provision of training and consultancy services.

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The spatial information management projects of individuals are recognised by your organisation or NRM regional body and are being managed in a systematic manner. Data and information management standards are in place and there exists linkage to some business processes and procedures. Training resources are allocated to individuals and/or departments.

The options presented in this module deal with staffing and procurement issues. To ensure compliance with your organisation's human resource and procurement policies, it is strongly recommended that you discuss the issues with the appropriate senior staff.

8.3 Options for training existing staff

A wide range of SIS staff training options are now available in Australia. These range from full-time university courses to short courses, in-house training, cadetships and mentoring through professional associations and informal networks.

There are a number of industry training courses on SIS available. These are run either by independent training providers or by companies selling SIS software and services. In the latter case, SIS vendors can provide either stand-alone introductory SIS courses—using their own software—or training associated with software purchases. Links to SIS software and hardware products are given in Module 7. In some cases, SIS vendors offer regionally based training courses or provide training through distance education.

The spatial sciences community now has competency standards for both the vocational education and training sector and the professions. The agreement of a competency framework has led to the development of a number of SIS training options including:

- Diploma of Spatial Information Services
- Advanced Diploma of Spatial Information Services
- Certificate III in Spatial Information Services.

These courses are more comprehensive than short courses, but last longer and so require a greater time commitment. Courses are currently offered in all jurisdictions.

For further information contact the National Training Information Service at http://www.ntis.gov.au/Default.aspx and enter 'spatial' in the search box.

There are also an increasing number of university programs which incorporate an SIS component. These include geography, town planning, surveying and computer science. As well as providing university courses for training, the lecturers teaching these courses are often available to run short courses for organisations or NRM regional bodies. This can have the advantage of providing training independent of software vendors.

Training can also be obtained through industry professional associations. Currently the association with a large membership within the NRM community is the recently formed Spatial Sciences Institute (SSI) (http://www.spatialsciences.org.au/). The SSI was formed through the coalition of five former major spatial-oriented associations, namely:

- Australasian Urban and Regional Information Systems Association (AURISA)
- Institution of Engineering and Mining Surveyors, Australia (IEMSA)
- Institution of Surveyors, Australia (ISA)
- Mapping Sciences Institute of Australia (MSIA)
- Remote Sensing and Photogrammetry Association of Australasia (RSPAA).

Raising staff capacity in SIS does not necessarily need formal training courses or conference attendance. Informal networking between other NRM regional bodies and local or state government staff working in the management of spatial information can be just as effective. This was the thinking behind the GIS section of the City of Swan local government forming its own GIS professional network (http://gis.swan.wa.gov.au/). The network meets occasionally to share experiences and also provides a simple online contact list so members can contact their colleagues in other local governments directly. The network is of great support to its members, particularly those outside the Perth metropolitan region, where those involved in GIS can often feel isolated from their peers.

Similar networks exist within the general NRM community (e.g. NRM Discussion Forum http://www.nrm.gov.au/do/forum.html and the NRM Talk Newsletter http://www.nrm.gov.au/publications/newsletters/nrm-talk.html) though they are not specifically SIS related.

8.4 Options for recruiting new staff

Specialist staff will be required by NRM regional bodies once their requirement for SIS reaches the point when existing staff no longer have the time and/or skills to manage it. Recruitment may also be required when it becomes more cost-effective to hire staff than continually use consultants.

As outlined above, there is now a wide range of specialist SIS training courses available at Diploma, Advanced Diploma, Certificate III and degree levels. The graduates of these courses will have a good grounding in the theory and practice of SIS development and implementation. The mix of practical and theoretical skills will vary between the levels of qualification and from institution to institution.

The criteria for choosing new staff will, of course, depend on the particular requirements of the organisation or NRM regional body. Job descriptions for SIS positions usually specify:

- experience with a particular SIS software package
- understanding geographic databases
- familiarity with SIS operations
- familiarity with maps and mapping conventions
- competence with computing operating systems
- experience with a range of related software products.

The above list is actually a reasonable guide for starting a recruitment process.

An example of a recent staff recruitment process for a Biodiversity Assessment GIS Project Officer is provided by the Audit (www.nlwra.gov.au). The position was advertised in August 2007 as suitable for a person with skills in GIS and spatial data analysis. The advertisement read:

The National Land & Water Resources Audit is looking for a person with skills in GIS and spatial data analysis, to analyse and map the extent and condition of Australia's biodiversity. The production of a range of products (maps, graphs and tables) is required for the 2008 biodiversity assessment, using ESRI ArcGIS software. The project officer would be working with GIS specialists within the Department of the Environment and Water Resources and the Biodiversity Assessment Coordinator. This position will be located at the Department of the Environment and Water Resources.

DUTIES:

1. Working with GIS specialists within the Department and the Biodiversity Assessment Coordinator, interrogate existing spatial data sets relating to biodiversity to produce products required for the 2008 assessment (maps, graphs and tables) using ESRI ArcGIS software.

2. Undertake a range of spatial analysis, data management and mapping tasks, such as mapping changes in native vegetation extent, condition and type, changes in extent and condition of wetlands, estuaries and rivers, threatened species and ecosystems, as well as pressures on biodiversity including land use change, grazing, fire regimes, hydrology, invasive species and climate change. Other tasks may be included.

3. Liaise with data providers within the Department and state agencies to update spatial data holdings, including maintenance of data licensing and metadata.

KNOWLEDGE AND EXPERIENCE REQUIREMENTS:

1. Demonstrated experience in the interrogation of spatial data using ESRI ArcGIS software.

2. Tertiary qualifications (or equivalent experience) in an appropriate field, including a strong spatial component (GIS, biodiversity information, spatial modelling), database development or programming component.

3. Demonstrated ability to deliver outputs alone or as part of a team including the ability to effectively manage tasks of competing priority to ensure the successful delivery of specified outcomes or outputs.

4. Ability to work effectively as a part of a team, recognising the abilities, differences and contributions of all members and fostering co-operation amongst the team.

5. Ability to communicate information effectively with a wide range of people including both technical and non-technical people.

6. Capability to provide technical advice including ability to interpret and advise on technical data related to biodiversity.

Source: Audit Web Site: Tenders and Vacancies

8.5 Choosing a GIS consulting firm

8.5.1 Choosing a GIS consulting firm – How do you know when you need one?

The following material is taken from a two-part article *Choosing a GIS Consulting Firm* by Marshall Payne. It is available online from the *Directions Magazine* website:

Choosing a GIS Consulting Firm: Part 1 - How do you know when you need one? (6 June 2003): http://www.directionsmag.com/article.php?article_id=358

Choosing a GIS Consulting Firm: Part 2 - What to watch out for (12 June 2003): http://www.directionsmag.com/article.php?article_id=371

There have been many articles published about how to ensure your GIS project is successful. Typically, these articles focus in particular areas or are provided in a "top 10 style" list. They are authored by consultants and project managers citing personal experiences. Rather than provide tips for a successful project, some articles will provide a list of common mistakes leading to failed projects. Some of the more common reasons for project failures include unplanned budget reductions, poor expectation management, scope creep, inadequate staff, or "flat out" missing the targeted business need. Tips commonly mentioned for successful projects will range from having an influential project champion, realistic expectations, developing a good scope, having an adequate budget and schedule, and one of the more important ingredients; making sure that users are in agreement as a successful application or system is one that gets used. But perhaps the most important factor for a successful project often comes down to choosing a good GIS consultant.

For many GIS projects, people will hire a consultant to implement technology, provide a total solution, or help manage an internal development project. But how do you know when you need a consultant, and more importantly, how do you choose one that is going to help make you and your project successful.

Knowing when you need a GIS consultant

There are many reasons to choose a consultant to help with your GIS projects. Obvious reasons include not having enough staff, the size or complexity of project is one that requires certain expertise not internally available, or specialised technical skills are required to supplement internal staff. However, before hiring a consultant you need to first understand your goals and objectives even if your objective is simply to help determine your needs or direction. Common GIS consulting projects will start out as needs assessment, cost benefit analysis, implementation plan, or an application design.

There are other signs to look for when you may need a GIS consultant. The following describes some scenarios when having a GIS consultant can help make all the difference and at the same time make you and your organisation successful even during the worst of times.

1. You have a particularly challenging or large application project where a consultant can provide the necessary specialised programming skills and direction. This could include a project where GIS needs to be integrated with other enterprise business systems. Using a

consultant that has extensive experience with both GIS and other systems can help expedite projects and provide diversity of skills that will be needed on large complex projects.

2. You simply need data development, conversion, or mapping services. Consultants specialising in these areas that are more tedious or laborious can often provide very cost effective solutions and deliver results in a much more timely fashion.

3. The growth of GIS in your organisation has stagnated. Often after a GIS program has been established the organisation in unable to move beyond data maintenance and map production work resulting in failing to capture or realise the return on investment. A consultant can help move things forward to achieve the full potential and benefits of GIS. A good GIS consultant can help overcome political barriers, build consensus, has outside perspectives, and knows what has worked and failed in other organisations. A good consultant will have lots of diverse experience and can bring many ideas to the table to help jump-start your GIS program.

4. Your organisation is at risk of loosing its GIS program because management or elected officials consider a GIS as a project rather than an on-going system. A consultant can help provide education to officials and lay out a plan to make GIS an integral component to an organisation's overall information infrastructure

5. Your budget and staff have been cut and you need to work smarter and be more efficient in order to sustain your GIS program. Consider project based contracted services as a solution to help with loss of staff.

6. You are preparing to undergo organisational change where consolidation of your GIS department or departments with the Information Technology (IT) department will occur. A consultant with experience in this area as well as has the technical expertise in both the GIS and IT areas can assist in the reorganisation. A good consultant with experience in GIS, IT, organisation development, and communications can act as “translator” providing education, etc. to help overcome the cultural differences.

7. GIS technology is rapidly changing and becoming more complex and has more dependencies on system resources and infrastructure. A consultant can help with selecting, migrating to or implementing this new technology. A consultant can introduce the technology in a way that is both practical and implemented at a pace that's conducive to the organisation.

8. You are tired of building applications in-house only to have the application programmer quit before the project is completed or documented. Sometimes it may seem like a good idea to build your applications in-house but it can be difficult finding the time to maintain and support them. It can also be difficult turning GIS Analysts into Visual Basic programmers. Using a consultant to help develop and maintain applications may save you time, money, and could be less risky.

So I need a consultant…now what?

If you are a private company seeking services the decision of when and who to choose is much easier than if you are a government organisation bound by procurement policies. For government entities there are many ways to hire a consultant. Some examples are described below.

1. If you have purchased software and need consulting services for implementation, customisation, or training it is typically a simple decision and services can be purchased in conjunction with the software procurement.
2. The most common way for a public entity to hire a consultant is to develop a scope of services and initiate a Request for Proposals or RFP. In some cases, typically with larger projects, a Request for Information or Qualifications (RFI and RFQ) will be completed as an initial step before conducting a RFP. With a RFP, consultants will provide proposals describing themselves, services, experience, and costs. From the proposals, a short list is determined and interviews are conducted to determine the consultant with the most appropriate qualifications and cost-effective solution.
3. An increasingly common approach is to hire a pool of preferred consultants for a 2–3 year contract period. This is typically done also using a RFP process where experience, services, and rates are evaluated to select top firms. Once contracts are signed, it greatly simplifies and streamlines the public organisation's ability to procure services or products. The organisation can choose amongst the firms on services and estimates provided using a task order process.

As previously mentioned there are many types of consultants to choose from and selecting the one that fits your needs best will partly depend on the type of service you are seeking and partly on the type of relationship you want to have with your consultant. This sounds funny but it's true. Once you determine the “what” and “how” you need to determine the “who.”

8.5.2 Choosing a GIS consulting firm – What to watch out for

There is literally a sea of GIS consultants and consulting firms out there, so how do you choose the “right” one? Well first you need to understand the many types of consultants and services they provide. Consulting firms will range from a person working out of their house to small firms to large corporations. Some consulting firms are more traditional while others only offer outsourcing services. Some firms specialise while others offer diverse services. Some are software vendors that offer consulting services centred on their products.

So how do you choose? Well there are the obvious things to look for such as the depth and diversity of skills, years of experience, costs or rates, and references. But what about things that aren't so easy to describe like ‘does it feel right?’ or are they ‘trustworthy’,’ dedicated,’ ‘creative,’ ‘fair,’ honest,’ and ‘hard working’. Keep in mind that when you hire a consultant you are not only entering into a contract but also a relationship. Often time consultants are ‘fired’ not because of their skills or qualifications are lacking but simply because there is too much friction or because ‘it didn't feel right’. There are countless situations where firms far superior on qualifications and experience, competitive on cost, etc. have lost projects because they did not have a previous relationship with the client or failed to create the right ‘spark’ with the client.

When hiring a consultant, make sure that they have what it takes to be in a relationship with your organisation. Will the consultant's staff mesh well with your staff? Will the consultant be responsive and understanding yet fair? Is the consultant dedicated to seeing your organisation successful? These are all important questions to consider when choosing a consultant.

When selecting a GIS consultant you should choose one that has the breadth and depth to meet your organisation's needs. These days GIS is being elevated in organisations and now plays more of an integral part in enterprise and mission critical business systems. Having a consultant that not only has excellent GIS experience but also has experience with database and internet applications as well as network and security skills will be invaluable. Many firms are specialised and don't have these skills so it is important to choose wisely depending on your needs.

8.6 Best practice guideline for hiring a GIS consultant

Rule of thumb

- Similar to choosing software—decide what is required and not what is offered by potential clients.
- Where possible develop a matrix or scorecard on what the consultants offer and what your requirements are.
- Leave room for evaluating intangibles—factors to consider include:
    - Potential for an ongoing relationship and support
    - Skill—does the consultant have the breadth and depth to meet your needs?
    - Distance—are they available at close call and is this important for your decision?
- Ensure your council’s procurement processes are followed.

8.7 Additional support

A wide range of consultants servicing the spatial industry is available throughout Australia. The following web sources are presented as a starting point for local governments to find out additional information about the spatial information industry and consulting firms in Australia.

Industry publications and services

Position Magazine: http://www.positionmag.com.au

Spatial Business Online: http://www.positionmag.com.au/SBN/sbn_frame.html

Associations and groups

Spatial Sciences Institute (SSI): http://www.spatialsciences.org.au/

Australian Spatial Industry Business Association: http://www.asiba.com.au/

Geospatial Information and Technology Association: http://www.gita.org.au/

MODULE 9

MODULE 9: Map Production Guidelines

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

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Guide for managers

Context

Maps are by definition a generalised representation of the real-world geography. Cartographers or technicians who make maps, use symbols to represent real-world features, such as lines for rivers or roads, points for cities, and polygons for provinces or districts. During the map-making process information is usually generalised to make maps clearer and easier to understand. For example, the map maker might choose to show only those cities with populations greater than 25,000 rather than cluttering up a map with every settlement with a population count recorded in the census database.

Modern day computer-assisted cartography (map making assisted by computers), is much faster and more efficient than traditional cartography. Current geographic information systems (GIS) and computer aided design (CAD) software programs allow for the rapid development of many map products and an effective means of communicating results. Prior to commencing the physical production of a map it is important to understand a number of principles involved in making a good map. In this respect the importance of quality and appropriateness of the underlying datasets cannot be over emphasised.

Module 9: Map production guidelines provides background information on principles of cartographic design and how to apply them to produce high-quality maps. In doing so they are not considered to be exhaustive and it should be recognised that each state/territory jurisdiction or NRM regional group may have specific overarching protocols which need to be considered.

The following elements form the basis of a 'good' map and thereby reflect best practice:

- descriptive title
- the map itself, including symbolisation of geographic features
- legend that explains the geographic symbols
- map scale
- map projection
- north arrow (or compass)
- copyright, data source/s and publisher statements.

Actions

To be effective maps need to convey relevant information to the expected audience.

Managers need to make sure that mechanisms are in place (as part of quality assurance procedures) to ensure map production fulfils relevant compliance criteria. In this respect, checklists identifying minimum requirements for internal and external map production are a useful method of facilitating quality control.

Printing large map products (e.g. A0-size) is often a very time-consuming process. As such, sufficient time needs to be allowed when preparing such products. Managers should ensure that stocks of standard products are maintained to service day-to-day requests.

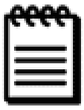
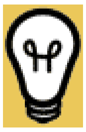
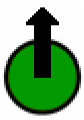
Acknowledgements

This module draws heavily on material from the book by Ed Madej (2001*) Cartographic Design Using ArcView GIS*, published by OnWord Press.

In addition, material from the Audit's operation manual has also been incorporated. These sources are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

9.1 Introduction

9.1.1 What makes a good map?

There are two main categories of map that are displayed on-screen or as hard copy:

- general reference maps
- thematic maps.

Most atlases are considered general reference maps and typically contain numerous features, none of which predominate. Reference maps are generally rich in detail and take longer to produce than other maps.

Thematic maps are at the other end of the spectrum of cartographic products. They generally emphasise one or two map features relative to other background items. A map showing soil type in a catchment is an example of a thematic map. The soil type is highlighted over any other map feature. Thematic maps are generally easier and faster to produce than good general reference maps.

Maps can be classified anywhere in the continuum between reference and thematic maps. For example a state road map may be rich in detail thus resembling a reference map, but the highways may be more predominantly displayed, making it more of a thematic map.

The following elements form the basis of a 'good' map:

- descriptive title
- the map itself, including symbolisation of geographic features
- legend that explains the geographic symbols
- map scale
- map projection
- north arrow (or compass)
- copyright, data source/s and publisher statements.

Map production guideline(s) have been produced and communicated to key staff based on the components outlined in *Module 9: Map production guidelines.*

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9.1.2 Descriptive title

A *descriptive title* is a short description about the purpose of the map. Consider a map showing state population change between 1980 and 2003 by a graduated change in levels of grey. A quick non-informative title for the map would be *State Population*. The title provides the user with very little information about the map. A more appropriate title would be *Victorian Provincial Population*

Growth: 1980–2003. This title, although an improvement on the first, is still potentially incorrect as the title implies an increase in population not a decrease. Some local government areas may have decreased in population.

Possibly the best title would be *Population Change by Local Government in Victoria 1990–2001*. This title conveys a lot of information in a short phrase and does not mislead the map user.

9.1.3 The map itself

The *map itself* is a generalised representation of the real-world geography of an area. During the map-making process information is usually generalised in order to make maps clearer and easier to understand. For example, the map maker might choose to show only those cities with populations greater than 25,000 rather than cluttering the map with every settlement with a population count recorded in the census database.

9.1.4 Map legend

The *map legend* clearly explains the symbols used to represent geographic features on the map. A legend does not necessarily need to include every symbol used in the map. For example, most map readers understand that wavy blue lines represent a river. The major symbols or themes however should always be prominent in the legend.

9.1.5 Map scale

Maps present a view of geography that is smaller than the real world, and as such it is necessary to note the scale of the map on the final map product. *Map scale* can be shown as a unit measure (e.g. 1:50 000), or as a graphic scale bar. Maps of a scale of 1:50 000 and less are considered large-scale maps, whereas maps of a scale of 1:500 000 or greater are classed as small-scale maps. Large-scale maps generally show more geographic detail than small-scale maps.

9.1.6 Map projection

Map projection allows the cartographer to represent a portion of the 3-D curved surface of the earth on a flat (or 2-D) piece of paper. A *map projection* is either set in the geographic data when it is created (and should be noted in the metadata), or it can be added or modified within most SIS applications. The most popular projections used in Australia are:

- For the whole of the Australian continent:
  - if users need to compare areas → Albers Equal Area Projection
  - if users need to compare distances/angular relationships → Lambert Conformal Conic Projection
- For small local areas of the Australian continent use the Map Grid of Australia (MGA). Data are mapped using the Geocentric Datum of Australia (GDA).

9.1.7 North arrow

Most SIS software and other mapping applications enable a *north arrow* or compass to be included on the map document. Depending on the map's extent and projection, the geographic north may be directly at the top of a page or slightly to the right or left of the top.

9.1.8 Copyright, data source and publisher statements

A source statement informs users of where the map data originated and at what scale the data were captured. A publisher statement identifies who produced the map and when the current version was printed. A copyright statement identifies any copyright details. As part of best practice procedures it is important that copyright information is included.

9.2 Things to consider prior to making a map

Before making a map the following points need to be considered:

- the intended audience
- data sources
- composition tools.

9.2.1 Audience

Most SIS software and other mapping applications can produce a wide variety of map products, from simple A-4 sized maps to large wall maps printed on A-0 plotters. It is important to consider and understand the intended requirements of the primary audience when producing a map product.

9.2.2 Data sources

It is widely acknowledged that approximately 90% of the time invested in a typical spatial information project involves the capturing or building of the geographic data. **When the time arrives to compile the data and produce a map it is critical that the map maker understands the data.** For example,

- What projection are the data in?
- At what scale were the data captured?
- When were the data gathered and who did it?
- If the map is saved, where is it located on the NRM regional body's network?

This information should be available from the metadata associated with each data theme and emphasises the importance of producing and maintaining metadata.

9.2.3 Composition tools

Most SIS and mapping applications have a range of composition tools that are available for making maps. A good understanding of them is required to produce a streamlined and efficient map production system.

The use of templates is useful when making a series of maps which require a consistent format (e.g. for a report). Most SIS software supports templates, and once created can save considerable time and effort leading to improved overall efficiency and effectiveness.

9.3 Design process

Producing a map that is simple, clear, uncomplicated and pleasing to the eye requires planning and, above all, it has to convey the information in the correct manner. When a user requests a map to assist making a decision, it is important that the map reflects what the user wants to see. For example, if the issue is to display council ward boundaries and town planning scheme zones, the first things the user should note when viewing the map are the zones and ward boundaries, and then any other information.

When viewed from a cartographic perspective, it is important that SIS people are aware of the basic elements of graphic design as well as where and how to apply them.

9.3.1 Cartographic design principles

There are four basic principles to consider during the cartographic design process:

- legibility
- visual contrast
- borders and neatlines
- hierarchical organisation of layers.

9.3.2 Legibility

Map symbols must be legible to the reader. For example, lines representing roads need to be clearly differentiated from lines representing rivers. Circular points symbolising settlements must be clearly different from points symbolising traffic monitoring locations. Map feature labels should be easily read by the map user within the context the map is designed for.

9.3.3 Visual contrast

Thematic maps in which map symbols represent data should have good contrast with other map features to draw attention to different shapes and colours. The layer or theme that contains the important data should stand out from the background or other layers.

The role of the mapmaker is to ensure the reader's eye is drawn to the features that define the map's purpose, and is not confused with other less important information.

9.3.4 Borders and neatlines

The use of borders and neatlines can aid overall presentation and give a map a professional finish. Borders can be placed around the whole map and/or around other elements (e.g. the legend, source, copyright and publisher statements). Map makers should ensure borders are aligned and clearly distinguishable.

9.3.5 Hierarchical organisation

A well-presented map is not a jumble of features but an intentionally organised series of geographic layers.

Most SIS and mapping applications enable the map maker to establish a hierarchical organisation of features between thematic layers. When carried out correctly, a typical layering hierarchy will involve raster data (e.g. satellite image or digital elevation grid) on the bottom layer, polygon layers above this, then line and point themes on the top. Ordering can also occur within a single theme or layer. For example, with road classifications different line widths and styles can be assigned to represent local roads, state roads or federal highways. In this situation, the ability to illustrate such features is dependent on the data source (i.e. the road dataset must have attribute coding that differentiates road type).

Hierarchical organisation (or ordering) also applies to layers of the same type. For example, when dealing with line themes in mountainous country the map maker may position contours under creeks, which in turn are lower than roads in the hierarchy.

Note: exceptions may occur, for example, when dealing with thematic maps. The subject layer can often be at the top, even though it may be a polygon (e.g. fire scars) or when dealing with very sparse or discrete polygons (e.g. swamp polygons may override contour lines and drainage to illustrate that a creek drains into the swamp).

9.4 Map production process steps

9.4.1 Preparation

Item	Task
On paper	Determine map purpose and audience Choose appropriate map product List data needed to accomplish map purpose Sketch draft map
On the computer	Gather and organise data layers and metadata documentation

9.4.2 Map production checklist

The following checklist, taken from the operations manual prepared for the Audit, provides an example of a checklist identifying mandatory and optional elements for the production of Audit maps. It serves as a useful template for the production of maps in most project type activities.

Checklist for map production—mandatory elements

☐	**Title**	A descriptive name of the map
☐	**Publisher**	The name of the publisher and place and date of publication
☐	**Copyright**	A statement indicating who holds copyright for the map and the year of publication
☐	**Acknowledgments and source**	The origin and nature of the information shown on the map, including derived or interpreted data—the statement should also indicate the currency of the data
☐	**Scale**	A scale bar with optional representative fraction in the form of 'Scale 1: xxx xxx'
☐	**Legend**	Clearly depict colouring and display characteristics for the information shown on the map—the legend should display symbols or coloured boxes with a brief description of each
☐	**Colours and shading**	In general, for large areas on the map use light colours, for small areas use dark colours, and ensure readers are able to easily distinguish between them. For maps to be viewed on a screen do not use colour spectrums (e.g. blue-green-yellow-red) as they do not print out well in black and white and some colour-blind people have difficulty reading them (particularly red-green combinations). The main principle to follow when choosing colour ramps to represent increasing or decreasing values is to use colours of increasing intensity or darkness. This allows the maps to be printed out in black and white and still accurately convey the information. Do not use a red colour ramp. While this is a little constraining, it ensures that your information products will cater for as broad an audience as possible.
☐	**Symbols**	Use established simple and clear symbols wherever possible. Symbols which create a mental image of the object or concept represented are preferred. Symbols portraying related objects or concepts should have common characteristics.
☐	**Font**	The number of different fonts and font sizes used should be kept to a minimum. Fonts that are sans (without) serifs, such as Verdana, Univers, Triumvirate or Helvetica are recommended, particularly for web products.
☐	**Projection and datum**	Australian continent: users need to compare areas → Albers Equal Area Projection

		users need to compare distances/angular relationships → Lambert Conformal Conic Projection For small local areas of the Australian continent use the Map Grid of Australia (MGA94). Data are mapped using the Geocentric Datum of Australia (GDA94). For Albers Equal Area, the parameters used when creating a map of Australia should be set to: map units: metres projection: Albers Equal-Area Conic spheroid: GRS80 or WGS84 Central Meridian of 132 degrees East (132°E) 1st standard parallel 18 degrees South (18°S) 2nd standard parallel 36 degrees South (36°S).
☐	**North arrow**	Only show if the clear delineation of north will be advantageous. If a graticule is used then a north arrow is redundant. Do not use a north arrow for small-scale maps with projections in Albers Equal-Area Conic or Lambert Conformal Conic as north varies across the map.
☐	**Map number**	Should be included if the map is part of a numbered series—normally grouped with the title
☐	**Contact**	Use the format 'For further information contact [name and/or position], [phone], [email]'
☐	**Status and constraints**	The status of the map may be draft, working map, version number, etc. Access constraints may include confidential, internal use only.
☐	**Caveats**	A statement of the reliability and restrictions on use
☐	**Graticule**	At scales larger than 1:5 million the minimum requirement to delineate geographic coordinates (e.g. latitude and longitude) is to display labelled graticule 'tics' (short lines) around the borderline of the map sheet.
☐	**Additional text**	Additional text should generally be the same font, size and colour as text for the publication block.
☐	**Logos**	Where a number of organisations are responsible for the content and publication of a map, each organisation's logo should receive equal prominence, however, logos should not be overly prominent on the map. Where more than one logo is included, they should be of the same size and prominence and generally grouped together.

9.5 Sample guidelines

The Herbert Resource Information Centre (HRIC) Map Production Guidelines is included at Attachment 9–1. Alternatively the guidelines are available online from the HRIC web site at http://www.hric.org.au/hric_site/hric_info/policies/map%20guidelines.pdf

9.6 Tips

Printing large A-0 maps is often a very time-consuming and expensive process. Specialised PostScript Raster Image Processing (RIP) software is available from numerous software vendors to speed up the process of plotting and exporting map outputs on inkjet plotters. Most mapping application vendors can supply information on RIP products that seamlessly integrate within SIS applications.

It is often good practice to identify a range of standard products and maintain printing consumables at sufficient levels to service day-to-day user requests.

The use of automated map production routines and templates (standard layouts) should be considered to improve efficiency in map production and streamline many of the tasks identified in the checklist above (e.g. north arrows, logos, caveats).

4 ▸▸ 5

Develop formal, documented and ongoing processes to ensure continuous improvement of map production guideline(s) for online and hardcopy maps. These are generated by quantified regional analysis and user feedback and implemented across regions through structured change management.

9.7 Additional support

General material on making maps is included in most documentation supplied with SIS software. These manuals can usually be purchased separately from software vendors.

Additional advanced material and support is also available in technical publications and reference books, and from software lists online.

Useful online resources exist that provide examples of map layouts, such as:

Map Gallery on the Directions Magazine web site: http://www.directionsmag.com/mapgallery/

Attachment 9–1

HRIC Map Production Guidelines

HRIC Map Production Guidelines

Minimum Requirement of Maps for External Use:

1. HRIC logo and/or JVP logo;
2. Scale bar and/or statement;
3. Scale projection statement – e.g. 'Universal Transverse Mercator Projection Zone 55. Geocentric Datum of Australia';
4. Descriptive title;
5. Data acknowledgements (Source, scale and currency) – e.g. 'Drainage information supplied by the Wet Tropics Management Authority, sourced from 1:100 000 Army repromats, current at July 1995.';
6. Disclaimer – 'While every care is taken to ensure the accuracy of the data used on this map, the HRIC and its partners make no representation or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which you might incur as a result of the data being inaccurate or incomplete in any way for any reason.'
7. Usage statement – e.g. 'This map is not to be sold or re-made as part of a commercial product.'
8. Reference and legend;
9. Copyright statement; - eg "© Hinchinbrook Shire Council [year]"
10. Graticule or North arrow;
11. Cartographer and date.

Minimum requirements of Maps for Internal Use:

1. Descriptive title;
2. Scale bar or statement;
3. Data acknowledgements;
4. Reference and legend;
5. "Internal Use Only – Not to be Distributed" statement.

<u>Additional requirements for **ALL** maps containing DCDB information:</u>

Points 1 and 2 should be displayed on every map containing DCDB information near the DCDB source acknowledgement regardless of use or map size. Point 3 may be replaced with the more general "HRIC & partners" version (under minimum requirements for External Use) where appropriate.

1. © The state of Queensland (Department of Natural Resources and Mines) [year of publication];
2. Based on Cadastral Data provided with the permission of the Department of Natural Resources and Mines (Current as at month/Year);
3. While every care is taken to ensure the accuracy of this data, the Department of Natural Resources and Mines makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including direct or consequential damage) and costs which you might incur as a result of the data being inaccurate or incomplete in any way and for any reason.

GIS Cheat Sheet

Media Sizes – Metric (ISO)

Size:	Portrait:	Landscape:
• A4	210 x 297 mm	297 x 210 mm
• A3	297 x 420 mm	420 x 297 mm
• A2	420 x 594 mm	594 x 420 mm
• A1	594 x 841 mm	842 x 594 mm
• A0	841 x 1189 mm	1189 x 841 mm

Area Calculations

1. 100 square millimetres (mm2) = 1 square centimetre (cm2);
2. 10 000 square centimetres (cm2) = 1 square metre (m2)
3. 10 000 square metres (m2) = 1 hectare (ha)
4. 100 hectares (ha) = 1 square kilometre (km2)
5. 1 acre = .405 ha
6. 1 ha = 2.47 acres

Scale Information

Scale 1:	Length (1km)	Area (1ha):
2 500	400.0 mm	40.0 mm2
5 000	200.0 mm	20.0 mm2
10 000	100.0 mm	10.0 mm2
20 000	50.0 mm	5.0 mm2
25 000	40.0 mm	4.0 mm2
30 000	33.3 mm	3.3 mm2

40 000	25.0 mm	2.5 mm2
50 000	20.0 mm	2.0 mm2
80 000	12.5 mm	1.3 mm2
100 000	10.0 mm	1.0 mm2
250 000	4.0 mm	0.4 mm2

MODULE 10

MODULE 10: Introduction to GPS and Best Practice Guidelines

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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ISBN: 978-0-642-37155-3

Guide for managers

Context

One of the prerequisites for natural resources management (NRM) involves the establishment and maintenance of a good database of information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making/planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis, standards, and communication are key components.

Under current arrangements, funding for NRM projects is increasingly being channelled from government agencies to regional groups, such as catchment management authorities and resource information centres. This often involves gaining access to, developing new, and processing existing data. It is important these data are collected to an existing standard and, once collected and processed, become part of the national resource base, and subsequently made available to the broader community.

Recent progresses in technology, and reductions in the cost of many products, has made it possible for general practitioners to have access to equipment previously considered the domain of specialists. The global positioning system (GPS) is one such piece of equipment becoming increasingly used by the general community. GPS receivers are widely used in NRM projects, e.g. determining the location of a stream recoding station, through to precision agriculture tasks relating yield to paddock locations, and sophisticated geodetic control surveys.

As with any data collection exercise, GPS surveys can be time consuming and expensive. As such, they should be treated like any other data collection and processing activity, and be carefully designed and planned to return maximum benefit. A number of issues need to be considered prior to undertaking a GPS survey. The intent of this guideline is to provide background information on the operations of GPS and an outline of the issues involved in designing GPS surveys.

It is acknowledged that each state and territory jurisdiction may have its own initiatives related to data collection and information management including governance guidelines and protocols related to the use of GPS.

Module 10: Introduction to GPS and best practice guidelines provides general material to assist practitioners and NRM regional groups in the selection and use of GPS.

Actions

Managers should be aware that in any data collection exercise there is a need for careful planning in the initial design stages.

Best practice guidelines and standards are available to assist in the design and implementation of GPS surveys. These should be followed to ensure that the collection of GPS data fulfils the level of accuracy required for the particular study. Similarly, when purchasing GPS equipment it is important to determine the functionality required. A template is provided to assist in identifying some of the criteria to consider when selecting GPS receivers.

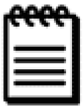
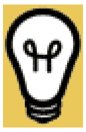
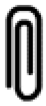
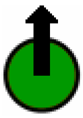
Acknowledgements

This module draws heavily on material from the Surveyors Board of Victoria (http://www.surveyorsboard.vic.gov.au/gps.htm) and has been included in this Toolkit with its permission.

In addition, material from the Point of Beginning Magazine website (http://www.pobonline.com) has also been incorporated into this module. These sources are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

10.1 Introduction

The following material is taken from the Surveyors Board of Victoria's website.

A checklist of criteria for selecting GPS receivers is given at Attachment 10–1 and background material and technical details involved in satellite positioning is given at Attachment 10–2.

1 ►► 2

Low understanding of GPS principles. GPS procurement driven by individual needs.

2 ►► 3

Understanding of GPS principles. GPS procurement integrated with needs and procurement based on endorsed plan.

10.2 Best practice guidelines for GPS surveys

In addition to these guidelines, the Surveyors Board recently worked in cooperation with the Intergovernmental Committee on Surveying and Mapping (ISCM) to develop a handbook on 'GPS Data Collection For Integration with Geographic Information Systems (GIS) Standards, Specifications & Best Practice Field Guide'.

An updated Version 7.2 of the handbook is available at:

http://www.nre.vic.gov.au/CA256F310024B628/0/311F3E48EE0204AFCA257110001EFCDE/$File/GPS+Handbook+v7.2.pdf

10.2.1 Introduction

There are a number of different methods by which surveyors can use GPS technology for surveying applications. The static and rapid static techniques are most common, however, with the development of real-time operation, kinematic techniques are becoming increasingly popular. The signals received from the GPS satellites are prone to a number of errors, many of which are removed by using differential positioning techniques. However, errors such as those caused by multipath are site dependent and are not removed using the differential approach. This highlights that each GPS survey is different in that the observing conditions are unlikely to be the same from day-to-day, month-to-month or year-to-year. It is, therefore, extremely difficult to develop a set of procedural guidelines which will ensure that required survey accuracy is achieved in all circumstances. A set of best practice guidelines can be developed to provide instruction to surveyors in a manner that will realise satisfactory results in most circumstances. As with any set of recommendations, it is up to the surveyor's professional discretion to judge the most appropriate manner in which a survey should be performed. Best practice guidelines provide a solid framework on which to base survey practice.

10.2.2 Guideline objectives

The guidelines recommended in this section are based on those developed by the ICSM. The aims of the guidelines for Victoria are:

- to provide a solid set of observation procedures that will enable inexperienced users to perform GPS surveys successfully
- to establish guidelines that can be adapted to specific circumstances by not being too prescriptive—this falls in line with the state survey regulations regarding cadastral surveys
- to provide conservative operating procedures which will be successful for the majority of observation conditions—surveyors should apply professional experience in adapting these guidelines for specific surveys.

10.2.3 The ICSM guidelines

The ICSM has developed a document titled ‘Best Practice Guidelines – Use of The Global Positioning System (GPS) For Surveying Applications’. The first version of the document was released in May of 1996. The second version was released one year later and incorporates changes to enable application of the guidelines in New Zealand. The development of the document has involved representatives from all states and territories of Australia, in addition to the army, navy and New Zealand representatives. The guidelines are, therefore, reflective of the views of surveyors from across the country.

The ICSM best practice guidelines are suitable for providing the framework for GPS surveying in Victoria (in the description of the ICSM guidelines, if a modification is recommended for use in Victoria, the * character is attached). All surveyors planning to perform GPS surveys should read the guidelines before attempting GPS surveys. The document contains a section discussing methods of classifying survey types which will not be discussed as each client's needs will differ according to the project being undertaken. The operational procedures of the document are of more relevance. The main points of the guidelines are:

10.2.4 Equipment validation

The ICSM recommends that all equipment should be validated on an appropriate network of control points. The network should contain baselines ranging in length from 50m to 10km and should be measured with electromagnetiic distance measurement (EDM) equipment where possible . If an EDM cannot be used, the points should be part of a first order geodetic network. Stations should have forced centering pillars if available. Currently, Land Victoria is funding a project which aims to develop a scheme for providing legal traceability of GPS measurements. The preliminary findings of the research involve connection to existing survey marks which have traceable coordinates. This concept is different from that described by the ICSM as the EDM is used to measure length, not position. GPS systems provide three-dimensional position differences, not simply lengths.

The ICSM guidelines also recommend that a zero baseline test be performed and the baseline length checked to be zero. The zero baseline test involves connecting two receivers to the same antenna using an antenna splitter device. However, rather than analysing the baseline length from a processing package, the raw measurements should be analysed. In the case of double differences, the double difference carrier phase residuals will provide an estimate as to how well the measurements are being recorded by the receiver. This enables the zero baseline test to be used to verify the performance of the receiver electronic circuitry in isolation.

10.2.5 Selection of observation technique

The observation technique used to perform a GPS survey will vary depending on the type of survey being performed. A section on Designing GPS Surveys, discusses several issues that need to be considered when planning a GPS survey. The ICSM has not made any recommendation regarding the observation technique employed by surveyors. The surveying industry is comprised of professionals who, given the correct background material, are capable of deciding on a surveying technique which is suitable and cost-effective for the survey task at hand.

> In Victoria, the selection of the surveying technique can be left to the discretion of the surveyor, however, with the following qualifier—if the accuracy required by the survey is at the limits of kinematic survey capability as defined by the manufacturer's specifications, or if the region of the survey is extremely large, static observation techniques should be adopted. In addition, if there is any doubt as to whether kinematic surveying techniques are appropriate, the surveyor should be conservative and choose the static option. Static surveys require the acquisition of measurements using stationary receivers. This provides a higher solution reliability than kinematic techniques as occupation times per point are longer.

10.2.6 General requirements

The general requirements for surveys recommended by the ICSM apply to all types of GPS surveys—static, rapid static and kinematic. It should be noted that the ICSM also provides guidelines for pseudo-kinematic (sometimes called intermittent static) surveying. This technique involves two short static occupations of the same mark, separated in time by a period of approximately one hour. This technique is extremely difficult to manage in practice and is not recommended for use in Victoria. The user should apply rapid static procedures in place of the pseudo-kinematic technique.

The general requirements include:

- Refer to the manufacturer's documentation for instructions as to the correct use of equipment.
- All ancillary equipment such as tripods and tribrachs should be in good condition.
- **Users should take extreme care when measuring the height of the antenna above the ground mark.**
- The point identifier should be recorded at the time of survey.

- Satellite geometry as defined by the GDOP should be less than 8.
- All receivers must observe at least four common satellites.
- The elevation mask in Australia should not be less than 15 degrees
- When establishing reference stations, marks with high quality coordinates should be adopted.
- When heights are required, marks with high quality height values must be used..
- Field observation sheets (as provided) should be used for all static survey occupations.
- It is not necessary to record meteorological readings and standard models should be used instead during data processing.
- Measurements for horizontal coordination purposes must form a closed figure and be connected to at least two marks with known coordinates in the desired coordinate system.
- Least squares adjustments should be carried out to ascertain whether required accuracy standards have been met.
- All least squares adjustments should be three dimensional in nature.

The best practice guidelines provide a basic framework for performing surveys. In Victoria, several modifications to these general guidelines have been made.

The ICSM also provides a set of guidelines for each of the observation techniques. The following details are recommended.

Static surveying

- The minimum observation period for baselines less than ten kilometres should be 30 minutes *.
- The recording rate should be 15 or 30 seconds.
- The satellite geometry should change significantly during the observation session.
- Single frequency receivers may be used for short lines for non high-precision applications.
- It is essential that the carrier phase ambiguities are constrained for lines less than 15km.

Rapid static surveying

- Baselines must be less than ten kilometres in length
- Manufacturer's documentation should be consulted for determining the occupation period.
- Dual frequency receivers are preferred.
- Five or more satellite should be observed.
- The recording rate may vary between five and ten seconds.

Stop and go kinematic surveying

- Five or more satellites should be observed.
- Receivers should be initialised per the manufacturer's recommendations.
- Each point should be occupied in a different session with different satellite geometry.
- The recording rate should be between one and five seconds.
- Each station should be occupied for between five and ten epochs.
- Single frequency receivers may be used although dual frequency receivers are preferred.

The guidelines conclude by recommending that all raw measurements be archived as they may be needed for future verification of coordinates.

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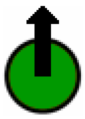
Email: Surveyors.Board@nre.vic.gov.au

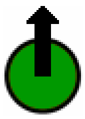
10.3 Criteria for selecting a GPS receiver

As with GIS software, GPS receivers have been the subject of a number of industry surveys. Criteria that may be used as a template to guide the purchase of GPS receivers are given as Attachment 10–1.



3 ▶▶ 4

Good understanding of GPS principles. Formal methods for GPS survey and processing. Procurement integrated with needs and procurement based on endorsed plan.



4 ▶▶ 5

Benchmarking of performance, with continuous effort for improving.

10.4 Additional Support

A range of resource material related to GPS is currently available online covering such topics as guidelines for purchasing GPS receivers, tutorials, frequently asked questions, news groups, and forums, etc.

The following sites are provided as a starting point. Note: Listing does not provide endorsement of product or view.

General information including reviews

http://gpsinformation.net/

http://www.gpsnuts.com/

http://www.innovativegis.com/basis/pfprimer/Topic7/TOPIC7.html

Vendor Information

Most vendors have detailed information on the range of products they provide along with additional support material, manuals and software downloads. The following sites are provided for illustration purposes:

Garmin: http://www.garmin.com

Trimble: http://www.trimble.com

Magellan: http://www.magellan.com.au

Topcon: http://www.topcon.com.au/

Organisations and industry sites

Australian GPS Society: http://www.gps-society.org/index.html

GPS World: http://www.gpsworld.com/gpsworld/

GIS software downloads

GPS Software Downloads: http://www.geocomm.com/channel/gps/software/

Attachment 10–1

Criteria for Selecting a GPS Receiver

Choosing a GPS

The following criteria, taken from the Point of Beginning website, serve as a template from which GPS receiver requirements and software products can be assessed. For additional information refer to http://www.pobonline.com/.

Program Name	GIS X
Manufacturer/Distributor	Company X
Manufacturer's Phone Number	
Receiver Model	
Receiver tracking characteristics	
- L1 only, C/A-Code	
- L1 codeless and L2 codeless	
- Other	
Max. number of satellites tracked simultaneously	
Number of receiver channels	
- Independent?	
- By multiplexing?	
- Fast-sequencing?	
If multiplexing or fast-sequencing, maximum number of satellites tracked per channel	
Can a satellite be swapped with another satellite without affecting lock-on in other channels?	
When four satellites are tracked, does the receiver display provide:	
- Satellite tracking status?	
- Coordinated Universal Time (UTC)?	
- Three-dimensional positions?	
- Velocity?	
- Dilution of precision?	
Does the receiver accurately measure and output:	
- Code Phase?	
- Carrier Phase?	
- Integrated Doppler?	
- Pseudo-range data?	
- Full wavelength L2 carrier-phase data when A/S is implemented?	
- Cross-correlated Y2 - Y1 pseudoranges?	
- Other dual-frequency technology	
On what medium is observed data recorded during the	

***observations*?**	
- Cassette?	
- Disk?	
- Internal memory?	
- Other medium?	
If recorded in the internal memory, what medium is available to transfer to after the observations end?	
Can the receiver perform real-time Differential GPS (DGPS)?	
- Is the receiver capable of picking up signals from U.S. CoastGuard beacons?	
- Is the receiver capable of picking up signals from the commercially available DGPS service companies?	
***To lock on the GPS signals, does the system require a reference position*?**	
- If "Yes," how accurate (e.g., 100m, 30km, etc.):	
- Horizontal position?	
- Vertical position?	
- How long does it take between when system connected to antenna is turned "On" and there is successful lock-on the first satellite? (seconds)	
- for all available satellites? (seconds)	
Can the system be preprogrammed or initialized with session observing criteria at an office before going to the sites?	
- If "Yes," can the system be programmed with information for multiple sessions?	
Size: (H" x W" x D")	
Weight: (lbs.)	
Is antenna included in the weight?	
ANTENNA	
Type:	
- Other?	
Is antenna built into the receiver?	
- If the answer is "Yes," is antenna removable?	
POSTPROCESSOR	
Is a system available for postprocessing data in the field?	
- If "Yes," is the processor IBM PC compatible?	
SUGGESTED LIST PRICE ($)	
- Receiver?	
- Antenna?	
- Post processing hardware and software?	

- Post processing software only?	
Warranty (months)	
- Receiver?	
- Antenna?	
- Post processing hardware?	

Attachment 10–2

The Global Positioning System – An Overview

The Global Positioning System (GPS)

An Overview

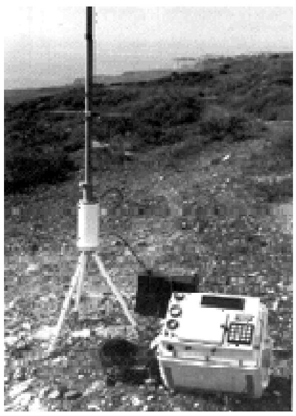
The following material is taken from the Surveyors Board of Victoria, who maintain a dedicated web area dealing with 'Surveying using the Global Positioning System' refer: http://www.surveyorsboard.vic.gov.au/gps.htm (Material has been included in this Toolkit with the permission of the Surveyors Board of Victoria).

The NAVSTAR (NAVigation Satellite with Timing And Ranging) Global Positioning System (GPS) is a military controlled venture designed for positioning, navigation and timing purposes. Although not designed for surveying, the use of interferometric techniques has enabled surveyors to use the satellite signals to great effect. The first GPS satellite was launched on the 22nd February, 1978 and became operational on the 29th March, almost one month later. As the end of the millennium approaches, more than twenty years since the first satellite launch, GPS promises to become one of the most widely used systems for marine navigation, aviation, vehicle tracking and management, recreational activities and surveying. The use of GPS is seen as an extension, *not a replacement*, to the surveyors range of equipment which, when combined with a total station, level and steel tape, enable the surveyor to use the most efficient positioning tool available for their client.

In the modern business environment, it is often difficult to keep up to date with changing technology. In the surveying industry, changes in microchip technology have seen electromagnetic distance measuring equipment (EDM), electronic total stations (ETS), digital levels, computer aided drafting and design (CADD) software, computer based engineering and mapping software, and now GPS, all become a reality in the surveying profession. Keeping abreast of the rapid changes in technology can be a full time job in itself, let alone trying to stay ahead of the competition in the highly competitive surveying industry.

Use of the Global Positioning System requires specialised equipment, data collection techniques and data processing algorithms. This document aims to provide a theoretical and practical foundation for surveyors as they try to embrace GPS technology and integrate use of GPS equipment into their daily business operations.

History of Satellite Positioning - The Transit System



The use of satellites for surveying purposes first became a practical reality with the development of the Transit system by the United States Navy. The Transit system used Doppler measurements from seven satellites arranged in polar orbits to determine position and trajectory. The orbits of the seven satellites form a circular birdcage effect with an orbital altitude approximately 1100km above the surface of the Earth.

The system was used for geodetic surveying applications in the 1970's and 1980's. However, due to the limited number of satellites, positioning was performed by observing for long periods. The low altitude of the satellites also meant that satellites were not visible at all times and gaps of 90 minutes between satellite passes had to be contended with. Typically, several satellite passes were required to position marks accurately on the ground.

Another limitation of the Transit system was also caused by the low orbital altitude of the satellites. The 1100km orbital altitude resulted in large forces, which are difficult to model, disturbing the satellite orbits. As a result, the accuracy of position estimates was not as high as ideally required for many applications. Regardless, the development and use of the Transit system provided a solid foundation from which to develop the Global Positioning System. The primary limitations of the Transit system that have been rectified in the development of GPS include the ability to now observe 24 hours per day and to coordinate features to a higher accuracy. The former has been achieved by increasing the number of satellites, the latter by placing the GPS satellites in significantly higher orbits than the Transit satellites.

The Global Positioning System

The Global Positioning System (GPS) is a space based radio-navigation system designed to satisfy the requirements of the United States Department of Defence (DoD). The system consists of satellites and their signals, a series of control stations which monitor and maintain the satellites, GPS receivers which are capable of recording the satellite signals and users who coordinate themselves using observation techniques designed to achieve certain levels of accuracy. Many texts discussing the use of GPS refer to these components as the three systems; space, control and user.

In order to use the GPS satellite transmissions for surveying purposes, a number of concessions must be made. First, a receiver capable of precise measurements is required. Such a receiver may cost in excess of $35,000 as compared to a lower accuracy receiver which may cost several hundred dollars. Second, more than one receiver must be used. The use of more than one receiver is termed differential operation and is mandatory for all surveying applications of GPS technology. Third, specially designed observation techniques must be used. This is to facilitate resolution of an integer bias that exists in the precise portion of the GPS signal. Finally, sophisticated mathematical algorithms are required to convert the satellite measurements to the user position. In addition to these requirements, the system is only useable in locations with a clear, unobstructed view of the sky. This obviously restricts the use of GPS in urban areas and for underground work.

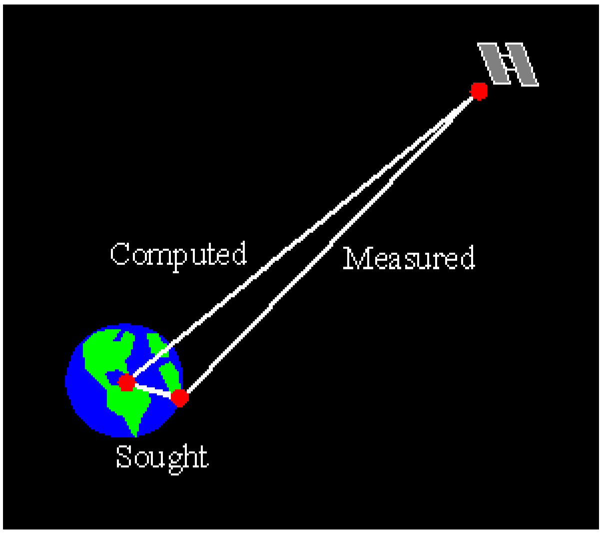
There are, however, a number of advantages of surveying using the GPS satellites. The system has been designed to provide continuous satellite coverage, which can be used at all times of day (and night). This provides additional flexibility when it comes to designing surveys. The satellites transmit L-band microwave signals which are not significantly affected by poor weather conditions. As a result, GPS equipment can be used in all types of weather. The system is also global and can be used in any location. Perhaps the greatest advantage of GPS is that the two receivers, required for differential operation (commonly termed the *reference* and *rover* in kinematic applications), can be separated by several tens of kilometres and do not require line of sight intervisibility. This enables surveyors to coordinate marks to survey accuracy over distances which previously may have required several days of traverse measurements. It is this feature that makes GPS so attractive for control survey work. No longer do marks need to placed on top of difficult to access hills, they can now be placed where they are needed. The use of GPS for control survey work is rapidly becoming routine.

The use of GPS technology introduces several concepts which are not used in terrestrial surveying applications. However, surveyors with a basic understanding of geodetic positioning will have little trouble in extending that positioning scenario to satellite use. Surveying with GPS is little more than a distance resection problem with the satellites acting as, albeit moving, control points.

Basic Positioning Concept

The basic positioning concept used by the Global Positioning System is illustrated by a diagram comprising a satellite which orbits the Earth and continuously transmits signals, the Earth with its geocentre defined as the centre of mass, and a user on the Earth with a receiver capable of interpreting the broadcast satellite signal.

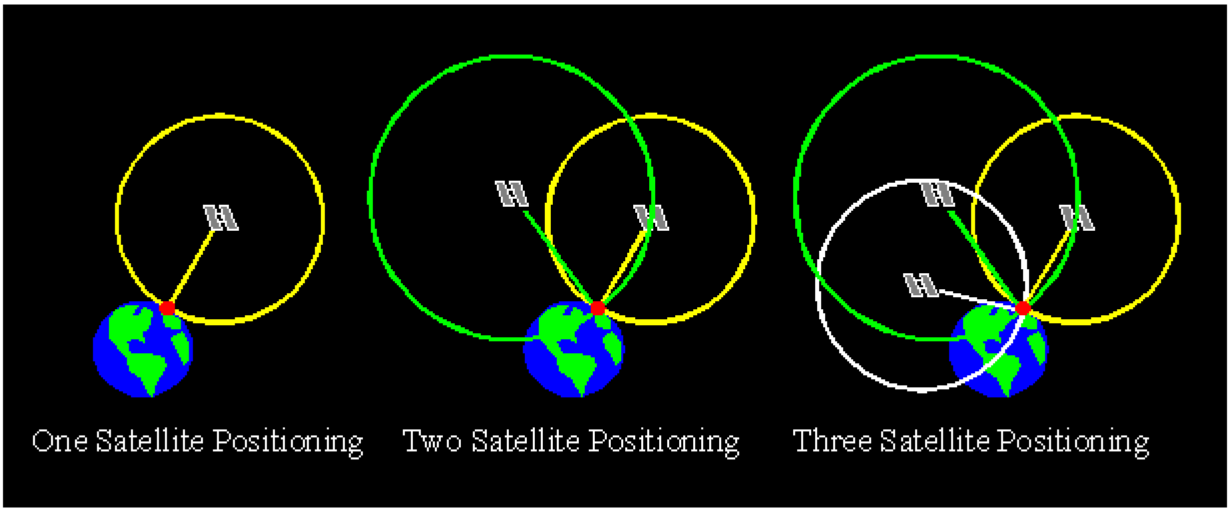
The position of the user can be represented by the vector from the Earth's geocentre to the receiver on the Earth's surface. This vector is three dimensional and is unknown. The vector from the Earth's geocentre to the satellite defines the three dimensional position of the satellite and is determined using the ephemeris transmitted as part of the satellite signal. The third vector is between the user on the Earth and the satellite. The magnitude of this vector, in other words, the one dimensional distance from the receiver to the satellite, is measured by the receiver.



If one satellite is observed, the user position lies somewhere on a sphere with radius equal to the distance to the satellite.

If a second satellite is simultaneously observed, the user position lies on a circle defined by the intersection of two spheres with radii equal to the two measured distances.

If a third satellite is introduced, the receiver position can be determined uniquely by the intersection of the three spheres with radii equal to the measured distances to the satellites. The use of three satellites simultaneously facilitates calculation of the three dimensional position of the receiver. Therefore, GPS is more than just a two dimensional positioning system, height information is also computed.



The development of the GPS signal structure required the system to be passive in order to protect the position of military users. To facilitate this, the satellite signals are generated by precise atomic clocks aboard the satellites. The user on the Earth utilises a receiver which generates internal signals, however, a less precise quartz crystal clock is used. The distance between the satellite and receiver is measured by aligning the satellite signal and the internally generated signal. The measurement relies on the satellite and receiver clocks being synchronised. A timing error of one microsecond (0.000001 seconds) results in a distance error of approximately 300m. Therefore, the measurement of time is a vital component of the GPS system. To eliminate the timing error from the computed receiver position, a fourth satellite is observed. This enables the three position components and the mis-alignment of the satellite and receiver clocks to be determined. All surveying applications of GPS technology require a minimum of four satellites to be simultaneously observed to obtain position estimates to a suitable accuracy.

Timing Reference System

The maintenance of precise time is a key element in the effective use of the GPS system. The satellites generate signals which are referenced to a specific epoch. The time is kept by atomic clocks, or *oscillators*, aboard the satellites. These clocks are also used to generate the signals transmitted by the satellites. The receivers used by surveyors on the Earth also house clocks which generate replica versions of the satellite signals for internal comparison purposes. To be able to use the satellite signals effectively, the time component of the measuring process must be regulated to a common time frame. The synchronisation of time in the entire GPS positioning process is paramount, therefore, a brief description of the timing reference system used by GPS is warranted.

A complete description of the GPS timing reference can be found at www.usno.navy.mil (Web), however, the underlying basis of the system is referenced to the second as defined by an atomic time scale. The United States Naval Observatory (USNO) monitors GPS time (GPST) as defined by the oscillations of an atom. The GPS satellite clock correction parameters are developed to correct the atomic clocks on board the satellites to this time frame. Universal Time Coordinated (UTC) is another atomic time scale, which is modified by inserting periodic leap seconds to keep

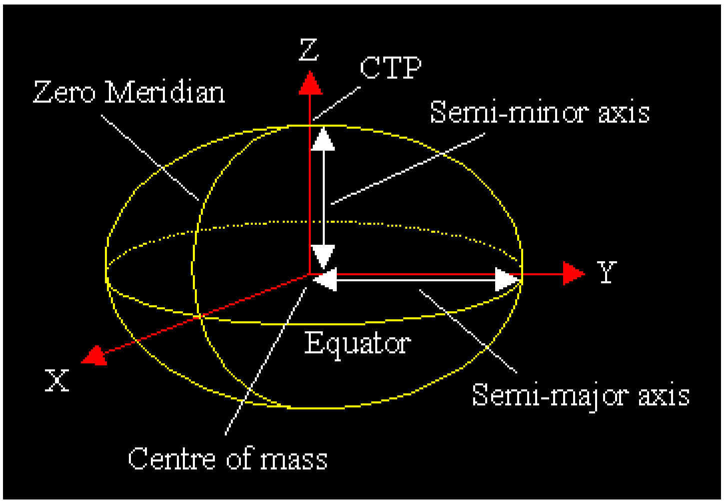
UTC close to Universal Time (UT). UT is governed by the Earth's rotation and the position of the sun (this is wrist watch time). Therefore, the offset between GPS time and UTC will alter by one additional leap second when the periodic adjustments are made to UTC. An adjustment is expected at the end of June, 1997 which will result in GPS and UTC differing by 12 seconds.

The time in the GPS system is referenced by the number of seconds in one week and a week number. GPS time was officially initialised at zero hours on January 6th, 1980. At this epoch, the difference between GPS time and UTC was zero. The week number has incremented every 604,800 seconds since this time. In the GPS signal specification, the week number is stored as a 10 bit integer value. The maximum value that the week number can have in an integer of this size is 2^{10} = 1024 weeks. This maximum value can be expected to "roll-over" before the end of the millennium. Users should be aware of this occurrence and check to see that their equipment and software are not affected by this week number roll-over.

For surveying applications, the maintenance of GPS time is a function performed by the GPS receiver and processing software. As a result, there is little intervention required by the user with regards to the elements of time. One point of interest regarding the time scales, the GPS satellite clocks are essentially keeping GPS time as defined by the USNO. After the clock correction parameters are applied, all satellites are synchronised to this highly accurate time frame. The GPS receiver uses an inexpensive quartz crystal oscillator, however, the observation of at least four satellites is required to compute the three dimensional user position and the receiver clock synchronisation error. Therefore, once the satellites are tracked and position computed, the receiver clock has effectively been transformed into an atomic clock as it is now synchronised with the satellite clocks. This is the manner in which precise time can be transferred using GPS equipment.

Coordinate Reference System

There are two reference systems employed by the Global Positioning System, the atomic GPS time reference as maintained by the United States Naval Observatory (USNO), and the coordinate reference system which has been defined by the Defence Mapping Agency (DMA). **The coordinate reference system used by the GPS system is the World Geodetic System 1984 (WGS84)**. This system is a geocentric based coordinate system with the origin of the defining spheroid located at the Earth's centre of mass. The spheroid has a semi-major axis of 6,378,137.0m and an inverse flattening of 298.257223563. The semi-minor axis is computed as 6,356,752.3142m. These parameters are the same



as those used to define the Geodetic Reference System 1980 (GRS80) spheroid.

The semi-major axis and flattening define the shape of the WGS84 spheroid. The centre of the spheroid is fixed to the Earth's centre of mass. The direction of the three Cartesian axes need to be defined to constrain the spheroid in space. The Z-axis is defined as passing through the Conventional Terrestrial Pole (CTP) at epoch 1984.0 as defined by the Bureau International de l'Heure (BIH). The X-axis is defined as being the intersection of the WGS84 reference meridian plane and the plane of the CTP's equator. The WGS84 reference meridian passes through Greenwich and is specifically defined by the BIH zero meridian at epoch 1984.0. The Y-axis completes a right handed, Earth Centred, Earth Fixed (ECEF) orthogonal coordinate system, measured in the plane of the CTP equator, 90 degrees east of the X-axis.

The position of the satellite at the instant of measurement is required in order to compute the unknown receiver position. The broadcast ephemeris is a set of orbital parameters that enable the Cartesian coordinates of the satellite to be easily computed. The resultant position of the satellite is referenced to the WGS84 coordinate datum. Therefore, the position estimates derived from GPS measurements are also referenced to the WGS84 datum. **In order to obtain coordinates in other systems, such as the Australian Geodetic Datum (AGD), users must transform their GPS coordinates from WGS84 to the new system.** As the next millennium approaches, Australia is moving towards a new geodetic datum, termed the Geocentric Datum of Australia 1994 (GDA94). This new datum is compatible with WGS84, therefore, users will directly obtain GDA94 coordinates from their GPS receivers. This will eliminate the need to perform transformation computations to integrate GPS observations into the GDA94 coordinate system.

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MODULE 11

MODULE 11: Partnerships and Working Together - The Potential for Collaboration

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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Guide for managers

Context

One of the additional benefits of introducing spatial information systems (SIS) into organisations and NRM regional bodies is that it can encourage cooperation and communication across the multiple sectors that require and use spatial information in their everyday work. It can also encourage organisations and NRM regional bodies to work together with neighbouring groups, plus local, state/territory and Australian governments.

The collection of data for an SIS can be costly and may require the purchase of specialised equipment and technical expertise. Careful planning is required to ensure collection activities are well coordinated and, where possible, data can be collected once and used many times by different business units within a single organisation. There are also potential cost savings in working together with other groups.

A number of key practices for working together on spatial information initiatives based on lessons from practice include the following:

- broad support for vision and expectations
- champion individuals/community support
- knowledgeable, respected participants
- frequent contact with national (higher order) organisations
- proactive, open, and inclusive processes/procedures to enable maximum participation/diverse perspectives
- improved understanding/outreach.

Experiences from groups working together through regional networks in Australia underline the benefits that can be achieved. These benefits are also highlighted in Queensland with an initiative by the state government to collaborate with local governments in the development of SIS.

Actions

Managers should consider the advantages and disadvantages of actively working across their organisation, with neighbouring organisations (either informally or through formal collaborative forums), other levels of government, business and the community in the development, maintenance and support of spatial information management systems. There are potentially great advantages in working collaboratively, however, establishing good working relationships takes time, effort and long-term commitment.

By working together, organisations and NRM regional bodies can also increase opportunities for sharing knowledge in relation to appropriate levels and types of investment in spatial information technology, adoption of standards and sourcing and acquiring spatial data at the lowest possible cost.

In some cases working together with neighbouring organisations and NRM regional bodies ensures that regional needs for spatial information can be better heard and understood by those working at a state/territory or federal government level.

Acknowledgments

This module draws heavily on the experiences and lessons learned from GeoData Alliance's 'Lessons from Practice: A Guidebook to Organizing and Sustaining Geodata Collaboratives': http://www.metrogis.org/documents/articles/lessons_entire.pdf. In addition, the specific experience of the MetroGIS, regional GIS approach in the Twin Cities, Minnesota region in the USA is drawn upon:

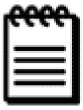
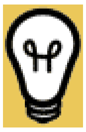
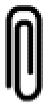
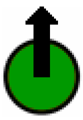
http://www.metrogis.org/documents/presentations/index.shtml.

A second example is drawn from the Queensland Government's Whole of Government GIS (Spatialink) involving shared access by all state and local government agencies.

Note: The majority of this module is taken from the ANLIC – Local Government Toolkit. This and other sources mentioned above are duly acknowledged.

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

11.1 Introduction

The principles of working together to develop effective spatial information systems (SIS) apply within organisations as much as they apply to NRM regional bodies working with other groups such as local, state and national government. There are, however, some important differences in how SIS can be implemented within a council compared with issues that should be considered when councils work together, or work together with other levels of government.

The overriding issue in all collaborations is the simple question: why collaborate? If the benefits (and disadvantages) of collaboration are carefully weighed up then collaborative mechanisms (if any) will become clearer.

In many cases NRM regional bodies work independently to develop SIS. This has the advantage of that group or body developing its systems, processes and capabilities according to its own specific local needs. Larger groups in particular, can have the skills and experience required to work independently, and can work directly with state/territory agencies to obtain state-wide spatial information datasets relevant to their area because they know where to look and who to contact.

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Develop performance measures and review processes to support formal service agreements for the provision of spatial information services both within council and to external organisations.

11.2 Characteristics of successful spatial data collaboration initiatives

The 2001 report from the GeoData Alliance entitled *Lessons from Practice: A Guidebook to Organizing and Sustaining Geodata Collaboratives* provides a summary of six diverse GIS collaboration initiatives from the USA. The initiatives analysed were:

- New York State Data-Sharing Cooperative
- Ramsey County GIS Users Group
- Pacific Salmon Information Network (PSIN)
- MetroGIS
- Pennsylvania Mapping and Geographic Information Consortium (PaMAGIC)
- National Cooperative Soils Survey (NCSS)

See http://www.geoall.net/docs/lessons_from_practice.pdf.

A total of seventeen key practices for successfully creating and sustaining their respective collaborative initiatives were distilled from the case studies (Table 10–1).

Table 11–1 Key practices for successfully creating and sustaining collaborative spatial data collaborations (Geodata Alliance, 2001)

Key practices to success	New York	Ramsey County	PSIN	MetroGIS	PaMagic	NCSS
Broad support for vision and expectations	X	X	X	X	X	X
Champion individuals/community support	X	X	X	X	X	X
Knowledgeable, respected participants	X	X	X	X	X	X
Frequent contact with national (higher order) organisations	X	X	X	X	X	X
Proactive, open and inclusive processes/procedures to enable maximum participation/diverse perspectives	X	X	X	X	X	X
Improved understanding/outreach	X	X	X	X	X	X
Champion organisation(s)	X		X	X		X
Documented stakeholder benefits/business argument	X		X	X		X
Maintain institutional memory			X	X	X	X
Focus on common business information needs		X	X	X		X
Business plan and well defined issues	X			X	X	X
Seek consensus on policy decisions			X	X		X
Timely and important issue			X		X	X
Active involvement of elected officials				X		X
Alignment with internal business needs				X		X
Incentives		X		X		
Short, interesting meetings			X		X	

Six of these seventeen key practices were found to be common to all six collaboratives (no order of significance is intended), namely:

- broad support for vision and expectations
- champion individuals/community support
- knowledgeable, respected participants
- frequent contact with national (higher order) organisations

- proactive, open and inclusive processes/procedures to enable maximum participation/diverse perspectives
- improved understanding/outreach.

Findings from these case studies were compared with a previous national survey of GIS used in the USA, and academic research. The results of this combined analysis produced some important lessons. These are (Geodata Alliance, 2001):

- keep it simple
- formalise structure
- ensure that contributions are fair, equitable and continuous
- determine and communicate control and ownership
- manage perceptions about data ownership
- control the 'what's in it for me?' syndrome
- manage the process
- provide project leadership
- define roles and responsibilities
- manage change.

The above lessons are elaborated below:

Keep it simple

- The extent of the interaction between organisations usually goes beyond data-related activities to include joint system development, personnel space, and applications.
- Moving from data to applications, the interactions increase not only in their sophistication and complexity but also in the difficulty of making them functional.
- Shared or jointly supported application developments are the most challenging.
- Think big but start small and build gradually.

Formalise structure

- Mutual trust is the key to successful cooperation, but supporting interaction with formal documentation (such as intergovernmental agreements, MOUs, data licences, contracts, etc.) is wise. Documentation is typically used more in relationships with other organisations than within an organisation.
- These documents may enable a continued data exchange even in cases where the other forms of interaction are discontinued.
- The nature of sharing structures also needs to be established early in the process. The key is to establish a stable and simple relationship structure.

Ensure that contributions are fair, equitable and continuous

- First, determine the contributions in advance and in specific terms. Data are the major contribution to coordinated activities. Financial and staff contributions are also substantial, the latter being more evident in intra-organisational settings.
- Take into account the concerns most organisations would have about how commensurate their contributions would be relative to their size, resources, and use of data or other joint products.
- Apply the principle of equity in accepting contributions and distributing the common resources.
- Extensive negotiations may be necessary to decide on contributions and returns.
- Loss of full independence and investment of energy and resources are deliberate and tangible contributions toward developing and maintaining relationships with other organisations.
-
- Some level of contribution from each participant tends to increase the commitment to the joint goals and raises the stakes in success.
- Secure long-term commitments for contributions.

Determine and communicate control and ownership

- As with any multi-party venture, participants need to feel empowered to plan, make decisions and bring them to realisation.
- Participants in inter-organisational activities expect a fair decision-making process to ensure adequate control over the joint activities and resources.
- Voting rights and decision authority must be carefully determined and clearly defined.
- Extensive negotiations may be necessary as well.
- Differences will occur in definitions of fairness and equity depending on the resources, power and role in the partnership of the various organisations.

Manage perceptions about data ownership

- Openness with regard to data access, minimal proprietary interest in data and no major financial gains expected from data distribution are conducive to less conflict and tension regarding the ownership of data.
- All parties must perceive the coordinating unit or coordinator and their location as neutral.

Control the 'what's in it for me?' syndrome

- This is only natural and should be taken seriously.

- Understanding and respecting the reasons that motivate organisational participation is part of the success.
- Saving resources and sharing a common mission and goals are the most frequently declared reasons for inter-organisational interaction.

Manage the process

- Ongoing communication and negotiation are inherent parts of coordination efforts.
- Identifying semantic differences and commonalties between concepts held by participants, and creating a common working language are prerequisites for effective communication.
- Communication happens both formally and informally.
- Persistence and willingness to compromise are the keys to success, particularly through difficult times.
- Coalition building and bargaining may be exercised as well.
- Differential commitment levels are possible.
- Process takes time and patience.
- The spirit of cooperation is crucial for keeping participants active and interested. It is based on teamwork, shared understanding, trust and mutual credibility.

Provide project leadership

- Leadership is the key success factor.
- Leadership provides vision, support and backing with resources.
- Project leadership exercises the authority to promptly act on common plans and decentralises power to allow for implementation of the agency-specific parts.
- Stability characterises effective project leadership structures.
- Project leadership ensures 'enforcement' of common standards.

Define roles and responsibilities

- The roles and responsibilities of each participant have to be well defined.
- Database development and maintenance responsibility is the life cord of inter-organisational activities.
- It is necessary to identify and secure support of the original data providers early in the coordination initiative so that data provision and updates will be kept close to the source or in organisations with compatible functions.
- Additional resources and support infrastructure need to be provided to the units with accepted new roles and responsibilities. Additional workloads and expenses may also be incurred.

- The units perceiving inequities in data maintenance commitments are prone to downgrade their own support of the system.
- Assignment of roles and responsibilities is highly susceptible to fairness issues and concerns.

Manage change

- In a highly technical field such as SIS, it is necessary to adapt local solutions to take advantage of technological change and innovations.
- The problems of mismatch between new database tasks and procedures and existing organisational structures are common in the newly initiated inter-organisational efforts.
- Technological change requires change in administrative and organisational structure and processes. Integrated and distributed data processing tends to generate leaner, more flexible and more responsive organisations with fewer management levels and more direct information exchange between the top and bottom layers.
- The sense of upcoming change, and the uncertainty brought with it, tends to be unsettling to many agencies and their personnel. It is crucial to confront the concerns about the implications of technological change and joint database activities for subsequent organisational and staff realignment.
- The status of the joint project needs to be frequently demonstrated and communicated to all participants and leaders. Project expectations should be managed at administrative, management and operational levels.
- The culture of both sharing and change must be nurtured.

11.3 Working together within organisations

As outlined in *Module 1: Information management and the sustainable development of natural resources*, how spatial information is used within organisations and NRM regional bodies depends on skills and capabilities which will, in turn, depend on their size, staffing numbers, budgets and location. With the increasing use of spatial information in all organisations there is often the need to consider how different groups can work together.

In essence, the principles for working between organisations, outlined in the sections above, also apply to working within organisations; but with the simplifying factor that accountability is to one chief executive and one organisation or NRM regional body.

Several factors affect the development of an organisational model and appropriate management strategies such as; potential benefits of shared spatial data among a number of business operations, specific operational needs of business operations, cost benefit trade-offs related to implementation alternatives, varied impacts on current business operations and related organisational impacts. Particularly relevant issues include (http://www.geoanalytics.com):

1. The organisation's vision, goals, and strategic plan

2. The vision, goals, and role for SIS within the organisation
3. The degree to which spatial data (base data and applications data) are to be shared among applications and users
4. The degree of autonomy of business units
5. The presence and use of related technologies and data, including desktop mapping, imaging, global positioning satellite technology, demographic and other thematic data, plus processing software, and data analysis software
6. The potential for business process re-engineering and organisational change
7. Strategic and operational time frames for implementing SIS
8. Financial issues, including requirements for cost-benefit justification and return, as well as levels and schedules of funding availability. These and other factors determine the direction and detail of SIS planning, which subsequently provide information for the development of an organisational plan and management strategies.

Additional material on enterprise application of SIS is provided in Section 10.5.

11.4 Examples of spatial information collaboration

1 ⏩ 2

Organisation or NRM regional body staff or technical departments provide services using spatial information to meet the requirements of others or through peer networks to other organisations.

11.4.1 South East Queensland

The South East Queensland Regional Organisation of Councils (SEQROC) was formed in July 1991 and comprises the 18 local governments in the region. The objectives of SEQROC are:

- to support and advance the interests of its members and their constituencies
- to formulate policies and strategies from which all member councils may act collaboratively in determining complementary plans for the coordination of regional growth and management of change
- to foster cooperation amongst members on issues of mutual concern or to further joint interests
- to act as an advocate to state/territory and Australian governments or public bodies on issues of concern to members.

SEQROC has a number of working parties including the Spatial Information Network Group which provides a forum to facilitate the effective use of SIS in local government, especially from a regional perspective. The group acts as a regional advocate for specific projects/issues raised by either state government or the private sector, allowing the network's members to present a consensus view. The group also serves as a technical forum for sharing expertise and looking for opportunities to better use and promote spatial information in the region.

A key focus of the group is identifying opportunities to reduce duplication of effort and cost in the development of spatial information through the introduction of common standards, applications, processes and accessibility to data. This promotes and encourages local governments to work together in the region through a focus on improved economic opportunities and outcomes, and economies of scale for their members.

In addition to its active membership of the SEQROC Spatial Information Network Group, Gold Coast City Council also participates in the New South Wales Northern Councils Spatial Information Group (NCSIG). NCSIG is coordinated by state government staff (volunteers), with the host council providing the facilities. Spatial information industry vendors are also invited to attend. Participation in NCSIG is not through a formal agreement, (unlike SEQROC) although the objectives are similar and, as such, has an informal networking approach. Southern Cross University (Lismore) is also a member providing opportunities to discuss whether the spatial information curriculum is relevant to state and local governments' needs.

11.4.2 Queensland whole-of government GIS (Spatialink)

Sharing spatial data has always been a vital and necessary process supporting GIS business units across all tiers of government. The level of such activity and demand for information by Queensland State Government agencies directly reflects core business information needs and the ability to direct resources accordingly. In relation to local government, larger councils, such as Gold Coast, Brisbane, Caloundra, Toowoomba and Hervey Bay have developed advanced in-house GIS capability equivalent to many state government agencies. However, the majority of councils, particularly those in rural and remote areas, have not been able to establish effective in-house GIS capability. This can be attributed in large part to cost of data acquisition as well as GIS technology and expertise. Surveys in the past have indicated that councils are keen to use GIS and are willing to exchange fundamental datasets with the state government. The processes for sharing data have been both complex, expensive and time consuming. The emergence of Regional Organisations of Councils (ROCs) in the state has, to some degree, provided a valuable forum for councils to discuss common issues and opportunities for data sharing and engaging generally with the state government. Additional initiatives are continually being introduced to improve data sharing.

Key drivers for partnerships and working together

- recent advances in technology providing opportunities for efficient sharing of information and delivery of services to the public
- in Queensland, the availability of a whole-of-government IT (GovNet and LG Online), providing connectivity between all state and local government agencies
- champion agencies/organisations willing to take a lead role in implementing GIS services that deliver benefits beyond their own interests, (i.e. whole-of-government benefit) e.g. the

Departments of Natural Resources and Water, Local Government and Planning, Emergency Services, and the Environmental Protection Agency in Queensland

- changing policy within agencies with a greater willingness to share information and less focus on charging for information.

A whole-of-government approach to GIS

The Queensland Department of Innovation and Information Economy has developed a number of important, whole-of-government information services. The GovNet infrastructure (unique to Queensland) emerged as a robust and secure environment from which to deliver these services.

In 2002, the Departments of Local Government and Planning, Innovation and Information Economy and the Local Government Association of Queensland sponsored a program to share planning information online for use by all agencies. The definition of whole-of-government was extended to include all 125 councils who were provided with access to GovNet via the recently established local government online portal. Appropriate spatial data were provided by state and local government agencies under a largely common set of licences. While some datasets were purchased from specific agencies, the assumption was that the cost of renewing these licences would significantly reduce once the efficiencies and benefits of this service were realised.

The Integrated Planning GIS was the first GIS service developed and was followed by the whole-of-government GIS Clearinghouse (Figure 10–1), the latter being comparable with the MetroGIS (USA) example outlined in Section 10.4.3.

Using technology to improve collaboration and service delivery

Queensland's whole-of-government GIS provides infrastructure and online tools supporting spatial data exchange, discovery and viewing. Much of the development effort addressed the need to simplify and automate the exchange of electronic data between state and local governments. Specifically this technology aimed to support:

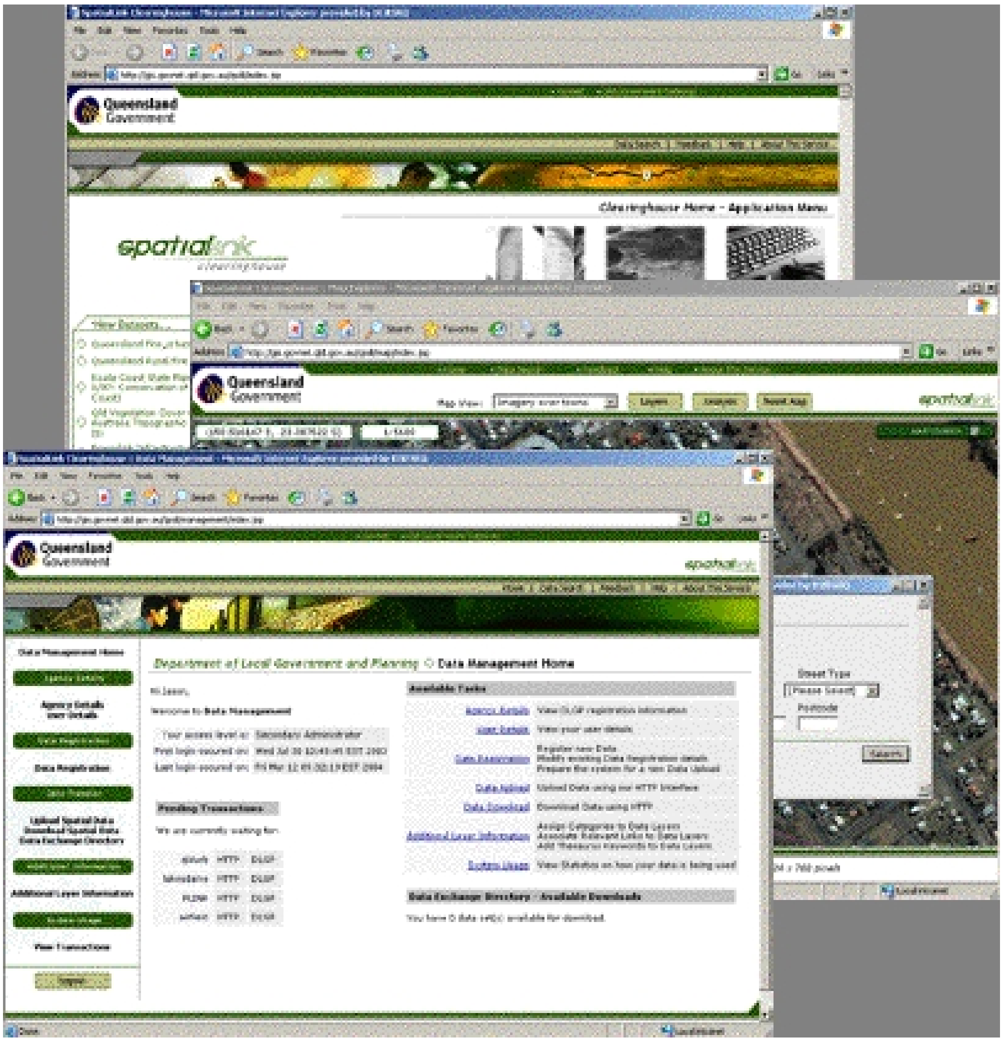
- a secure area for each agency to manage data exchange, including:
  - registering dataset details and 'rules of use/access'
  - privacy control over elements within a dataset
  - supply or preparation of ANZLIC-compliant metadata
  - issue of a standard, QSIIC endorsed e-licence for all downloadable datasets
  - messaging services to automatically notify owners/users of such transactions
  - choice of preferred GIS formats (upload/download auto-formatting)
- options to directly transfer data to nominated agencies or to the whole-of-government GIS for viewing online
- online mapping facility for map building, analysis and hardcopy generation.

The assumptions behind the concept of a whole-of-government GIS clearinghouse was that technology could be used to:

- improve access generally to GIS and its value in supporting day-to-day business within organisations (approximately 150,000 state and local government staff)
- provide a one-stop-shop for spatial data in the state and thus make them easier to discover
- standardise and streamline traditionally complex and time-consuming processes associated with accessing spatial data
- drive down the cost of spatial data through demonstrating the benefits of shared online services
- improve the climate of working together through the establishment of sustainable services that provide ongoing benefits across government
- create real opportunities for agencies on modest budgets to participate in developing their own GIS services by using existing infrastructure and shared data licences.

The focus was on implementing shared services which would support efficient processes for data exchange as well as provide new opportunities for collaboration. The whole-of-government GIS technology comprising network connectivity, servers and in-house developed GIS applications would also be available for any government agency to use, dramatically reducing the cost of individual agencies wishing to participate in this space.

Figure 11–1 The Queensland Spatialink Clearinghouse



Benefits

As a direct result of these initiatives, Queensland has generated new interest and activity in the areas of data sharing and cost. These services have also promoted new interest in collaboration to develop online SIS by agencies with little previous involvement in this area, including:

- connectivity through GovNet and Local Government Online between all state and local government agencies for a wide range of SIS and other business—one-stop-shop to all state and local government spatial data
- access to a wide (and growing) range of state-wide spatial datasets accessible under common whole-of-government licences. Sophisticated online tools to support immediate exchange of spatial and other data between state and local government. Spatial data formatted automatically for most desktop SIS applications
- support for recognised standards relating to licences, metadata, etc.
- enhanced tools to view and query data using online mapping and query tools

- opportunities for agencies to leverage their own SIS services using common whole-of-government infrastructure and data licences (including support for OGC web services standards).[1]

Maintaining a sustainable SIS infrastructure for all agencies to use requires the ongoing support and participation of all agencies. It is envisaged that during the 2004–2005 period both state and local governments will escalate their data exchange activities through this infrastructure as well as work collaboratively to deliver shared information.

11.4.3 The MetroGIS Initiative: Minneapolis–St. Paul metropolitan area, USA

The MetroGIS initiative is a voluntary collaboration of organisations in the Minneapolis–St. Paul metropolitan area that uses geographic information systems technology to carry out their business functions.

Lessons learned from MetroGIS found that the intangible benefits of participation in a multi-participant GIS initiative included:

- improved cost-efficiency through reduced redundancy in data development and maintenance, and cost-sharing opportunities
- improved decision-making support and improved methods of analysis and presentation
- access to data from other jurisdictions in a compatible format for analysis and query
- improved communication with the public
- improved management and retrieval of data
- enhanced revenue opportunities from private sector for data consistency from county-to-county throughout the region
- enhanced academic research capability
- stronger bargaining position with vendors for purchase and support.

The MetroGIS mission statement is to:

- Provide an ongoing, stakeholder-governed, metro-wide mechanism through which participants easily and equitably share geographically referenced data that are accurate, current, secure, of common benefit and readily usable. The desired outcomes of MetroGIS include:
    - improved participant operations

[1] Early examples of agencies taking advantage of this include the Treasury Government Asset Management System and the Department of Education (both developed as a web service). With the existing infrastructure and data licences in place, these services were able to be developed at a fraction of the 'normal' cost and in a matter of weeks rather than months.

- minimised stakeholder expense and duplication of effort
- supported cross-jurisdictional decision-making.

Benefits of MetroGIS core services and desired outcomes

1. Foster GIS coordination among stakeholders

- provide an inclusive, trusted forum to collaboratively resolve geospatial data and GIS technology-related issues and opportunities of common interest
- improve trust and mutual understanding within the GIS community through frequent opportunities to communicate with colleagues and peers
- build sustainable solutions to common geodata-related needs through the use of collaborative and consensus-based processes that seek to institutionalise custodian roles and responsibilities pertaining to capture, maintenance, documentation and distribution of commonly needed data
- enhance individual stakeholder GIS programs and capabilities through sharing technology and proven practices with colleagues and peers.

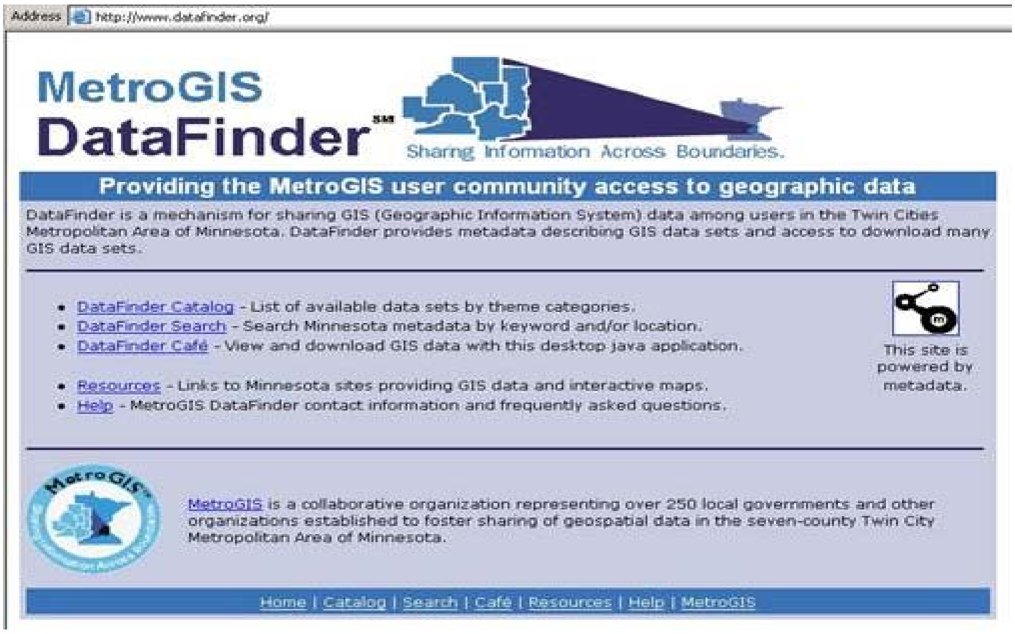
2. Oversee solutions to common information needs

- increase access to, and use of, trusted, reliable and current data required to support business needs through sharing data and creating community-endorsed regional data solutions—build once and share many times
- improve decision support for its entire stakeholder community through the use of minimal data standards pertaining to assembly of data produced by multiple organisations into regional datasets. These datasets work together horizontally within a given geospatial data theme and vertically among themes
- facilitate use of data standards and best practices.

3. Support MetroGIS DataFinder (www.datafinder.org)

- support data discovery and distribution through a centralised internet-based tool that is a node of the US National Spatial Data Infrastructure (NSDI) (Figure 10–2).

Figure 11–2 The MetroGIS DataFinder™



What principles guide MetroGIS?

MetroGIS makes a practical assumption that organisations cooperate out of self-interest. Very early, participants agreed to support the 'data sharing' ideal only if it met their own business needs. For MetroGIS, the principal stakeholders are the metropolitan council, other regional agencies, and local units of government—counties, cities, school districts, and watershed districts—few of which need geodata for the same purpose, or use it in the same form. The principal challenge for MetroGIS is to meet the common geodata needs of these organisations without costing them more in resources or time than would otherwise be the case if they developed or assembled the data they needed from others independently.

Based on this 'self-interest' assumption, MetroGIS is guided by several fundamental principles, including:

Secure champions

Broadly supported 'proven practices' will not just happen. Sustained collaboration requires leadership from organisations with related business needs and a willingness to participate.

Broad support of vision and expectations

Reach collective agreement on the desired purpose of the collaborative and continually monitor the correctness of the stated purpose.

Actively involve policy makers

Empower elected officials (councillors) early on and throughout the initiative to maintain policy focus on the broader public good, broaden understanding of the issues and benefits, provide direction on strategic initiatives, provide a reality check for proposed courses of action, identify appropriate areas for collaboration, advocate with higher authorities when needed, and set policy.

Promote understanding

To help policy board members better understand the value of geospatial data and use of GIS technology, a demonstration is made at each board meeting to show the benefits of using the technology and what can be gained through data sharing and collaboration.

Seek consensus on policy decisions

Consensus among policy board members is sought for action on issues and opportunities fundamental to the success of MetroGIS.

Represent diverse perspectives

MetroGIS's decision making derives from work performed by broadly representative committees and workgroups, comprised of committed managers and technical staff with appropriate expertise. No single organisation or faction dominates.

Document stakeholder benefits

Identifying and documenting stakeholder benefits in a manner readily understandable by the various stakeholder communities are fundamental to strengthening commitments to MetroGIS.

Maintain focus on common business information needs

MetroGIS made a particular effort to identify common business information needs of key stakeholder organisations via a broadly collaborative process and then embarked on a regional geodata strategy focused on meeting these common needs.

Focus on stakeholder benefits

Identifying stakeholder benefits is fundamental to strengthening commitments to MetroGIS.

Acknowledge fair-share contribution options

Contributions to the sustained operation of the regional collaborative, from any one stakeholder, may be in the form of funding, data, and/or people and equipment.

Align with internal business needs

No stakeholder organisation will be asked to perform a function for the collaborative that exceeds their internal business needs.

Maintain an institutional memory

Champions at all levels of the collaborative initiative have and will continue to leave MetroGIS, which may result in stakeholders not being able to keep abreast of all MetroGIS activities. Creditable documentation of meetings, policy decisions, studies, etc. is critical to maintaining a course consistent with previously agreed policy and direction.

Connect with geodata initiatives on the state and national levels

MetroGIS's endorsed procedures for addressing its stakeholders' common information needs and its one-stop data distribution mechanism have been highly influenced by the vision of the National Spatial Data Infrastructure (NSDI) to ensure that MetroGIS is part of the larger vision.

11.5 Additional support

State/territory SDI sites and atlas sites

Queensland: http://www.qsiis.qld.gov.au and http://www.information.qld.gov.au/

Western Australia: http://www.walis.wa.gov.au/ and http://www.atlas.wa.gov.au/

New South Wales: http://canri.nsw.gov.au/nrdd/ and http://www.nratlas.nsw.gov.au/wmc/savedapps/nratlas

Tasmania: http://www.thelist.tas.gov.au/

ACT: http://asdd.ga.gov.au/asdd/tech/node/act-1.html and http://www.gim.act.gov.au/actLocate/index.dwt

Victoria: http://www.land.vic.gov.au and http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/vrohome

Northern Territory: http://www.ntlis.nt.gov.au/ and http://www.ntlis.nt.gov.au/imfPublic/imf.jsp?site=nt_atlas

South Australia: http://www.asdd.sa.gov.au/ and http://www.atlas.sa.gov.au/

Intra-organisational spatial data collaboration support

A wide range of support materials is available at the GeoAnalytics website:

http://www.geoanalytics.com

In particular, valuable papers specifically on organisational issues include:

Management and Governance Dimensions of Enterprise IS/GIS

For specific support on the science of organisational GIS see the paper by Rebecca Somers 'Developing GIS Management Strategies for an Organization' from the Journal of Housing Research, Volume 9, Issue 1 (1988):

http://www.fanniemaefoundation.org/programs/jhr/pdf/jhr_0901_somers.pdf

Inter-organisation spatial data collaboration support

Centre for Technology in Government (USA): New Models of Collaboration: A Guide for Managers: http://www.ctg.albany.edu/publications/online/new_models/

This includes a case study of the New York State Geographic Information System Coordination Program and hosts a formal data sharing cooperative and a variety of educational and support services to encourage state and local development and use of spatial data.

GeoData Alliance Lessons from Practice: A Guidebook to Organizing and Sustaining Geodata Collaboratives: http://www.geoall.net/what_we_do.html

A summary of six successful geodata collaboratives from the USA is presented, including examples from local government.

Academic paper from Australian local and state-based collaboration: the key to unlocking the potential of SDI by Mathew Warnest, Kevin McDougall, Abbas Rajabifard and Ian P Williamson: http://eprints.infodiv.unimelb.edu.au/archive/00001116/01/Spatial%20Sciences-2003-Mathew.pdf

The paper provides an academic examination of critical factors in the success of four GIS collaboration initiatives in Australia.

NATIONAL LEVEL

LOCAL TAB: National Level

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

Table of Contents

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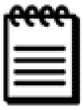
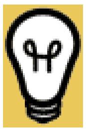
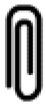
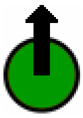
Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

Local tab: National Level

Considerable resource material related to natural resources management (NRM) programs (including the development of spatial data infrastructures, data discovery and visualisation services, monitoring and evaluation and, information management policies) is available on the web. The following are selected examples relevant to the national level.

1 Material on national NRM programs

Caring for Our Country: http://www.nrm.gov.au/

National Action Plan for Salinity and Water Quality: http://www.napswq.gov.au/napswq/index.html

Natural Heritage Trust: http://www.nht.gov.au/

National Land & Water Resource Audit: http://www.nlwra.gov.au/

2 Spatial data infrastructures and policies

General resource material

Australian Spatial Data Infrastructure (ASDI): http://www.anzlic.org.au/infrastructure_ASDI.html

ANZLIC policies: http://www.anzlic.org.au/policies.html

Australian Spatial Data Infrastructure (ASDI): http://www.ga.gov.au/nmd/asdi

Office of Spatial Data Management (OSDM): http://www.osdm.gov.au/

'Snapshot of SDI Development in Australia':
http://www.geom.unimelb.edu.au/research/publications/IPW/024_Warnest%20REF.pdf

3 Copyright and intellectual property

Copyright: The Australian Copyright Council produces a number of information sheets and a range of detailed practical guides that provide additional information about copyright law and how it applies in practice.

The information sheets and additional resource material are available at http://www.copyright.org.au/information/introductory.htm.

Intellectual Property or IP: IP represents the property of the mind or intellect. In business terms this also means proprietary knowledge. Types of IP include patents, trade marks, designs, copyright, circuit layout rights, plant breeder's rights, and confidentiality/trade secrets. IP Australia maintains a website providing background information on IP in Australia and guidelines on how to develop a strategy to protect IP rights. See: http://www.ipaustralia.gov.au/ip/introduction.shtml

4 Data access and licensing policies

The National Land & Water Resources Audit (the Audit) and ANZLIC – the Spatial Information Council (ANZLIC)

The Audit and ANZLIC have collectively developed a Data Access and Management Agreement signed by all jurisdictions in September 2001. The agreement provides for consistent access arrangements to the datasets held by the Audit and its jurisdictional partners. See http://www.anzlic.org.au/get/2375374673

In addition, ANZLIC and the Audit have collaborated in developing a model agreement for use in any NRM program. The *Model Data Access and Management Agreement* (http://www.anzlic.org.au/get/2375374755) incorporates guidelines for custodianship, metadata, archiving, accessing, data licensing and pricing and puts them into an operational context.

Other policies and guidelines include:

- Guidelines for Custodianship of spatial data
- Policy Statement on Spatial Data Management
- Metadata protocol and standard metadata profile
- Guiding Principles for Spatial Data Access and Pricing Policy
- Privacy guidelines for spatial information
- Access to Sensitive Spatial Data.

The Audit and ANZLIC have also recently developed an *Information for Sustainability: Statement of Intent* (http://www.nlwra.gov.au/library/scripts/objectifyMedia.aspx?file=pdf/96/89.pdf&siteID=9&str_title=ANRII%20Vision.pdf) which outlines a vision for an improved Australian natural resource information infrastructure and provides a set of guiding principles and steps for moving forward.

The Office of Spatial Data Management (OSDM)

The Australian Government Office of Spatial Data Management (OSDM) is charged with implementing the Australian Government Policy on Spatial Data Access and Pricing. See http://www.osdm.gov.au/policy/accessPricing.html.

In addition, the OSDM provides a licence for Australian Government spatial data provided online. The licence is designed for transfers of Australian Government spatial datasets listed on the schedule. It designates OSDM as the party contracting on behalf of the Commonwealth. The OSDM licence is designed for use with the OSDM Licence Registrations Service (OLRS)—a licence authentication service for schedule datasets. It allows registered users to access multiple datasets from all participating Australian Government agencies after a single registration process. As such, users who have previously agreed to the OSDM licence conditions can access a range of spatial datasets without having to agree to new licences each time.

5 Data discovery, visualisation and reporting

Australian Natural Resources Atlas (ANRA)

http://audit.ea.gov.au/ANRA/atlas_home.cfm

ANRA holds theme assessments undertaken by the Audit.

The Atlas is housed within the Department of the Environment, Water, Heritage and the Arts and contains:

- Natural Resource Topics—online versions of the Audit's theme assessments (including the Audit's 1997–2002 'Black Books')
- Map Maker—a dynamic online mapping tool for viewing Audit theme data and contextual information and producing customised maps.

The Audit is developing a new module within the Atlas called *Australia's Resources Online* (http://www.anra.gov.au/aro/) for reporting on the National Monitoring and Evaluation Framework indicators. Australia's Resources Online (ARO) will progressively report against the indicators, directly from state/territory-provided information sources.

Australian Natural Resources Data Library (ANRDL)

http://adl.brs.gov.au/anrdl/php/basic_search.php

ANRDL provides a number of different tools for the discovery and access to data and information online, *viz* reports, posters and GIS ready spatial datasets. It is designed to distribute data provided by the Audit in a timely and reliable fashion to approved participants in Audit projects and other users.

Environmental Reporting Tool

http://www.environment.gov.au/erin/ert/index.html

This reporting tool allows the user to find information on nationally listed species and ecological communities, wetlands and protected areas, and heritage sites recorded in national databases. The tool searches the environmental databases of the Department of the Environment and Water Resources, and can produce summary reports by region, local government area, postcode or self-defined search areas.

Other sources of spatial data

Some datasets from these websites are available for download:

- Australian Agriculture and Natural Resources Online database
- Australian Bureau of Agricultural and Resource Economics Data
- Australian Bureau of Statistics
- Australian Soil Resource Information System
- Australian Spatial Data Infrastructure
- Australian Spatial Data Directory—online searches of all connected nodes for Australian spatial data maintained by GeoScience Australia
- Bureau of Meteorology

- Discover Information Geographically
- Geoscience Australia
- Murray Darling Basin Commission
- Office of Spatial Data Management

6 NRM monitoring and evaluation

The Natural Resource Management Ministerial Council, which includes representatives of the Australian Government and all states and territory governments, was established to develop a coordinated approach to issues affecting NRM in Australia. The council endorsed two national level documents to help set targets, monitor, evaluate and report on natural resource management:

National Framework for Natural Resource Management Standards and Targets

National Natural Resource Management Monitoring and Evaluation Framework

A users' guide to these documents provides background information and helps interpret the national framework.

These documents are currently being reviewed in preparation for implementation of future NRM programs.

A set of Resource Condition Indicators are being refined to provide more detail on how to monitor each 'matter for target' set out in the National Framework for Natural Resource Management Standards and Targets. The Audit is responsible for coordinating the collation of data and information against the national matters for targets and the relevant resource indicators. It uses national coordination committees or technical advisory groups to test and refine these indicators and to provide guidance on the most practical and effective set of measures to be used. More details of progress, with further development of the resource condition indicators, can be found on the Audit's website:
http://www.nlwra.gov.au/About_Us/Monitoring_and_Evaluation/index.aspx.

The initial set of indicators developed by the Australian Government Monitoring and Evaluation Working Group has been used as the starting point for further development by the Audit. Information on the initial indicator set can be found at
http://www.nrm.gov.au/me/index.html

Note: This site may not have the most up-to-date information on indicators.

Australian Government contacts for further information relating to the matters for target and associated issues

Theme	Custodian Agency/s	Contact	Website
Soils	**CSIRO**	CSIRO Land and Water GPO Box 1666 Canberra ACT 2601 Tel: 02 6246 5916	**ASRIS** http://www.asris.csiro.au/index_ie.html
	DAFF	Department of Agriculture, Fisheries and Forestry GPO Box 858 Canberra ACT 2601 Tel: 02 6272 3933	**Digital Atlas of Australian Soils** http://www.daffa.gov.au/brs/data-tools/daas-lut-metadata **Healthy Soils for Australian Farms** http://www.daff.gov.au/natural-resources/land-salinity/soils
Water	**BoM**	Bureau of Meteorology GPO Box 1289 Melbourne VIC 3001 Tel: 03 9669 4000	http://www.bom.gov.au/hydro/wr/index.shtml
	NWC	National Water Commission 95 Northbourne Ave, Canberra ACT 2600 Tel: 02 6102 6000 Email: enquiries@nwc.gov.au	http://www.water.gov.au
Vegetation	**DEWHA**	Department of the Environment, Water, Heritage and the Arts GPO Box 787 Canberra ACT 2601 Tel:02 6274 1111	**National Vegetation Information System** http://www.environment.gov.au/erin/nvis **Vegetation Mapping and Monitoring Links** http://www.environment.gov.au/erin/nvis/links.html
	DAFF	Department of Agriculture, Fisheries and Forestry GPO Box 858 Canberra ACT 2601 Tel: 02 6272 3933	**Integrated Vegetation Information for NAP and NRM regions** http://data.brs.gov.au/mapserv/intveg/index.html **DAFF Vegetation** http://www.daff.gov.au/naturalresources/vegetation
Biodiversity	**DEWHA**	Department of the Environment, Water, Heritage and the Arts GPO Box 787 Canberra ACT 2601 Tel:02 6274 1111	**Biodiversity Home Page** http://www.environment.gov.au/biodiversity **Species Profile and Threats Database** http://www.environment.gov.au/cgi-

Theme	Custodian Agency/s	Contact	Website
			bin/sprat/public/sprat.pl
Estuarine, Coastal and Marine	**DEWHA** **GeoScience Australia**	Department of the Environment, Water, Heritage and the Arts GPO Box 787 Canberra ACT 2601 Tel:02 6274 1111 GeoScience Australia GPO Box 378 Canberra ACT 2601 Tel: 02 6249 9111	**DEWHA Coasts and Oceans Home Page** http://www.environment.gov.au/coasts/index.html **OzCoasts and OzEstuaries Home Page** http://www.ozcoasts.org.au/ **NLWRA** http://www.nlwra.gov.au/Natural_Resource_Topics/Estuarine_Coastal_and_Marine
Invasive Species	**DAFF** **DEWHA**	Department of Agriculture, Fisheries and Forestry GPO Box 858 Canberra ACT 2601 Tel: 02 6272 3933 Department of the Environment, Water, Heritage and the Arts GPO Box 787 Canberra ACT 2601 Tel:02 6274 1111	**Australian Government Weeds** http://www.weeds.gov.au/ **Australian Weeds Committee – Weeds Australia Website** http://www.weeds.org.au/ **DAFF Weeds** http://www.daff.gov.au/natural-resources/invasive/weeds **CRC for Australian Weed Management** http://www.weeds.crc.org.au/index_flash.html **Invasive Animals CRC** http://www.invasiveanimals.com/ **Australian Government/BRS Feral Animals** http://www.feral.org.au **NLWRA** http://www.nlwra.gov.au/Natural_Resource_Topics/Invasive_Species

Land Salinity	**DAFF**	Department of Agriculture, Fisheries and Forestry GPO Box 858 Canberra ACT 2601 Tel: 02 6272 3933	**National Dryland Salinity Program** http://www.ndsp.gov.au/ **CRC for Plant-based Management of Dryland Salinity** http://www.crcsalinity.com/index.php **DAFF Dryland Salinity** http://www.daff.gov.au/natural-resources/land-salinity/salinity **NLWRA** http://www.nlwra.gov.au/Natural_Resource_Topics/Land_Salinity/index.aspx
Land Use	**DAFF**	Department of Agriculture, Fisheries and Forestry GPO Box 858 Canberra ACT 2601 Tel: 02 6272 3933	**Land Use and Management** http://www.daff.gov.au/brs/land/use-management
Rangelands	**DEWHA**	Department of the Environment, Water, Heritage and the Arts GPO Box 787 Canberra ACT 2601 Tel:02 6274 1111	**Managing Rangelands** http://www.environment.gov.au/land/management/rangelands/index.html **Desert Knowledge CRC** http://www.desertknowledge.com.au/ **Rangelands** http://www.daff.gov.au/brs/land/rangelands **Sustainable Rangelands and Savannas** http://www.csiro.au/science/RangelandsSavannas
Rivers and Wetlands	**DEWHA**	Department of the Environment, Water, Heritage and the Arts GPO Box 787 Canberra ACT 2601 Tel:02 6274 1111	**Aquatic Ecosystems** http://www.environment.gov.au/water/environmental/ecosystems/index.html **Wetlands** http://www.environment.gov.au/water/environmental/wetlands/index.html **NLWRA** http://www.nlwra.gov.au/Natural_Resource_Topics/Rivers_and_wetlands/index.aspx

Signposts for Australian Agriculture	**DAFF**	Department of Agriculture, Fisheries and Forestry GPO Box 858 Canberra ACT 2601 Tel: 02 6272 3933	**Signposts for Australian Agriculture** http://signposts4ag.com/signposts-grains/about-signposts **NLWRA** http://www.nlwra.gov.au/Natural_Resource_Topics/Signposts_for_Australian_Agriculture/index.aspx
Socio-economic	**DAFF**	Department of Agriculture, Fisheries and Forestry GPO Box 858 Canberra ACT 2601 Tel: 02 6272 3933	**NLWRA** http://www.nlwra.gov.au/Natural_Resource_Topics/Socio-economic/index.aspx **Australian Bureau of Agricultural Resource Economics** http://www.abareconomics.com/ **Australian Bureau of Statistics** http://www.abs.gov.au/
Species and Communities	**DEWHA**	Department of the Environment, Water, Heritage and the Arts GPO Box 787 Canberra ACT 2601 Tel:02 6274 1111	**Threatened species and ecological communities** http://www.environment.gov.au/biodiversity/threatened/index.html

NEW SOUTH WALES

LOCAL TAB: New South Wales

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

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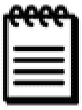
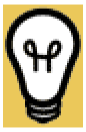
Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
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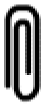
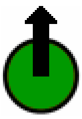
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

Local Tab: New South Wales

Considerable resource material related to natural resources management (NRM) programs (including the development of spatial data infrastructures, data discovery and visualisation services, monitoring and evaluation and information management policies) is available on the web. The following are selected examples relevant to activities in New South Wales. For additional information users should also refer to the National Local Tab.

1 Material on state NRM programs

NRM in NSW is a complex mix of state agencies, statutory bodies (both regional and state-wide), local government, advisory committees, Landcare, Bushcare and Coastcare networks and the general community.

General material is available from:

Natural Resources Commission: http://www.nrc.nsw.gov.au/

Department of Environment and Climate Change:

http://www.environment.nsw.gov.au/index.htm

http://naturalresources.nsw.gov.au/

Department of Primary Industries: http://www.dpi.nsw.gov.au/

Department of Water and Energy: http://www.dwe.nsw.gov.au/

Catchment Management Authorities: http://www.cma.nsw.gov.au/

Natural Resources Advisory Council: http://www.nrac.nsw.gov.au/

Local Government and Shires Association of NSW: http://www.lgsa.org.au/www/html/292-local-governments-role-in-nrm.asp?intSiteID=1

2 Spatial data infrastructures and policies

Common Spatial Information Initiative:

http://www.bossi.nsw.gov.au/_media/bossi/pdf/notices_and_initiatives/BOSSI_Common_Spatial_Information_Initiative.pdf

NSW Spatial Data Infrastructure:

http://www.maps.nsw.gov.au/metadata.html#NSWSpatialDataInfrastructure

NSW Natural Resources Information Management Strategy:

http://nrims.nsw.gov.au/policies/strategy.html and http://nrims.nsw.gov.au/policies/custodian.html

The Australian Spatial Data Infrastructure (ASDI) is a national framework for linking users with providers of spatial information: http://www.anzlic.org.au/infrastructure_ASDI.html

3 Copyright and intellectual property

Intellectual Property Management Framework for the NSW Public Sector:

http://www.dpc.nsw.gov.au/publications/memos_and_circulars/circulars/2005/c2005-06

4 Data access and licensing policies

CANRI Information Policies: http://www.canri.nsw.gov.au/policies/index.html

NSW Natural Resources Information Management Strategy:

http://www.nrims.nsw.gov.au/policies/strategy.html and

http://nrims.nsw.gov.au/policies/custodian.html

NSW Department of Commerce Government Chief Information Office:

http://www.gcio.nsw.gov.au/ict-key-strategies/information-management-1/

Note: the Information Management and Brokerage section of the Department of Environment and Climate Change (DECC) is currently implementing an Information Management Framework for DECC, including custodianship, brokerage, pricing and initiatives for the consolidation of spatial data and systems across NSW.

5 Data discovery, visualisation and reporting

The Australian Spatial Data Directory (ASDD) provides these search interfaces to discover geospatial dataset descriptions (metadata) throughout Australia:

http://asdd.ga.gov.au/

Australian Spatial Data Directory NSW node

The NSW Natural Resources Data Directory (NRDD) provides a search interface to metadata for natural resources information held within NSW:

http://www.canri.nsw.gov.au/nrdd/index.html

NSW Natural Resource datasets held by NSW government agencies:

http://www.canri.nsw.gov.au/core_data/

http://waterinfo.nsw.gov.au/about/core_data.shtml (NSW Government water datasets)

NSW Natural Resources Atlas:
http://www.nratlas.nsw.gov.au

Spatial Information Exchange:
http://maps.nsw.gov.au/

Atlas of NSW Wildlife:
http://wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp

ACA – NSW Node of the Austalian Coastal Atlas:

http://canri.nsw.gov.au/aca/

NSW Water Information

http://waterinfo.nsw.gov.au

State of Environment Reporting:

http://www.environment.nsw.gov.au/soe/index.htm

AirView – Aerial Photography System:

http://www.lands.nsw.gov.au/airview/

iPlan – Planning Information and Services:

http://www.iplan.nsw.gov.au/

6 NRM monitoring and evaluation

The Natural Resources Commission (NRC) provides independent advice to the NSW Government on a range of NRM issues. The NRC reports to the Premier, reflecting its independent nature: http://www.nrc.nsw.gov.au/Home.aspx

State Government contacts for further information relating to the Matters for Target and associated issues:

Abbreviations:

Department of Environment and Climate Change – DECC

Department Primary Industries – DPI

Natural Resources Commission – NRC

Department of Water & Energy – DWE

Theme	Contact Agency/s	Contact	Website
Soils	**DECC**	Soil Science Section Spatial Data Programs Section	http://www.canri.nsw.gov.au/core_data/
Water	**DWE**	Water Monitoring	http://waterinfo.nsw.gov.au/
Vegetation	**DECC**	Native Vegetation Science Section Spatial Data Programs Section	http://www.canri.nsw.gov.au/core_data/

Theme	Contact Agency/s	Contact	Website
Biodiversity	**DECC**	Spatial Data Programs Section	http://wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp
Estuarine, Coastal & Marine	**DECC**	Coastal Estuaries and Floodplain Management Section	http://www.canri.nsw.gov.au/core_data/fisheries_inventory_of_estuarine_habitats.html
Invasive Species	**DPI**	Emergencies, Weeds and Pest Animals Branch	http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds and http://www.dpi.nsw.gov.au/agriculture/pests-weeds/vertebrate-pests
Land Salinity	**DECC**	Soil Science Section	http://www.canri.nsw.gov.au/core_data/
Land Use	**DECC**	Spatial Data Programs Section	
Rangelands	**DECC**	Spatial Data Programs Section	

Theme	Contact Agency/s	Contact	Website
Rivers and Wetlands	**DECC & DWE**	DECC Spatial Data Programs Section DWE Water Monitoring	http://www.canri.nsw.gov.au/core_data/ http://waterinfo.nsw.gov.au/
Species and Communities	**DECC**	Spatial Data Programs Section	http://www.canri.nsw.gov.au/core_data/

NORTHERN TERRITORY

LOCAL TAB: Northern Territory

Building capacity to implement natural resources information management systems.

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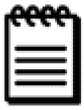	Information which readers should take particular note of
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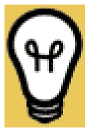	Tips for readers—based on experience and aimed at saving time and resources
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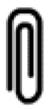
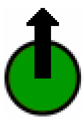
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
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Local Tab: NT Level

Considerable resource material related to natural resources management (NRM) programs (including the development of spatial data infrastructures, data discovery and visualisation services, monitoring and evaluation, and information management policies) is available on the web. The following are selected examples relevant to activities in the Northern Territory. For additional information users should also refer to the National Local Tab.

1 Material on state NRM programs

Department of Natural Resources, Environment and the Arts (NRETA):
http://www.nt.gov.au/nreta/natres/index.html

2 Spatial data infrastructures and policies

General resource material

Australian Spatial Data Infrastructure (ASDI): http://www.anzlic.org.au/infrastructure_ASDI.html

Northern Territory Spatial Data Infrastructure and Accessibility:

http://www.ntlis.nt.gov.au/forum/ntlis_documents/spatial-data-accessibility-project/

Other Northern Territory Land Information Systems (NTLIS) documents:

http://www.ntlis.nt.gov.au/forum/ntlis_documents/

3 Copyright and intellectual property

http://www.nt.gov.au/ntg/disclaimer.html

4 Data access and licensing policies

Most custodians will provide access to data under a licensing agreement. Details can be found on the relevant web pages for each custodian—refer to table below.

5 Data Discovery, Visualisation and Reporting

NRETA Maps:
www.nt.gov.au/nretamaps

6 NRM Monitoring and Evaluation

NRM Monitoring and Evaluation information for the Northern Territory is outlined in the Regional Investment Strategy, developed by the Landcare Council of the Northern Territory (LCNT) Refer: http://www.nt.gov.au/nreta/natres/nht/inrm/ris/index.html

Monitoring, evaluation and reporting are critical activities for NRM as they:

- provide feedback on progress with implementation programs and help to identify emerging challenges to their success
- provide information on the environmental, social and economic health of a region
- help to determine if objectives are being met
- are the basis for continuous improvement and adaptive management processes because they reveal changes, trends and underlying social or biophysicial processes
- contribute to the assessment of how plans, projects and stakeholders are 'performing', thereby reinforcing the accountability required of participants.

Additional monitoring, evaluation and reporting information is available in the Integrated Natural Resource Management Plan prepared by the Department of Natural Resources, Environment and the Arts (NRETA).

Refer: http://www.nt.gov.au/nreta/natres/nht/inrm/finalplan.html

Government Contacts for further information relating to the Matters for Target and associated issues

Theme	Custodian Agency/s	Contact	Website
Soils	**Land & Vegetation, NRETA**	Principal Scientist, Land & Vegetation 08 8999 4443	http://www.nt.gov.au/nreta/natres/soil/index.html
Water	**Water Resources, NRETA**	Principal Engineer 08 89993615	http://www.nt.gov.au/nreta/water/index.html
	Water Management	Manager Lic. & Reg. 08 8999 3632	http://www.nt.gov.au/nreta/water/index.html
Vegetation	**Land & Vegetation, NRETA**	Senior Scientist 08 89993623	http://www.nt.gov.au/nreta/natres/natveg/index.html
	Vegetation & Land Management,	Director 08 8999 3467	http://www.nt.gov.au/nreta/natres/natveg/index.html

Theme	Custodian Agency/s	Contact	Website
	NRETA		
	NT Herbarium, NRETA	Curator 08 89994512	http://www.nt.gov.au/nreta/wildlife/plants/index.html
Biodiversity	**Biodiversity, NRETA**	Principal Scientist 08 8995 5001	http://www.nt.gov.au/nreta/wildlife/animals/index.html
Estuarine, Coastal & Marine	**Marine Biodiversity, NRETA**	Principle Scientist 08 89209261	http://www.nt.gov.au/nreta/wildlife/marine/index.html
	Coastal & Marine Hydrography, NRETA	Manager 08 89993694	
Integrated Natural Resource Condition			
Intensive Land Use Zone			

Theme	Custodian Agency/s	Contact	Website
Invasive Species	**Weeds, NRETA**	Director 08 89994414	http://www.nt.gov.au/nreta/natres/weeds/index.html
	Wildlife Management, NRETA	Senior Scientist 08 8995 5007	http://www.nt.gov.au/nreta/wildlife/programs/threats/index.html
Land Salinity	**Land & Vegetation, NRETA**	Principal Scientist 08 8999 4443	http://www.nt.gov.au/nreta/natres/soil/index.html
Land Use	**Land & Vegetation, NRETA**	Land Resource Officer 08 8999 94586	http://www.nt.gov.au/nreta/natres/soil/landuse/index.html
Rangelands	**Rangelands Management, NRETA**	Director 08 89994474	http://www.nt.gov.au/nreta/natres/rangeland/index.html
Rivers and Wetlands	**Aquatic Ecosystems, NRETA**	Manager 08 89993475	http://www.nt.gov.au/nreta/water/aquatic/index.html

Theme	Custodian Agency/s	Contact	Website
Signposts for Australian Agriculture			
Socio-economic			
Species and Communities	**Museum, Natural Sciences, NRETA**	08 89998264	http://www.nt.gov.au/nreta/museums/collection/science/index.html Land and vegetation, herbarium, biodiversity and marine biodiversity could all fall under this category also.

QUEENSLAND

LOCAL TAB: Queensland

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

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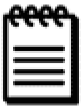	Information which readers should take particular note of
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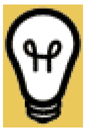	Tips for readers—based on experience and aimed at saving time and resources
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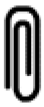
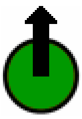
	Additional information
	Capability raising—used to show a signpost to a higher capability level
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Local Tab: Queensland

Considerable resource material related to natural resources management (NRM) programs, (including the development of spatial data infrastructures, data discovery and visualisation services, monitoring and evaluation and information management policies) is available on the web. The following are selected examples relevant to activities in Queensland. For additional information users should also refer to the National Local Tab.

1 Material on state NRM programs

Regional NRM is the Queensland Government's website for regional natural resource management. It contains information on regional NRM, the healthy regions agenda, community and regional NRM groups, regional NRM plans and investment strategies, research, education and careers resources, and who's who in regional NRM:

http://www.regionalnrm.qld.gov.au/

2 Regional Groups Collective

The Regional Groups Collective represents the state-wide interests of the fourteen regional NRM bodies in Queensland.

There has been a flexible approach to regionalised community-based NRM in Queensland.

Reflecting the diversity of the state, the regional bodies in Queensland differ in terms of corporate structure, stakeholder interests, and their stage of planning and implementation of NRM activities.

Despite these differences, there are many issues that are best addressed in a coordinated manner. The Collective provides a strategic approach and efficiencies in addressing challenges that cross regional boundaries:

http://www.regionalgroupscollective.com.au/

3 Spatial data infrastructures and policies

Information Queensland (IQ) is providing a smarter way for people to access information about the government and the state—especially information about the physical, environmental, economic and social characteristics of Queensland:

http://www.information.qld.gov.au/

Queensland Spatial Information Council (QSIC) provides strategic direction and a framework for the development and use of spatial information to support business, community and the environment across the state:

http://www.qsic.qld.gov.au/qsic/QSIC.nsf

The Australian Spatial Data Infrastructure (ASDI) is a national framework for linking users with providers of spatial information:

http://www.anzlic.org.au/infrastructure_ASDI.html

4 Copyright and intellectual property

The **Department of State Development** is responsible for the administration of crown copyright and other intellectual property in the Queensland Government:

http://www.dtrdi.qld.gov.au/dsdweb/v3/guis/templates/content/gui_cue_cntnhtml.cfm?id=8181

Queensland Government Intellectual Property website:

http://premiers.govnet.qld.gov.au/dsdi_intellectualproperty/ip_home.htm

Queensland Government Intellectual Property Register:

http://www.ipregister.qld.gov.au/

5 Data access and licensing policies

NRW Data Share Agreements

Contact NRW Regional Information Managers:

- **South East:** Ross Brown, Ph (07) 5451 2281
- **West:** Glenn Knight, Ph (07) 4688 1140
- **Central:** Scott Irvine, Ph (07) 4967 0810
- **North:** Rick Messer, Ph (07) 4741 1735

The **Government Information Licensing Framework (GILF)** project is about creating and implementing a new standardised information licensing arrangement for all Queensland government information, not just spatial information:

http://www.qsic.qld.gov.au/qsic/QSIC.nsf/CPByUNID/6C31063F945CD93B4A257096000CBA1A

The Business Framework was developed by QSIC to assist organisations that have an interest in acquiring or supplying spatial information products:

http://www.qsic.qld.gov.au/QSIC/QSIC.nsf/TPByUNID/0E8A783ED9DA2DB64A2570C00081FAC3#agreements

Department of Natural Resources and Water (NRW) Licences:

http://www.nrw.qld.gov.au/products/access_pricing/licence.html

NRW information management policies:

http://www.nrw.qld.gov.au/about/policy/list.php?theme=Information+Management

6 Data discovery, visualisation and reporting

The Australian Spatial Data Directory (ASDD) provides search interfaces to discover geospatial dataset descriptions (metadata) throughout Australia:

http://asdd.ga.gov.au/

Australian Spatial Data Directory (ASDD) QSIC node is a compilation of spatial metadata supplied by Queensland State Government departments, Queensland statutory authorities, Queensland local governments, and private companies who do not have their own ASDD node:

http://asdd.ga.gov.au/asdd/tech/node/qsiis-1.html

Information Queensland (IQ):

http://www.information.qld.gov.au/

Department of Natural Resources and Water (NRW) products and services:

http://www.nrw.qld.gov.au/products/index.php

7 NRM monitoring and evaluation

Department of Natural Resources and Water (NRW) plays a critical role in the stewardship of Queensland's natural resources. The department manages and allocates the state's land and water resources, and manages native vegetation and the use and sale of native forest resources:

http://www.nrw.qld.gov.au/topics/index.html

Regional NRM is the Queensland Government's website for regional natural resource management. It contains information on regional NRM, the healthy regions agenda, community and regional NRM groups, regional NRM plans and investment strategies, research, education and careers resources, and who's who in regional NRM:

http://www.regionalnrm.qld.gov.au/

The Environmental Protection Agency deals with a wide range of environmental matters including protecting air, water and soil quality, managing waste, preventing or controlling pollution, managing the state's coastline, and promoting sustainable industry:

http://www.epa.qld.gov.au/environmental_management

Department of Primary Industries and Forestry promotes sustainable development through the responsible use of the state's natural resources and encourages the development of environmentally sustainable industries and jobs:

http://www.dpi.qld.gov.au/cps/rde/xchg/dpi/hs.xsl/4789_ENA_HTML.htm

AgForward provides tools and information to better manage property and vegetation:

http://www.agforward.org.au/

Land Manager's Monitoring Guide provides a suite of natural resource monitoring information to assist land managers in monitoring and demonstrating the results of more sustainable management actions:

http://www.nrw.qld.gov.au/monitoring_guide

NRW fact sheets about sustainable management of our land, water and vegetation:

http://www.nrw.qld.gov.au/factsheets/index.php

Salinity monitoring framework review in the Queensland Murray-Darling Basin:

http://www.nrw.qld.gov.au/salinity/pdf/qmdb_monitoring_1.pdf

Surface water monitoring:

http://www.nrw.qld.gov.au/water/monitoring/current_data/map_qld.php

http://www.nrw.qld.gov.au/watershed/

Soils and land resource information provides a description of landscapes and their characteristics and attributes for land management and planning:

http://www.nrw.qld.gov.au/science/slr/index.html

State government contacts for further information relating to the Matters for Target and associated issues:

Abbreviations:

Department of Natural Resources and Water – NRW

Environment Protection Agency – EPA

Department Primary Industries and Fisheries – DPIF

Office of Economic and Statistical Research – OESR

National Land, Water & Resource Audit – NLWRA

Theme	Contact Agency/s	Contact	Website
Soils	**NRW**	Email: NRScDataCoordinator@nrw.qld.gov.au	http://www.nrw.qld.gov.au/land/index.html
Water	**NRW** **EPA**	Email: NRScDataCoordinator@nrw.qld.gov.au Email: water.data@epa.qld.gov.au	http://www.nrw.qld.gov.au/water/index.html http://www.epa.qld.gov.au/environmental_management/water/water_quality_monitoring

Theme	Contact Agency/s	Contact	Website
Vegetation	**NRW** **EPA**	Email: NRScDataCoordinator@nrw.qld.gov.au Email: regional.ecosystem@epa.qld.gov.au	http://www.nrw.qld.gov.au/vegetation/index.html http://www.epa.qld.gov.au/REMAPS/
Biodiversity	**EPA**	Email: Wildlife.Online@epa.qld.gov.au	www.epa.qld.gov.au/wildlifeonline
Estuarine, Coastal & Marine	**EPA**	Email: wetlands@epa.qld.gov.au	www.epa.qld.gov.au/wetlandinfo
Integrated Natural Resource	**NRW**	Email: NRScDataCoordinator@nrw.qld.gov.au	http://www.nrw.qld.gov.au
Intensive Land Use Zone	**NRW** **Local Govt**	Email: NRScDataCoordinator@nrw.qld.gov.au Contact local government	http://www.nrw.qld.gov.au/land/index.html
Invasive Species	**EPA** **DPIF**	Email: Queensland.herbarium@epa.qld.gov.au Email: Wildlife.Online@epa.qld.gov.au Email:callweb@dpi.qld.gov.au	www.epa.qld.gov.au/herbarium www.epa.qld.gov.au/wildlifeonline http://www.dpi.qld.gov.au/cps/rde/xchg/dpi/hs.xsl/4790_4823_ENA_HTML.htm

Theme	Contact Agency/s	Contact	Website
Land Salinity	**NRW**	Email: NRScDataCoordinator@nrw.qld.gov.au	http://www.nrw.qld.gov.au/salinity/index.html
Land Use	**NRW** **EPA**	Email: NRScDataCoordinator@nrw.qld.gov.au Email: data.coordinator@epa.qld.gov.au	http://www.nrw.qld.gov.au/land/index.html http://www.epa.qld.gov.au/emaps
Rangelands	**Rangelands Australia**	Email: rangelands@uqg.uq.edu.au	http://www.rangelands-australia.com.au/index.html
Rivers and Wetlands	**EPA**	Email: wetlands@epa.qld.gov.au	www.epa.qld.gov.au/wetlandinfo
Signposts for Australian Agriculture	**NLWRA**	Email: info@nlwra.gov.au	http://www.nlwra.gov.au/Natural_Resource_Topics/Signposts_for_Australian_Agriculture/index.aspx
Socio-economic	**OESR**	Email: oesr@treasury.qld.gov.au	http://www.oesr.qld.gov.au

Theme	Contact Agency/s	Contact	Website
Species and Communities	**EPA**	Email: Wildlife.Online@epa.qld.gov.au Email:csc@epa.qld.gov.au Email: ecosystem.conservation@epa.qld.gov.au	http://www.epa.qld.gov.au/emaps

SOUTH AUSTRALIA

LOCAL TAB: South Australia

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

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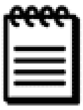
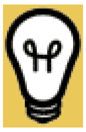
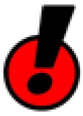
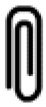
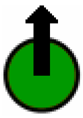
Product Number: PN21205

ISBN: 978-0-642-37155-3

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

Local Tab: South Australia

South Australia has recently undergone a major restructuring and now has the nation's most comprehensive natural resources management (NRM) legislation which establishes a structure for the development of ecological sustainability for the state:

http://www.dwlbc.sa.gov.au/nrm/index.html

1 Material on South Australian NRM programs

Material on South Australian NRM programs is available online via a series of dedicated websites dealing with the NRM Council, NRM Register, State NRM Plan, Regional NRM Plans, and Reports and Publications:

http://www.dwlbc.sa.gov.au/nrm/index.html

2 Additional material on NRM programs

NRM Program: http://www.nrm.gov.au/

National Land & Water Resource Audit: http://www.nlwra.gov.au/

3 Spatial data infrastructures and policies

South Australian NRM Policy Information

http://www.dwlbc.sa.gov.au/nrm/topics/nrm_policies.html

General resource material

Australian Spatial Data Infrastructure (ASDI):

http://www.anzlic.org.au/infrastructure_ASDI.html

ANZLIC policies: http://www.anzlic.org.au/policies.html

Australian Spatial Data Infrastructure (ASDI): http://www.ga.gov.au/nmd/asdi

Office of Spatial Data Management (OSDM): http://www.osdm.gov.au/

'Snapshot of SDI Development in Australia':

http://www.geom.unimelb.edu.au/research/publications/IPW/024_Warnest%20REF.pdf

4 Copyright and intellectual property

South Australian Office of the Chief Technical Officer (CTO)

http://www.cto.sa.gov.au/architecture-and-standards/policies-and-standards/data-and-information/cto_p3-4_protection_intellectual_property_rights.pdf

Additional Information:

Copyright: The Australian Copyright Council produces a number of information sheets and a range of detailed practical guides that provide additional information about copyright law and how it applies in practice.

The information sheets and additional resource material are available at:

http://www.copyright.org.au/information/introductory.htm.

Intellectual Property or IP: IP represents the property of the mind or intellect. In business terms this also means proprietary knowledge. Types of IP include patents, trade marks, designs, copyright, circuit layout rights, plant breeder's rights, and confidentiality/trade secrets. IP Australia maintains a website providing background information on IP in Australia and guidelines on how to develop a strategy to protect IP rights. See: http://www.ipaustralia.gov.au/ip/introduction.shtml.

5 Data access and licensing policies

The *Office of the Chief Technology Officer website* is the central, authoritative point of reference for information and communications technology standards, architecture, initiatives, service delivery, contact management and sourcing information:

http://www.cto.sa.gov.au/architecture-and-standards/policies-and-standards/index_html and

http://www.cto.sa.gov.au/architecture-and-standards/policies-and-standards/data-and-information

The National Land & Water Resources Audit (the Audit) and ANZLIC – the Spatial Information Council

The Audit and ANZLIC have collectively developed a Data Access and Management Agreement signed by all jurisdictions in September 2001. The agreement provides for consistent access arrangements to the datasets held by the Audit and its jurisdictional partners. See http://www.anzlic.org.au/get/2375374673

In addition, ANZLIC and the Audit have collaborated in developing a model agreement for use in any natural resource management program. The Model Data Access and Management Agreement (http://www.anzlic.org.au/get/2375374755) incorporates guidelines for custodianship, metadata, archiving, accessing, data licensing and pricing and puts them into an operational context.

6 Data discovery, visualisation and reporting

NRM Information

Numerous South Australian Government agencies maintain and manage spatial datasets. For a listing of datasets refer:
http://www.environment.sa.gov.au/mapland/sicom/accessing_data.html#dataset and
http://www.environment.sa.gov.au/mapland/spatial_products.html

Nature Maps

The South Australian Department for Environment and Heritage's interactive online mapping site supporting NatureLinks:

http://www.naturemaps.sa.gov.au/

Atlas of South Australia

Planning SA's online mapping application providing economic, images, infrastructure, land management, natural environment, population and social thematic datasets for visualisation: http://www.atlas.sa.gov.au/.

Other sources of spatial data

Some datasets from these websites are available for download:

- SA Spatial – the website of the Spatial Information Committee
- Australian Agriculture and Natural Resources Online database
- Australian Bureau of Agricultural and Resource Economics Data
- Australian Bureau of Statistics
- Australian Soil Resource Information System
- Australian Spatial Data Infrastructure
- Australian Spatial Data Directory—online searches of all connected nodes for Australian spatial data maintained by GeoScience Australia
- Bureau of Meteorology
- Discover Information Geographically
- Geoscience Australia
- Murray Darling Basin Commission
- Office of Spatial Data Management

7 NRM monitoring and evaluation

An appropriate monitoring and evaluation (M&E) process should be an integral part of all NRM projects. Regardless of the funding source, it provides early recognition, and subsequent justification, to adjust any abatement or enhancement program to ensure optimal efficiency in investment and outcome for natural resources. Monitoring and evaluation is an important aspect for adaptive management of NRM programs.

In the past, monitoring and evaluation has tended to focus on actions (outputs) rather than changes (outcomes). This focus has tended to result in greater resources being directed towards activities with short-term pay-offs, at the expense of strategic programs that more effectively address resource condition issues.

Monitoring and evaluation, under new NRM arrangements in SA, will attempt to move away from that paradigm to a model that focuses on the changes in resource condition that result from the actions undertaken. However, for this model to work effectively, there will need to be a recognition by all parties that many of these changes will not occur within the life-time of current programs.

The new M&E framework ensures that monitoring and evaluation across the state is coordinated, integrated, effective and efficient, and consistent with the National Monitoring and Evaluation Framework that applies to relevant bilateral agreements between South Australia and the Commonwealth Government.

South Australia's M&E framework establishes the following policies:

- all NRM plans, programs and projects are to include monitoring and reporting on the state and condition of natural resources over appropriate scales and timeframes
- evaluations are to be conducted at designated stages of delivery that are identified in the planning process
- costs of NRM monitoring will be shared amongst beneficiaries.

Under this model natural resource information should be:

- obtained to meet the strategic needs of government, industry and the community
- readily available to government, industry and the community
- captured on an agreed priority basis
- collected using a coordinated approach with uniform measurement standards, data management protocols, storage and retrieval
- consistent with national and international standards and protocols.

For additional information refer:

http://www.dwlbc.sa.gov.au/nrm/topics/monitoring_evaluation.html and

http://www.dwlbc.sa.gov.au/assets/files/NRM_StateNRMPlan2006.pdf

National Land & Water Resources Audit

http://www.nlwra.gov.au/About_Us/Monitoring_and_Evaluation/index.aspx

The initial set of indicators developed by the Australian Government Monitoring and Evaluation Working Group has been used as the starting point for further development by the Audit. Information on the initial indicator set can be found at: http://www.nrm.gov.au/me/index.html Note: This site may not have the most up-to-date information on indicators.

South Australian Government contacts for further information relating to the Matters for Target and associated issues

Theme	Custodian Agency/s	Contact	Website
Soils	**DWLBC** **PIRSA**	Department of Water, Land and Biodiversity Conservation Erosion: Giles Forward Senior Scientific Officer (Land Condition Monitoring Program) 08 8463 6835 forward.giles@saugov.sa.gov.au Soil Carbon: David Maschmedt Soil Scientist 08 8463 6682 maschmedt.david@saugov.sa.gov.au Primary Industries and Resources SA – Rural Solutions SA Acidity: Glenn Bailey Land Management Consultant 08 8762 9171 bailey.glenn@saugov.sa.gov.au	**Australian Soil Resource Information System (ASRIS):** http://www.asris.csiro.au/index_ie.html **Digital Atlas of Australian Soils:** http://www.daffa.gov.au/brs/data-tools/daas-lut-metadata **DAFF Healthy Soils for Australian Farms:** http://www.daff.gov.au/natural-resources/land-salinity/soils
Vegetation	**DEH**	Department of Environment and	**Ecological Communities – Biological Surveys:**

Theme	Custodian Agency/s	Contact	Website
		Heritage Felicity Smith GIS Team Leader 08 8463 3972 smith.felicity@saugov.sa.gov.au	http://www.environment.sa.gov.au/biodiversity/biosurveys.html **Naturemaps – interactive online mapping site:** http://www.naturemaps.sa.gov.au/ **National Vegetation Information System:** http://www.environment.gov.au/erin/nvis/index.html **Vegetation Mapping and Monitoring Links:** http://www.environment.gov.au/erin/nvis/links.html **Integrated Vegetation Information for NAP and NRM regions:** http://data.brs.gov.au/mapserv/intveg/index.html **DAFF Vegetation:** http://www.daff.gov.au/natural-resources/vegetation
Significant native species and ecological communities	**DEH**	Department of Environment and Heritage	**Ecological Communities – Biological Surveys:** http://www.environment.sa.gov.au/biodiversity/biosurveys.html **Naturemaps - interactive online mapping site:** http://www.naturemaps.sa.gov.au/
Water Quality (surface, marine and groundwater)	**EPA**	Environment Protection Authority David Duncan Principal advisor, water quality 08 8204 2094 david.duncan@epa.sa.gov.au	**Water Quality in South Australia:** http://www.epa.sa.gov.au/water_quality.html **Australian Water Resources Information System (AWRIS):** http://www.water.gov.au – Search on AWRIS **OzCoasts and OzEstuaries Home Page:** http://www.ozcoasts.org.au/
Coastal, Estuarine & Marine	**DEH**	Department of Environment and Heritage	**Water Quality in South Australia:** http://www.epa.sa.gov.au/water_quality.html

Theme	Custodian Agency/s	Contact	Website
		Patricia von Baumgarten Principal Marine Adviser 08 8124 4809 vonbaumgarten.patricia@saugov.sa.gov.au	**Naturemaps – interactive online mapping site:** http://www.naturemaps.sa.gov.au/ **Coasts and Oceans Home Page:** http://www.environment.gov.au/coasts/index.html **Coastal CRC:** http://www.coastal.crc.org.au/ **National Land and Water Resources Audit:** http://www.nlwra.gov.au/Natural_Resource_Topics/Estuarine_Coastal_and_Marine/index.aspx
Land Use	**DWLBC**	Department of Water, Land and Biodiversity Conservation David Tonkin GIS Manager 08 84636836 tonkin.david@saugov.sa.gov.au	**Bureau of Rural Sciences:** http://www.daff.gov.au/brs/land/use-management
Invasive Species	**DWLBC**	Department of Water, Land and Biodiversity Conservation Mark Ramsey Manager, Animal and Plant Control Group 08 83039530 ramsey.mark@saugov.sa.gov.au	**DWLBC:** http://dwlbc.sa.gov.au/biodiversity/pests/index.html **Weeds:** **Australian Government Weeds:** http://www.weeds.gov.au/ **Australian Weeds Committee – Weeds Australia website:** http://www.weeds.org.au/ **DAFF Weeds:** http://www.daff.gov.au/natural-resources/invasive/weeds

Theme	Custodian Agency/s	Contact	Website
			CRC for Australian Weed Management: http://www.weeds.crc.org.au/index_flash.html **Invasive Animals:** **Invasive Animals CRC:** http://www.invasiveanimals.com/ **Australian Government/BRS Feral Animals:** http://www.feral.org.au **National Land & Water Resources Audit:** http://www.nlwra.gov.au/Natural_Resource_Topics/Invasive_Species/index.aspx
Land Salinity	**DWLBC**	Department of Water, Land and Biodiversity Conservation James Hall Senior Soil and Environmental Scientist 08 84636833 hall.james@saugov.sa.gov.au	**National Dryland Salinity Program:** http://www.ndsp.gov.au/ **CRC for Plant-based Management of Dryland Salinity:** http://www.crcsalinity.com/index.php **DAFF Dryland Salinity:** http://www.daff.gov.au/natural-resources/land-salinity/salinity **National Land & Water Resources Audit:** http://www.nlwra.gov.au/Natural_Resource_Topics/Land_Salinity/index.aspx **Australian Soil Resource Information System (ASRIS):** http://www.asris.csiro.au/index_ie.html
Rangelands	**DWLBC**	Department of Water, Land and Biodiversity Conservation David Leek Manager, Pastoral Programme	

Theme	Custodian Agency/s	Contact	Website
		08 83039758 leek.david@saugov.sa.gov.au	
Wetlands	**DEH**	Department of Environment and Heritage Biodiversity significance and value: Russell Seaman Principle Wetlands Officer 08 8222 9355 seaman.russell@saugov.sa.gov.au Department of Water, Land and Biodiversity Conservation Environmental flows, ecosystem processes: Glen Scholz Senior Ecologist 08 8463 6993 scholz.glen@saugov.sa.gov.au Environment Protection Authority Peter Goonan Senior Aquatic Ecologist 08 8204 2044 peter.goonan@epa.sa.gov.au	
Socio-economic	**PIRSA**	Primary Industries and Resources SA	

Theme	Custodian Agency/s	Contact	Website
Biodiversity	**DEH**	Department of Environment and Heritage Mapping, monitoring, databases, condition metrics: Stuart Pillman Coordinator Monitoring and Databases 08 222 9440 pillman.stuart@saugov.sa.gov.au	
Species and Communities	**DEH**	Department of Environment and Heritage Threatened Species and Communities, ecosystem recovery, landscapes: Vicki Linton Acting Manager Biodiversity Conservation Programs 08 82229416 linton.vicki@saugov.sa.gov.au	**Ecological Communities – Biological Surveys:** http://www.environment.sa.gov.au/biodiversity/biosurveys.html

LOCAL TAB: Tasmania

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

TASMANIA

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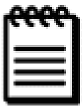
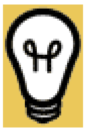
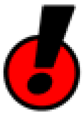
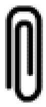
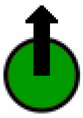
Product Number: PN21205

ISBN: 978-0-642-37155-3

Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

Local Tab: Tasmania

Considerable resource material related to natural resource management (NRM) programs is available on the web. This includes the development of spatial data infrastructures, data discovery and visualisation services, monitoring and evaluation and information management policies. The following are selected examples relevant to activities in Tasmania. For additional information users should also refer to the National Local Tab.

1 Material on Tasmanian NRM programs

NRM in Tasmania is a complex mix of state agencies, local government, advisory committees, Landcare, Bushcare and Coastcare networks and the general community.

General material is available from:

Department of Primary Industry and Water: http://www.dpiw.tas.gov.au/

Local Government and Shires Association: http://www.lgsa.org.au/www/html/292-local-governments-role-in-nrm.asp?intSiteID=1

2 Spatial data infrastructures and policies

Common Spatial Information Initiative

Note: The Land Information System Tasmania (the LIST) is a whole of government integrated land information infrastructure with a web-based delivery system. The LIST is a showcase of what can be achieved through cooperation, leadership, smart technology and smart thinking:

http://www.thelist.tas.gov.au/

Tasmania Spatial Data Infrastructure

The LIST: http://www.thelist.tas.gov.au/docs/about.html

The LIST Status and Future Directions:

http://www.thelist.tas.gov.au/docs/licc/futuredirections.html

The Australian Spatial Data Infrastructure (ASDI) is a national framework for linking users with providers of spatial information: http://www.anzlic.org.au/infrastructure_ASDI.html

3 Copyright and intellectual property

4 Data access and licensing policies

The LIST Information Policies:

http://www.thelist.tas.gov.au/docs/pricing.html

Spatial Digital Data Distribution and Pricing Guidelines:

http://www.thelist.tas.gov.au/docs/licc/LICC_Spatial_Digital_Data_Distribution_and_Pricing_Guidelines.htm

Spatial Digital Data Distribution and Pricing Model:

http://www.thelist.tas.gov.au/docs/licc/LICC_Spatial_Digital_Data_Distribution_and_Pricing_Model.htm

Spatial Metadata Policy:

http://www.thelist.tas.gov.au/docs/licc/spatialmetadatapolicy.html

Custodianship Policy:

http://www.thelist.tas.gov.au/docs/licc/custodianshippolicy.htm

Data Share Agreement Policy:

http://www.thelist.tas.gov.au/docs/licc/datashareagreement.htm

Tasmania Natural Resources Information Management Strategy:

http://www.thelist.tas.gov.au/docs/licc/futuredirections.html

5 Data discovery, visualisation and reporting

The Australian Spatial Data Directory (ASDD) provides search interfaces to discover geospatial dataset descriptions (metadata) throughout Australia:

http://asdd.ga.gov.au/

The LIST

http://www.thelist.tas.gov.au/thelistprod/list_security.handlePublic?p_URL=list_metadata.contents?p_dummy=X

http://www.thelist.tas.gov.au/listmap/listmapstart.jsp

6 NRM monitoring and evaluation

State Government contacts for further information relating to the Matters for Target and associated issues:

Abbreviations:

DPIW – Department of Primary Industry and Water

RMC – Resource Management and Conservation

DTAE– Department Tourism, Arts and the Environment

DIER – Department Infrastructure, Energy and Resources

State Government Contact for discovery, access and cataloguing of spatial data and information for and arising from NRM activities

Theme	Custodian Agency/s	Contact	Website
NRM Data Library	**DPIW & NRM Regions**	**Email :** nrmdatalibrary@dpiw.tas.gov.au	http://nrmdatalibrary.dpiw.tas.gov.au

State Government contacts for further information relating to the Matters for Target and associated issues

Theme	Custodian Agency/s	Contact	Website
Soils	**RMC – DPIW**	**Principal Land Management Officer** Phone: (03) 6233 6212 Email: Declan.McDonald@dpiw.tas.gov.au **Regional Land Management Officer (North West)** Phone: (03) 6421 7695 Email: Jason.McNeill@dpiw.tas.gov.au **Senior Spatial Information Systems Officer** Phone: (03) 6336 5224 Email: Mark.Brown@dpiwe.tas.gov.au **Soil Officer** Phone: (03) 6336 5246 Email: Darren.Kidd@dpiw.tas.gov.au	**SOIL MAPS OF TASMANIA:** HTTP://WWW.DPIW.TAS.GOV.AU/INTER.NSF/WEBPAGES/EGIL-53E2YX?OPEN **Soil Management Data and Information:** http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/EKOE-4ZG66F?open Data viewable via LIST map: http://www.thelist.tas.gov.au/ Under the following category in 'Manage Layers': • environmental
Water	**DPIW** **Water Resources**	**Manager (Water Assessment)** Phone: (03) 6233 6834 Email: Martin.Read@dpiw.tas.gov.au	**Water Quality, Nutrients, Water Salinity** WIST (Water Information System of Tasmania): http://water.dpiw.tas.gov.au/wist/ui State of Rivers Reports (2003) and Waterways Monitoring Report Cards: http://www.dpiw.tas.gov.au/inter.nsf/WebPages/JMUY-5C76P7?open Conservation of Freshwater Ecosystem Values Project: HTTP://WWW.DPIW.TAS.GOV.AU/INTER.NSF/WEBPAGES/JMUY-5QF35H?OPEN
		Environment Division Phone: (03) 6233 2616 Email: Greg.Dowson@environment.tas.gov.au	

Theme	Custodian Agency/s	Contact	Website
Vegetation	**RMC – DPIW**	**Coordinator, Tasmanian Vegetation Mapping Program** Phone: (03) 6233 4501 Email: tasveg@dpiw.tas.gov.au **Section Head & Principal Scientist (Vegtn Cnsrvtn)** Phone: (03) 6233 2543 Email: Stephen.Harris@dpiw.tas.gov.au	**TASVEG:** Monitoring and Mapping Tasmania's Vegetation: Data viewable via LIST Map: http://www.thelist.tas.gov.au/ Under the following category in 'Manage Layers': • vegetation Data and information on vegetation and vegetation monitoring: http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/BHAN-54746E?open
Biodiversity	**RMC – DPIW**	**Biodiversity Conservation Branch** Phone: (03) 6233 6556 Fax: (03) 6233 3477 Email: Biodiversity.Enquiries@dpiw.tas.gov.au	**See invasive species** and **Species and Communities**
Estuarine, Coastal & Marine	**DPIW Primary Industries Division**	**Marine Environmental Management Project Leader** Phone: (03) 6233 3179 Email: Colin.Shepherd@dpiw.tas.gov.au **Manager (Wild Fisheries Management Branch)** Phone: (03) 6233 3157 Email: Grant.Pullen@dpiw.tas.gov.au	**Data viewable via LIST map:** http://www.thelist.tas.gov.au/ Under the following categories in 'Manage Layers': • climate Change • coastal Atlas • coastal Values **Integrated South East Coastal Management Strategy:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/PMAS-6B56BV?open **Tas Esturaries**: http://www.dpiw.tas.gov.au/inter.nsf/WebPages/RPIO-4Y34MG?open **Marine Protected Areas Strategy:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/BHAN-54983Z?open **Integrated South East Coastal Management Strategy:** http://www.environment.tas.gov.au/cm_sgp_SE_coastal_management_strategy.html
	DTAE	**Manager – Coastal and Marine Branch** Phone: (03) 6233 3963 Email: Chris.Rees@environment.tas.gov.au OR Coastal.Enquiries@environment.tas.gov.au.	**Coastal Vulnerability report and maps** **Coastal management, coastal policy, coastal values, coastline:** http://www.environment.tas.gov.au/coastal_management.html **Draft Tasmanian esturine, coastal and marine indicators:** http://www.environment.tas.gov.au/cm_dti_tasmanian_indicator_compendium.html

Theme	Custodian Agency/s	Contact	Website
Integrated Natural Resource Condition	**RMC – DPIW**		**Tasmania's NRM Framework:** http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/LBUN-62U7ZJ?open **Nature Conservation Strategy 2002–2006:** http://www.dpiw.tas.gov.au/inter.nsf/Attachments/JCOK-5L2664?open http://www.dpiw.tas.gov.au/inter.nsf/Attachments/JCOK-5L2843?open **Nature Conservation Report Series – ISSN 1441-0680 (old):** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/LJEM-6EM25L?open http://www.nrmtas.org/
Intensive Land Use Zone	**DIER**		**Rural land use:** http://www.dier.tas.gov.au/forests/rural_land
Invasive Species	**RMC – DPIW**	**Principal Weed Management Officer** Phone: (03) 6233 6168; Email: Michael.Askey-Doran@dpiw.tas.gov.au **Weed Management Planning Officer** Phone: (03) 6233 3650 Email: Andrew.Crane@dpiw.tas.gov.au **Senior Marine Environmental Officer (Pests)** Phone: (03) 6233 7577 Email: Alastair.Morton@dpiw.tas.gov.au	**General information on weeds pests and diseases:** http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/DREN-4VH82R?open **Weeds and management plans:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/SSKA-73U3QA?open **The Weed Management Act 1999:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/TPRY-4ZV4BS?open**.**

Theme	Custodian Agency/s	Contact	Website
Land Salinity	**RMC – DPIW**	**Principal Land Management Officer** Phone: (03) 6233 6212 Email: Declan.McDonald@dpiw.tas.gov.au **Regional Land Management Officer (North)** Phone: (03) 6336 5259 Email: Colin.Bastick@dpiw.tas.gov.au **Land Resource Assessment Officer** Phone: (03) 6336 5441 Email: Rob.Moreton@dpiw.tas.gov.au	**Tasmanian Salinity Strategy (June 2007):** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/LBUN-74AAH8?open **Groundwater and Salinity:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/JMUY-4Z57WZ?open **Tasmanian Salinity Audit:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/EKOE-4ZG948?open
Land Use	**RMC – DPIW**	**Principal Land Management Officer** Phone: (03) 6233 6212 Email: Declan.McDonald@dpiw.tas.gov.au **Land Resource Assessment Officer** Phone: (03) 6336 5441 Email: Rob.Moreton@dpiw.tas.gov.au or LandManagement.Enquiries@dpiw.tas.gov.au	**Land assessment, Land Capability Reports and Data:** http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/LBUN-6EX9PS?open Data viewable via LIST map: http://www.thelist.tas.gov.au/ Under the following category in 'Manage Layers': • environment **Land Management:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/TPRY-5P53FY?open
Rangelands		**NA**	
Rivers and Wetlands	**DPIW** **Water Resources**	**Water Resources Division** Phone:(03)6233 6753 Email: Water.Enquiries@dpiw.tas.gov.au	**Water Resources Information:** http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/DREN-4VH8C4?open **Rivers, Lakes and Wetlands:** http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/RPIO-4Y4W36?open **Tasmanian Wetland strategy:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/RPIO-4YH3AY?open CFEV: http://www.water.dpiw.tas.gov.au/ (will be available after testing) **RiverCare:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/RPIO-4YL9F9?open
Signposts for Australian Agriculture	**ASB**		**Australian Bureau of Statistics – Agricultural Census:** http://www.abs.gov.au/Websitedbs/c311215.nsf/20564c23f3183fdaca25672100813ef1/8ccb36ca38c144bdca257118000cad33!OpenDocument
	BRS		**Bureau of Rural Sciences – Agriculture Theme:** www.brs.gov.au/landuse **Australian Collaborative Land use Mapping Tool:** http://adl.brs.gov.au/mapserv/landuse/

Theme	Custodian Agency/s	Contact	Website
Socio-economic	**ABS**		**Tasmania:** http://www.abs.gov.au/Websitedbs/c311215.nsf/22b99697d1e47ad8ca2568e30008e1bc/e4999c9c6353d213ca2568a2001f9f94!OpenDocument
Species and Communities	**RMC – DPIW**	**Section Head (Threatened Species)** **Phone: (03) 6233 2863** Email: Phil.Bell@dpiw.tas.gov.au **Senior Conservation Scientist** Phone: (03) 6233 8538 Email: Louise.Gilfedder@dpiw.tas.gov.au **Manager (Private Property Conservation Program)** Phone: (03) 6233 5439 Email: John.Harkin@dpiw.tas.gov.au **Principal Wildlife Management Officer** Phone: (03) 6233 6751 Email: Greg.Hocking@dpiw.tas.gov.au **Threatened Species Enquiries** Phone: (03) 6233 8759 Email: ThreatenedSpecies.Enquiries@dpiw.tas.gov.au **Biodiversity Conservation Branch** Phone: (03) 6233 6556 Email: NaturalValuesAtlas@dpiw.tas.gov.au	**Natural Values Atlas: flora and fauna information including threatened species:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/LJEM-6TV6TV?open **TasVEG:** Simplified species observation information is available via the LIST: www.thelist.tas.gov.au **Significant native species and ecological communities:** Threatened species http://www.dpiw.tas.gov.au/inter.nsf/WebPages/SJON-58E2VD?open **Threatened flora (2003):** http://www.dpiw.tas.gov.au/ThreatenedFloraCD/ **Current Vascular Plant Census (2007):** http://www.tmag.tas.gov.au/Herbarium/TasVascPlants.pdf **Tasmanian Devil Program:** http://www.dpiw.tas.gov.au/inter.nsf/Topics/JCOK-69973H?open **Tasmanian Fox:** http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/LBUN-5K438G?open\ **Threatened Species Strategy:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/RLIG-544755?open **Tasmania's Threatened Fauna Handbook:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/RLIG-5446TS?open **Threatened Native Vegetation Communities List 07:** http://www.dpiw.tas.gov.au/inter.nsf/WebPages/AWAH-6547ZL?open **Native Pastures:** http://www.dpiw.tas.gov.au/inter.nsf/Publications/LJEM-6SA3HT?open

VICTORIA

LOCAL TAB: Victoria

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

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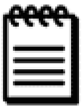
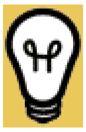
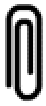
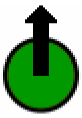
Guide to symbols

The following symbols are used throughout the Toolkit as a guide to users, and draw attention to important issues and information.

	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
Boxed Text	Highlighting of issues specifically related to ANZLIC or the Audit

Local Tab: Victoria

1 Material on Victorian NRM programs

Department of Sustainability and Environment: http://www.dse.vic.gov.au

Department of Primary Industies: http://www.dpi.vic.gov.au

Victorian Resources Online: http://www.dpi.vic.gov.au/vro

Corangamite Catchment Management Authority: http://www.ccma.vic.gov.au

East Gippsland Catchment Management Authority: http://www.egcma.com.au

Glenelg Hopkins Catchment Management Authority: http://www.ghcma.vic.gov.au

Goulburn Broken Catchment Management Authority: http://www.gbcma.vic.gov.au

North Central Catchment Management Authority: http://www.nccma.vic.gov.au

North East Catchment Management Authority: http://www.necma.vic.gov.au

Mallee Catchment Management Authority: http://www.malleecma.vic.gov.au

Port Phillip & Westernport Catchment Management Authority: http://www.ppwcma.vic.gov.au

West Gippsland Catchment Management Authority: http://www.wgcma.vic.gov.au

Wimmera Catchment Management Authority: http://www.wcma.vic.gov.au

NRM Program: http://www.nrm.gov.au/

National Action Plan for Salinity and Water Quality: http://www.napswq.gov.au/napswq/index.html

National Land & Water Resource Audit: http://www.nlwra.gov.au/

2 Spatial data infrastructures and policies

General resource material

Land Channel: http://www.land.vic.gov.au/spatial including: Victorian Spatial Information Strategy, Spatial Information Guidelines, Spatial Information Management Framework (forthcoming)

Victorian Spatial Council:
http://www.land.vic.gov.au/Land/lcnlc2.nsf/alltitle/Victorian+Spatial+Council

DataSearch Victoria:
http://services.land.vic.gov.au/SpatialDatamart/dataSearch.html

Victorian Spatial Data Directory:
http://www.land.vic.gov.au/vsdd

Australian Spatial Data Infrastructure (ASDI): http://www.anzlic.org.au/infrastructure_ASDI.html

ANZLIC policies: http://www.anzlic.org.au/policies.html

Australian Spatial Data Infrastructure (ASDI): http://www.ga.gov.au/nmd/asdi

Office of Spatial Data Management (OSDM): http://www.osdm.gov.au/

'Snapshot of SDI Development in Australia':
http://www.geom.unimelb.edu.au/research/publications/IPW/024_Warnest%20REF.pdf

3 Copyright and intellectual property

Copyright: The Australian Copyright Council produces a number of information sheets and a range of detailed practical guides that provide additional information about copyright law and how it applies in practice.

The information sheets and additional resource material are available at http://www.copyright.org.au/information/introductory.htm

Intellectual Property or IP: IP represents the property of the mind or intellect. In business terms this also means proprietary knowledge. Types of IP include patents, trade marks, designs, copyright, circuit layout rights, plant breeder's rights, and confidentiality/trade secrets. IP Australia maintains a website providing background information on IP in Australia and guidelines on how to develop a strategy to protect IP rights: See: http://www.ipaustralia.gov.au/ip/introduction.shtml.

4 Data access and licensing policies

Victorian Government Spatial Policy

A range of policy documents and operational guidelines for custodianship, metadata, archiving, access, quality, data licensing and pricing are available on the Land Channel website:

http://www.land.vic.gov.au/Land/lcnlc2.nsf/childdocs/-418EED712A81C5AE4A256A0A0015CDC1-F31E2DE1F7D75F504A256A4F0017DA3E-B3B667568E6561444A256A5700195F0E?open

The National Land & Water Resources Audit (the Audit) and ANZLIC – the Spatial Information Council

The Audit and ANZLIC have collectively developed a Data Access and Management Agreement signed by all jurisdictions in September 2001. The agreement provides for consistent access arrangements to the datasets held by the Audit and its jurisdictional partners. See http://www.anzlic.org.au/get/2375374673

In addition, ANZLIC and the Audit have collaborated in developing a model agreement for use in any natural resource management program. The Model Data Access and Management Agreement (http://www.anzlic.org.au/get/2375374755) incorporates guidelines for custodianship, metadata, archiving, accessing, data licensing and pricing and puts them into an operational context.

5 Data discovery, visualisation and reporting

DataSearch Victoria
DataSearch Victoria is an online facility that enables users to search for data via three easy-to-use methods: a simple text query, e.g. National parks and reserves; a range of themes and topics, e.g. 'Geological and geophysical'; and location—by drawing a box around the particular geographical

area of interest. The user can also preview the data and review the relevant metadata to ensure they are fit for purpose before clicking on a list of data providers to determine acquisition options.

MapShare Interactive Mapping Facilities

These interactive maps allows the operator to zoom in and out, pan around the map, identify features in the map, perform queries on databases, generate reports, link to other sites and create printable maps (in PDF) based on themes.

Biodiversity Interactive Map provides information on the biodiversity of Victoria and displays flora and fauna data.

Catchment Information Mapper allows the operator to display and query land and catchment themed spatial information along with administrative boundaries and contextual information.

Explore Victoria Online – Geovic is used for the display and inquiry of spatial features across the state of Victoria—primarily for those interested in minerals and petroleum.

Fireplan provides information about planned burns within the Fire Operations Plan.

Forest Explorer Online provides access to Victorian forest information and allows the operator to become familiar with the data used in forest management decision-making. Forest Explorer provides an important basis for engagement between the Department of Sustainability and Environmant (DSE) and individuals/communities in relation to forest management issues.

Index of Wetland Condition (IWC) Base Maps tool is used to create wetland maps that are used in the IWC. The IWC is a method for rapidly assessing the condition of wetlands in Victoria. It is currently provisional, pending further use and testing which is being coordinated by DSE. For more information on the method see the Index of Wetland Condition website.

Interactive Map can be used to find a property or place (by street address, suburb or town, lot on plan, coordinates or street directory) and generate a property report with location details, planning information and more. There is also facility to search and view street directories (Melway and VicRoads) by page number and grid reference.

Land and Survey Spatial Information replaces ‘Public View’ and provides all of its features in the comfort of the office/home via a web browser. Search by address, lot on plan, crown description, street directory, coordinates, survey label and survey mark. View the property map base with survey annotation and print/save maps.

Marine Map – Victoria provides information on the marine and coastal environment of Victoria. The data have been compiled by the Victorian Government with support from Environment Australia.

Planning Maps Online allows viewing of planning scheme and overlay maps, searching using a property address, Melways reference or lot and plan number, and printing a PDF Planning Property Report for the designated property.

Urban Development Program is a major initiative to support the implementation of the state government's Metropolitan Strategy, Melbourne 2030. The purpose of this program is to ensure adequate supply of land for future development. The interactive map allows a search for an area, generation and printing of the relevant map and report. Themes: Broadhectare residential land, major residential redevelopment sites and industrial land.

Victorian Water Resources integrates water-related data from the State Hydrographic network, Victorian Water Quality Monitoring Network, Index of Stream Condition, Waterwatch Victoria, Groundwater Management System, Department of Primary Industries, Primary Industries Research Victoria (PIRVic) salinity bores.

6 NRM monitoring and evaluation

Issues and opportunities associated with NRM monitoring and evaluation were recently reviewed in the Victorian Catchment Management Council's (VCMC) 2007 Catchment Condition Report. The VCMC is the Victorian Government's peak advisory body on land, water and biodiversity issues and priorities related to catchment management. It is uniquely placed, being independent of government agencies, catchment management authorities and non-government organisations. The VCMC facilitates integrated and coordinated catchment management through Victoria's Catchment Management Framework.

State Government websites for further information relating to the Matters for Target and associated issues:

Abbreviations:

Department of Sustainability & Environment – DSE

Department Primary Industries – DPI

Theme	Contact Agency/s	Website
Soils	**DPI**	http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil-home
Water Quality	**DSE**	http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/water-home http://www.vicwaterdata.net/vicwaterdata/home.aspx http://www.dse.vic.gov.au/dse/wcmn202.nsf/Home+Page/592E2077307FBB0CCA256FE100095CDD?open

Theme	Contact Agency/s	Website
Vegetation	**DSE**	http://www.dse.vic.gov.au/dse/nrenlwm.nsf/childdocs/-FA20C94F64F19A5E4A2567D7000B194D-6913EC9CCBBC588A4A2567D7000B1ADD?open http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/vegetation http://www.dse.vic.gov.au/DSE/dsencor.nsf/LinkView/836EE128E54D861FCA256DA200208B945FD09CE028D6AA58CA256DAC0029FA1A
Estuarine, Coastal & Marine	**EPA**	http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/marine http://www.dse.vic.gov.au/DSE/dsencor.nsf/LinkView/836EE128E54D861FCA256DA200208B945FD09CE028D6AA58CA256DAC0029FA1A http://www.dse.vic.gov.au/dse/nrencm.nsf/Home+Page/DSE+Coasts%7EHome+Page?open
Invasive Species	**DPI**	http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/landwatermgmt
Land Salinity	**DSE** **DPI**	http://www.dse.vic.gov.au/dse/nrenlwm.nsf/FID/-EAA75240DF7E38514A2569450019FE66?OpenDocument http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/water-gw-salinity-program http://www.dse.vic.gov.au/DSE/dsencor.nsf/LinkView/836EE128E54D861FCA256DA200208B945FD09CE028D6AA58CA256DAC0029FA1A

Theme	Contact Agency/s	Website
Species and Communities	**DSE**	http://www.dse.vic.gov.au/DSE/nrenpa.nsf/LinkView/076D320AB2AEC004CA256BAC000F3E52730F433356FA4CE14A2567D600824A63 http://www.dse.vic.gov.au/DSE/nrenari.nsf/LinkView/75BC32560A404427CA2571EE0011BAA5A2A10FA90B8883144A256DEA0017F485 http://www.dse.vic.gov.au/DSE/dsencor.nsf/LinkView/836EE128E54D861FCA256DA200208B945FD09CE028D6AA58
Rivers	**DSE** **EPA**	http://www.vicwaterdata.net/vicwaterdata/home.aspx http://www.dse.vic.gov.au/isc
Wetlands	**DSE**	http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/3EA5B6AEFB53EE3DCA25708B00145F44522C816829EBF3F7CA25700C00240E63 http://www.dse.vic.gov.au/DSE/nrence.nsf/childdocs/-8946409900BAC6344A256B260015D4AF- http://www.dse.vic.gov.au/DSE/dsencor.nsf/LinkView/836EE128E54D861FCA256DA200208B945FD09CE028D6AA58CA256DAC0029FA1A

Theme	Contact Agency/s	Website
Biodiversity	**DSE**	http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/biodiversity http://www.dse.vic.gov.au/DSE/nrence.nsf/childdocs/-8946409900BAC6344A256B260015D4AF?open http://www.dse.vic.gov.au/DSE/dsencor.nsf/LinkView/836EE128E54D861FCA256DA200208B945FD09CE028D6AA58CA256DAC0029FA1A
Land Use	**DPI**	http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/landuse-home http://www.dse.vic.gov.au/DSE/dsencor.nsf/LinkView/836EE128E54D861FCA256DA200208B945FD09CE028D6AA58CA256DAC0029FA1A
Socio-economic	**DSE**	To be developed

WESTERN AUSTRALIA

LOCAL TAB: Western Australia

Building capacity to implement natural resources information management systems.

www.nlwra.gov.au

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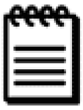
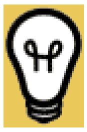
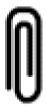
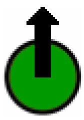
	Information which readers should take particular note of
	Best practice information
	Tips for readers—based on experience and aimed at saving time and resources
	Caution—readers are advised that particular care should be taken or that the subject issue may be complex
	Additional information
	Capability raising—used to show a signpost to a higher capability level
Bold Text	Used to highlight a particular issue
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Local Tab: Western Australia

Spatial information management in Western Australia is currently undergoing significant changes in response to a series of drivers. Demand for spatial information for natural resource management (NRM) in particular has increased significantly since the signing of bilateral agreements between the Australian and Western Australian governments for the regional delivery of NRM prgrams. In Western Australia, a number of state agencies act as custodians for the key natural resource databases that, together, provide a comprehensive information base.

The Western Australian Land Information System (WALIS) is a partnership of government agencies working with business, education and the general community to manage and promote the state's geographic information. Established by the WA Government in 1981, WALIS is responsible for coordinating across-government access and delivery of the geographic information held by WA government agencies. WALIS achieves this through committees and the WALIS office.

The mission of WALIS is to build networks of people and technology to share land and geographic information, and to continually improve the data's usefulness and accessibility. In 2005 work commenced on building a Shared Land Information Platform (SLIP) for sharing spatial information held by WALIS members. The SLIP is now operational and provides access to spatial information through specialised web portals (providing ready-made views of data), and web services that can be accessed directly from desktop GIS software.

Formal membership of WALIS currently comprises state government agencies with representation from the Commonwealth and local government, and an increasing number of private sector organisations, industry advisory bodies and community organisations.

1 Material on Western Australia NRM programs

WA NRM Program: http://www.nrm.wa.gov.au/

Rangelands NRM Co-ordinating Group: http://www.rangelandswa.info/

Northern Agricultural Catchment Council: http://www.nacc.com.au/default.asp?documentid=2

Avon Catchment Council: http://www.avonnrm.org.au/nrm_information

South Coast Regional Iniative Planning Team: http://www.script.asn.au/

South West Catchments Council: http://www.swcatchmentscouncil.com/

Swan Catchement Council: http://www.wrc.wa.gov.au/swanavon/

NRM Program: http://www.nrm.gov.au/

National Action Plan for Salinity and Water Quality: http://www.napswq.gov.au/napswq/index.html

National Land & Water Resource Audit: http://www.nlwra.gov.au/

2 Spatial data infrastructures and policies

General resource material

Shared Land Information Platform (Landgate): http://www.walis.wa.gov.au/SLIP

Western Australian Land Information System: http://www.walis.wa.gov.au/

Australian Spatial Data Infrastructure (ASDI): http://www.anzlic.org.au/infrastructure_ASDI.html

ANZLIC policies: http://www.anzlic.org.au/policies.html

Australian Spatial Data Infrastructure (ASDI): http://www.ga.gov.au/nmd/asdi

Office of Spatial Data Management (OSDM): http://www.osdm.gov.au/

'Snapshot of SDI Development in Australia':
http://www.geom.unimelb.edu.au/research/publications/IPW/024_Warnest%20REF.pdf

3 Copyright and intellectual property

Copyright: The Australian Copyright Council produces a number of information sheets and a range of detailed practical guides that provide additional information about copyright law and how it applies in practice.

The information sheets and additional resource material are available at

http://www.copyright.org.au/information/introductory.htm.

Intellectual Property or IP: IP represents the property of the mind or intellect. In business terms this also means proprietary knowledge. Types of IP include patents, trade marks, designs, copyright, circuit layout rights, plant breeder's rights, and confidentiality/trade secrets. IP Australia maintains a website providing background information on IP in Australia and guidelines on how to develop a strategy to protect IP rights. See: http://www.ipaustralia.gov.au/ip/introduction.shtml.

4 Data Access and Licensing Policies

Western Australian Land Information System (WALIS)

All WALIS policies and standards have been developed in partnership with WALIS participants and represent a whole-of-community perspective on the issues that affect the effective use and management of the state's geographic information. The policies are still in development in some regions. The collaboration has resulted in guidelines for use, collection and maintenance, ownership, custodianship, management, metadata, access, pricing, distribution and licensing of spatial data. See: http://www.walis.wa.gov.au/policies.

The National Land & Water Resources Audit (the Audit) and ANZLIC – the Spatial Information Council

The Audit and ANZLIC have collectively developed a Data Access and Management Agreement signed by all jurisdictions in September 2001. The agreement provides for consistent access arrangements to the datasets held by the Audit and its jurisdictional partners. See: http://www.anzlic.org.au/get/2375374673.

In addition, ANZLIC and the Audit have collaborated in developing a model agreement for use in any natural resource management program. The Model Data Access and Management Agreement (http://www.anzlic.org.au/get/2375374755) incorporates guidelines for custodianship, metadata, archiving, accessing, data licensing and pricing and puts them into an operational context.

5 Data discovery, visualisation and reporting

NRM Information

http://spatial.agric.wa.gov.au/slip/

This website is the single point of access for viewing and querying a wide range of NRM data from across WA. It is built on the Shared Land Information Platform and provides online reporting, querying and basic map making functionality. It includes NRM spatial data, databases, aerial photography and Landsat imagery.

WA Atlas

https://www2.landgate.wa.gov.au/waatlas

This WALIS initiative provides access to view a wide range of spatial information across WA plus tools to search for locations and localities. It provides viewing access to SLIP, WMS and WFS data services and has basic map making facilities.

Native Vegetation Map Viewer

http://portal.environment.wa.gov.au/portal/page?_pageid=119,50334&_dad=portal&_schema=PORTAL

This portal helps to identify the location of environmentally sensitive areas, mining tenements plus status of clearing permits. You can add the ESA, clearing permits and mining tenements layers. There is also a search tool for these layers. Metadata is listed for all available datasets. The tool is designed to search the Department of Environment and Conservations databases.

Geographic Data Atlas

http://portal.environment.wa.gov.au/portal/page?_pageid=119,50334&_dad=portal&_schema=PORTAL

A collaborative effort between the Department of Environment and Conservation and the Department of Water provides an interactive web mapping tool that allows you to freely view and download DoE and DoW geographic data. The map viewer is similar to the Native Vegetation map viewer, and has got limited environmental and administrative data.

Naturemap—due for release in 2008

This cooperative initiative between the Department of Environment and Conservation and the WA Museum will provide spatial data about species distributions and will be able to be queried and downloaded in future, depending on user privileges. Users will be able to produce species lists for arbitrary areas (both user-defined and standard layers such as conservation estate), reports on endemism, etc. Near-publication quality maps of query results will be available.

Hydrogeological Atlas

http://portal.water.wa.gov.au/portal/page/portal/MapsDataAtlases/HydrogeologicalAtlas

The Department of Water's map viewer provides access to spatial information across the state. A 'drill down' function is available that lists all attributes for the different datasets available. Maps can be printed off the web page which contains a text description of each aquifer used for groundwater management.

Perth Groundwater Atlas

http://portal.water.wa.gov.au/portal/page/portal/MapsDataAtlases/PerthGroundwaterAtlas

The Perth Groundwater Atlas allows users to query and view groundwater information of any parcel of land in the metropolitan area as well being able to calculate depth to groundwater where data is available. Maps and easy-to-read forms can be produced and printed off the web page.

FloraBase

http://florabase.calm.wa.gov.au/

FloraBase provides botanical information from the Department of Environment and Conservation on all Western Australian vascular plant families, genera and species, as well as identification tools, photos, maps, a database of botanical literature and, (for registered users) the collection details of over 658,871 vouchered herbarium specimens from across the state.

Wetlandbase

http://florabase.calm.wa.gov.au/

The Department of Environment and Conservation provides a single point of access for viewing and querying a wide range of data from across WA. Reporting and basic map making functionality is also available. This portal also provides a large variety of aquatic related information including environmental and administrative data. The portal is also linked to the SLIP via NRM Info.

Landgate map viewers

http://www.landgate.wa.gov.au/corporate.nsf

Landgate provides a variety of map viewers, including a number of channel or theme-based map viewers. Access to some channels is through a subscription and basic searching and map making facilities are available. The various map viewers provide information specific to the needs of government, surveyors, planning and farmers.

GeoVIEW

http://www.doir.wa.gov.au/3992.aspx

GeoVIEW is an online browser-based visual tool provided by the Department of Industry and Resources. Data layers can be queried and simple maps can be produced. Information includes geology, petroleum maps and mineral information.

Other sources of spatial data

Some datasets from these websites are available for download:

- Geographic Data Atlas – Department of Environment and Conservation
- Geographic Data Atlas – Department of Water
- Data and Software Centre – Department of Industry and Resources
- Department of Indigenous Affairs
- Australian Agriculture and Natural Resources Online database
- Australian Bureau of Agricultural and Resource Economics Data
- Australian Bureau of Statistics
- Australian Soil Resource Information System
- Australian Spatial Data Infrastructure
- Australian Spatial Data Directory—online searches of all connected nodes for Australian spatial data maintained by GeoScience Australia.
- Bureau of Meteorology
- Discover Information Geographically
- Geoscience Australia
- Murray Darling Basin Commission
- Office of Spatial Data Management

6 NRM monitoring and evaluation

The West Australian NRM Resource Condition Monitoring Plan coordinates current resource condition monitoring programs and the new monitoring programs required to meet NAP, NHT and other program requirements. As part of this, West Australian data collection standards are being reviewed and considered. New Western Australian standards will comply with the Audit's national standards (protocols) and provide guidance on how these national standards should be applied in the Western Australian context.

Lead state agencies have been allocated to each of the NRM themes and have clear mandated responsibilities for particular NRM issues. Regional project proponents are encouraged to contact these lead agencies when determining what Western Australian standards for data collection apply in their particular field.

The Natural Resource Management Ministerial Council, which includes representatives of the Australian Government and all states and territory governments, was established to develop a coordinated approach to issues affecting NRM in Australia. The Council endorsed two national level documents to help set targets, monitor, evaluate and report on NRM. These documents are the:

National Framework for Natural Resource Management Standards and Targets

National Natural Resource Management Monitoring and Evaluation Framework

A users' guide to these documents provides background information and helps interpret the national framework.

These documents are currently being reviewed in preparation for implementation of Caring for our country programs.

A set of Resource Condition Indicators are being refined to provide more detail on how to monitor each 'matter for target' set out in the National Framework for Natural Resource Management Standards and Targets. The Audit is responsible for coordinating the collation of data and information against the national matters for targets and the relevant resource indicators. It uses national coordination committees or technical advisory groups to test and refine these indicators and to provide guidance on the most practical and effective set of measures to be used. More details of progress with further development of the resource condition indicators can be found on the Audit's website:

http://www.nlwra.gov.au/About_Us/Monitoring_and_Evaluation/index.aspx

The initial set of indicators developed by the Australian Government Monitoring and Evaluation Working Group has been used as the starting point for further development by the Audit. Information on the initial indicator set can be found at:

http://www.nrm.gov.au/me/index.html.

Note: This site may not have the most up-to-date information on indicators as further developed through Audit processes. Check the Audit website for the link to the latest information.

Western Australian Government contacts for further information relating to the Matters for Target and associated issues

Theme	Custodian Agency/s	Contact	Website
Soils	**DAFWA**	Department of Agriculture and Food WA Contact: Noel Schoknecht Manager, Land Resource Assessment and Monitoring Tel: 08 9368 3707 Email: nschoknecht@agric.wa.gov.au	**Australian Soil Resource Information System (ASRIS):** http://www.asris.csiro.au/index_ie.html **Digital Atlas of Australian Soils:** http://www.daffa.gov.au/brs/data-tools/daas-lut-metadata **DAFF Healthy Soils for Australian Farms:** http://www.daff.gov.au/natural-resources/land-salinity/soils
Vegetation	**DEC** **DAFWA**	Department of Environment and Conservation Contact: Ken Wallace Manager, Natural Resources Branch Tel: 08 9334 0333 Email: Ken.Wallace@dec.wa.gov.au Department of Agriculture and Food WA Contact: Damian Shepherd	**National Vegetation Information System:** http://www.environment.gov.au/erin/nvis/index.html **Vegetation Mapping and Monitoring Links:** http://www.environment.gov.au/erin/nvis/links.html **Integrated Vegetation Information for NAP and NRM Regions:** http://data.brs.gov.au/mapserv/intveg/index.html **DAFF Vegetation:** http://www.daff.gov.au/natural-resources/vegetation

Theme	Custodian Agency/s	Contact	Website
		Manager Geographic Information Services Tel: 08 9368 3853 Email: dshepherd@agric.wa.gov.au	
Significant native species and ecological communities	**DEC**	Department of Environment and Conservation Contact: Ken Atkins Tel: 08 9334 0333 Email: Ken.Atkins@dec.wa.gov.au	
Estuarine monitoring / Inland Aquatic	**DoW**	Department of Water Contact: Malcom Robb Tel: 08 6364 7600 Email: Malcom.Robb@water.wa.gov.au	**Australian Water Resources Information System (AWRIS):** http://www.water.gov.au – Search on AWRIS **OzCoasts and OzEstuaries Home Page:** http://www.ozcoasts.org.au/
Coastal & Marine	**DoF**	Department of Fisheries Contact: Fred Wells Tel: 08 9482 7342 Email:	**Coasts and Oceans Home Page** http://www.environment.gov.au/coasts/index.html **Coastal CRC:** http://www.coastal.crc.org.au/

Theme	Custodian Agency/s	Contact	Website
		fwells@fish.wa.gov.au	**National Land & Water Resources Audit:** http://www.nlwra.gov.au/Natural_Resource_Topics/Estuarine_Coastal_and_Marine/index.aspx
Land Use	**DAFWA**	Department of Agriculture and Food WA Contact: Damian Shepherd Manager Geographic Information Services Tel: 08 9368 3853 Email: dshepherd@agric.wa.gov.au	**Bureau of Rural Sciences:** http://www.daff.gov.au/brs/land/use-management
Invasive Species	**DAFWA**	Department of Agriculture and Food WA Contact: Damian Collopy Manager, Invasive Species Program Tel: 08 9780 6218	**Weeds:** **Australian Government Weeds** http://www.weeds.gov.au/ **Australian Weeds Committee – Weeds Australia website:** http://www.weeds.org.au/ **DAFF Weeds** http://www.daff.gov.au/natural-resources/invasive/weeds **CRC for Australian Weed Management** http://www.weeds.crc.org.au/index_flash.html **Invasive Animals:** **Invasive Animals CRC:** http://www.invasiveanimals.com/ **Australian Government / BRS Feral Animals:** http://www.feral.org.au

Theme	Custodian Agency/s	Contact	Website
			National Land & Water Resources Audit: http://www.nlwra.gov.au/Natural_Resource_Topics/Invasive_Species/index.aspx
Land Salinity	**DAFWA**	Department of Agriculture and Food WA Contact: Neil Coles Projects Director, Ecohydrology Tel: 08 9368 3617 Email: ncoles@agric.wa.gov.au	**National Dryland Salinity Program:** http://www.ndsp.gov.au/ **CRC for Plant-based Management of Dryland Salinity:** http://www.crcsalinity.com/index.php **DAFF Dryland Salinity:** http://www.daff.gov.au/natural-resources/land-salinity/salinity **National Land & Water Resources Audit:** http://www.nlwra.gov.au/Natural_Resource_Topics/Land_Salinity/index.aspx
Wetlands		Department of Environment and Conservation Contact: Michael Coote Tel: 08 334 0333 Email: michael.coote@dec.wa.gov.au	**Wetlands Database (WetlandBase):** http://www.naturebase.net/content/view/981/987/
Socio-economic		Department of Agriculture and Food WA Contact: Juana Roe Tel:08 9690 2195 Email: jroe@agric.wa.gov.au	
Species and Communities		Department of Environment and	

Theme	Custodian Agency/s	Contact	Website
		Conservation Contact: Ken Atkins Tel: 08 9334 0333 Email: Ken.Atkins@dec.wa.gov.au	