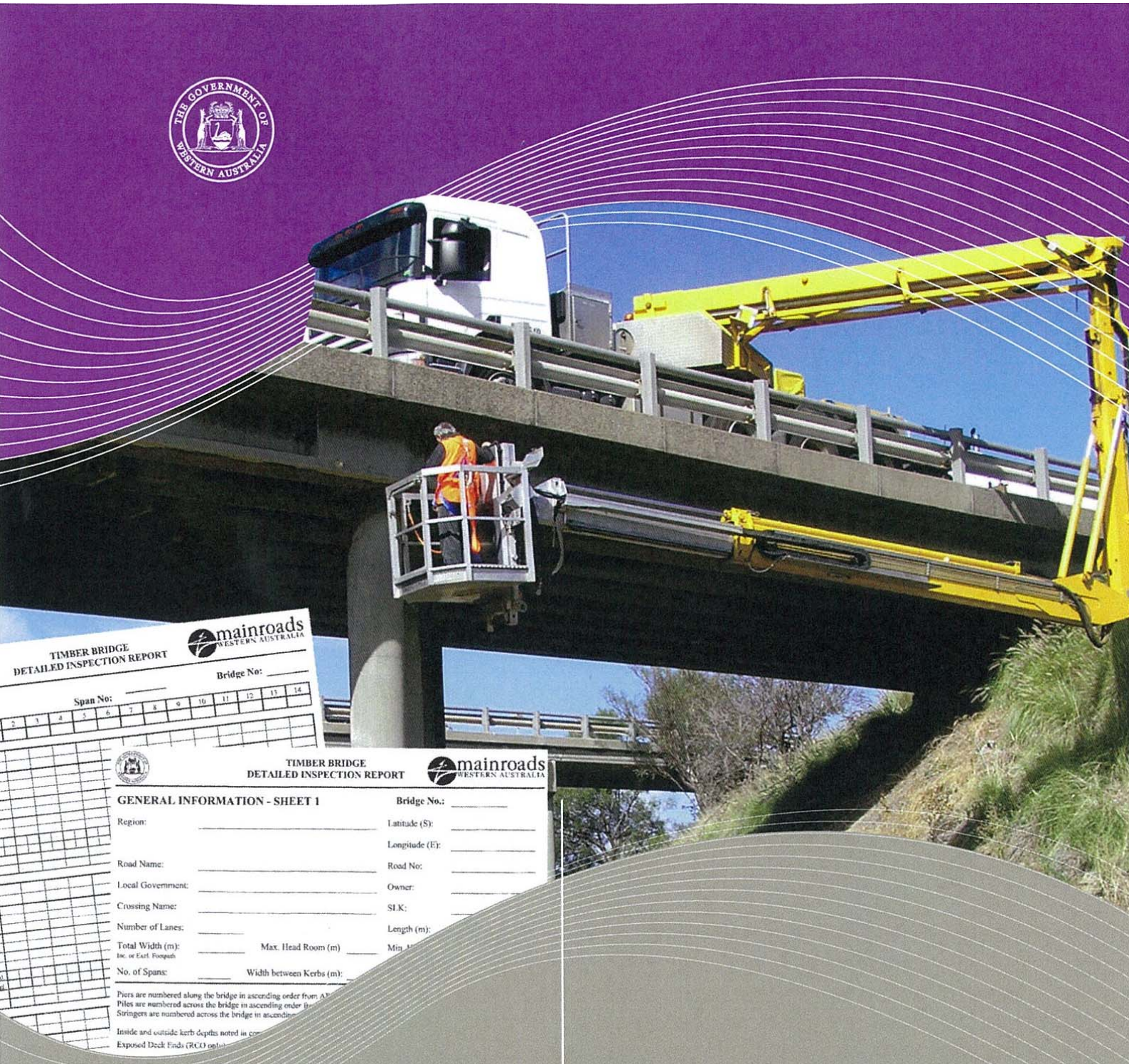

Structures Engineering

Structures Inspection and Information Management Policy

mainroads
WESTERN AUSTRALIA

Document No. 6706-01-202

STRUCTURES INSPECTION & INFORMATION MANAGEMENT POLICY

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AUTHORISATION

As head of Structures Engineering of Main Roads Western Australia, I authorise the issue and use of this document.

R F SCANLON

SENIOR ENGINEER STRUCTURES

Date: 09/09/2011

Document No. 6706-01-202

REVISION STATUS

Page No.	Revision No.	Revision Date	Revision Description	Approved By	Signature
All	1	16/08/13	Adjustment of sign gantry definition. General update.	A Lim	

All controlled copies shall be marked accordingly

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FOREWORD

The primary objectives of this policy are to:

- Contribute to the asset management task to ensure that the bridges, gantries, culverts and walls continue to perform their function under acceptable conditions of safety whilst optimising service life;
- Detail the inspection policy and process that ensures that the condition of Western Australia's structures (bridges, gantries, culverts and walls) on public roads is known with sufficient accuracy to protect public safety;
- Ensure that the information gathered is relevant, appropriate and current;
- Ensure that all inspections are carried out in a consistent and uniform manner;
- Facilitate the effective identification of maintenance and preservation requirements, and auditing of completed work; and
- Facilitate the effective and efficient management of heavy load movements throughout the State.

This policy will assist Main Roads Western Australia (MRWA), Local Government and all asset owners in the management of structures, and provide a framework for identifying maintenance and replacement needs.

1.0 INTRODUCTION

Western Australia is in a unique situation of having its preeminent road authority, MRWA, providing significant assistance to the State's Local Government Authorities (LGAs) and other bridge owners in terms of the management of bridges on unclassified roads.

MRWA has statutory authority and thus responsibility to manage assets on classified roads, State Roads and National Highways, and is responsible for the regulatory signing of bridges on all public roads for the safe and efficient management of heavy loads. Because of these statutory responsibilities, MRWA has historically provided assistance to LGAs and other bridge owners to manage bridges on public roads. This assistance variously includes collecting and maintaining bridge data, condition inspections, planning and programming of preservation, maintenance and refurbishment requirements, engineering and technical assistance and implementation of construction works.

This assistance has been extensively provided from the inception of MRWA such that most bridge owners now rely almost exclusively on MRWA for the provision of these services. Very few are resourced or structured to undertake this work themselves.

MRWA does not assist LGAs and other asset owners in the management of their gantries, culverts or walls on public roads but is responsible for managing those owned by MRWA located on State Roads and National Highways.

Consequently, this policy includes bridges on all public roads, and gantries, culverts and walls on State Roads and National Highways.

- There are approximately 2,815 road bridges, pedestrian bridges, underpasses and sign gantries in Western Australia.
- There are over 26,000 culvert structures in Western Australia on State Roads and National Highways.
- The number of walls (fences, noise walls, retaining walls and sea walls) on State Roads and National Highways is not yet fully quantified but data is in the process of being collected for input into the Integrated Road Information System (IRIS) Road Data. Currently there are approximately 1,300 walls on State Roads and National Highways.

Age profiles of Western Australia's structures reflect the fluctuations in investment over the past 100 years, with peaks in the 1930s and 1960s.

2.0 STRUCTURES INSPECTION POLICY

Key Policy Principles:

- All structures to be inspected on the following basis and frequencies:

	Level 1	Level 2	Level 3
	Routine Visual	**Detailed Visual**	**Special Inspections and Investigations**
Bridges & Sign Gantries			
Timber	Annually	5 year cycle	As requested
Concrete	Annually	7 year cycle	As requested
Steel	Annually	7 year cycle	As requested
Culverts			
Timber	As required	5 year cycle	As requested
Concrete	As required	7-10 year cycle	As requested
Other	As required	7-10 year cycle	As requested
Walls			
Noise Walls, Fences and Retaining Walls	As required	7-10 year cycle	As requested
Sea Walls	As required	5 year cycle	As requested

Note: Refer 'Structures Management Practice', Section 3.2 for Structure Definitions

- All inspections to be carried out in a uniform and consistent manner in accordance with MRWA guidelines and practice, refer Appendix A;
- Level 2 and 3 inspection reports for bridges, gantries, culverts and walls attached to structures to be reviewed and audited by experienced, senior engineers;
- All Level 2 inspection reports to undergo an engineering assessment to determine action requirements;
- Maintenance work requirements are determined from inspection reports as part of this inspection policy. Further asset management phases undertake activities to prioritise, cost and programme these works; and
- All records and databases are to be updated on a regular ongoing basis.

3.0 STRUCTURES MANAGEMENT PRACTICE

3.1 Introduction

Bridges and culverts are critical assets in the road network, and represent a major investment of community resources. Because of their strategic function, any failure or load capacity reduction may limit or severely restrict traffic over a large part of the road network, with consequent inconvenience and economic loss. Walls and gantries are minor structures that too can have an impact on the road network. It is therefore imperative that these assets are properly managed to ensure they are maintained in a safe and serviceable condition.

3.2 Structure Definitions

It is important to have clear definitions for bridges, sign gantries, culverts and walls to ensure the allocation of responsibilities for managing the asset is clear.

- Bridge: a structure (with the exception of sign gantries) having a clear opening in any span of greater than 3 metres measured between the faces of piers and/or abutments or structures of a lesser span with a deck supported on timber stringers. Note: A traffic-supporting structure that is a combination of bridge and culvert openings is managed as a 'Bridge'.
- Precast Box Unit Bridge: a specific superstructure bridge type consisting of precast box units of clear opening in any span of greater than 3 metres. Referred to as a 'Bridge'.
- Sign Gantry: an overhead structure spanning, or partially spanning (if cantilevered), a road carriageway for the specific purpose of carrying regulatory, advisory, warning, variable message (VMS) or directional signs.
- Culvert: a structure under a road having only clear openings of less than or equal to 3 metres measured between the faces of piers and/or abutments or a pipe shaped structure of any diameter.
- Wall: an upright structure for the specific purpose of enclosing, dividing or protecting an area or for retaining soil or water. They include noise walls, retaining walls, sea walls and fences.

3.3 Management Definition

Management includes all those processes necessary to ensure that all bridges, gantries, culverts and walls on the road network are kept in a safe condition with the most efficient use of resources.

A key process in the effective management of the structural asset is the inspection process, including data collection and data management.

Regular inspections over the life of a structure are required to maximise its serviceable life and minimise its whole-of-life cycle costs.

3.4 Increased Need for Structures Management

While new technologies, social and environmental developments are expanding the sphere of interest for road authorities, management of assets remains their core business. The need for more efficient use of funds requires constant improvements in the design, management and maintenance of assets. There is a greatly increased need for

maintenance, accurate assessment and monitoring of the condition and load capacity of structures.

Increased structures management is needed for the following reasons:

- dramatic increase in the number of long heavy vehicles using the network, and the increasing demand for network access;
- implementation of heavy vehicle access permit vehicles and the continual upwards pressure for increased axle masses;
- developments in transport technology and the need to realise the significant benefits arising from increased axle mass and transport efficiencies;
- increased cost of maintenance and refurbishment with no comparable increase in funding; and
- increasing average age of the structures, whereby the deterioration of the structure and its materials are becoming increasingly important factors in determining the structure's serviceability.

3.5 Management Processes

The effective management of structures is a prime responsibility of MRWA, and can be divided into the following process tasks, as applicable:

- Data collection (inspection)
- Data management (inspection reports and databases)
- Evaluation of load capacity (rating)
- Heavy loads management
- Planning and programming of works
- Strategic planning
- Maintenance and rehabilitation
- Replacement
- Asset valuation

A schematic flowchart of the asset management cycle is shown in Appendix B.

3.6 Bridge Management System (including Gantries)

MRWA's objective is to develop and provide a centralised, corporately managed system which will become an effective tool for the management of all bridge assets, including gantries.

Currently, MRWA's bridge inventory including gantries is held in an Oracle database that forms part of IRIS. Refer to Appendix C for a schematic diagram of this database.

The IRIS system is a repository for all the inventory data for the structure, such as the date built, location details, geometric details, bridge type and configuration (span, length, width, height etc), ownership, drawing numbers and load capacity rating values.

IRIS and the Bridge Management System also store the other management data such as inspection schedules, condition, maintenance requirements, estimated costs and program priorities. This forms the basis for preparing the annual Programme of Works and the 10-Year Bridge Strategies.

3.7 Culvert Management System

Compared to bridges, culverts are smaller and less critical but most of the foregoing discussion on bridge management practice is applicable to culverts. The risk profile and funding allocations vary for culverts and each shall be treated on its merits.

MRWA is only responsible for the management of culverts on State Roads and National Highways.

The IRIS database stores data for culverts as part of road inventory. Only inventory data is stored for the culvert, such as the date built, location details, geometric details, culvert type, material, ownership and drawing numbers.

3.8 Wall Management System

Walls are not traversed by vehicular traffic and their significance to the road network is not as critical as bridges and culverts. They are, however, infrastructure that serve an important function to the road network and appropriate management is needed.

MRWA is only responsible for the management of walls on State Roads and National Highways.

The IRIS database stores data for walls as part of road inventory. Only basic inventory data is stored, such as the date built, location details and wall type (noise wall, fence, retaining wall or sea wall).

4.0 RESOURCE REQUIREMENTS

To implement the Structures Inspection & Information Management Policy and to manage the infrastructure effectively requires a commitment to significant resources on an on-going basis. The purpose of this section is to provide an overview of the broad functions requiring resources for MRWA to effectively manage the structural infrastructure. Both Structures Engineering and the Regions have principal roles in the management of the infrastructure.

Regional structural resource requirements are very much dependent on the number of structures and distances needing to be travelled. For example, Level 1 annual inspections of the 13 bridges in Goldfields-Esperance Region can be completed in approximately 2 weeks using 2 resources and 1 vehicle whereas the 81 bridges in Wheatbelt South Region take approximately 2 months using 1 resource and 1 vehicle.

The major resource requirements are needed for the following broadly defined fields of activity:

- Condition Assessment including routine and detailed inspections, condition assessment and load ratings;
- Inventory and Data Management;
- Physical Works Management including developing proposed treatments, managing the preparation of design and documentation, clearances and delivery; and
- Network Analysis including monitoring of the network, forecasting needs and capital works.

A major component of the condition assessment is the inspection of structures. A 5-yearly cycle for the 1250 timber and a 7-yearly cycle for the 1520 non-timber bridges and gantries requires that approximately 470 structures be given a detailed inspection (Level 2 Condition Assessment) each year.

With Level 1 Routine Visual inspections on State Roads and National Highways undertaken by MRWA every year for all bridges and gantries, this requires that approximately 1,150 structures be given an inspection each year.

In addition, Level 2 Detailed Visual inspections on a 5-yearly cycle for timber culverts and on a 7 to 10-yearly cycle for all other culverts, requires that approximately 3,100 culverts be given an inspection each year.

There is no current corporate formalised practice for the inspection of walls and the number of walls on State Roads and National Highways is yet to be fully quantified.

A certain amount of the inspection tasks are required to be performed in-house. In particular, Level 2 inspection of timber bridges is a specialised skill that is unique to MRWA, with training only available on-the-job, and is fully undertaken in-house to ensure certainty and consistency of results. Level 2 inspections of non-timber bridges and Level 1 inspections are less specialised and can be adequately carried out external to MRWA but a certain amount of these inspections still need to be undertaken in-house to ensure appropriate standards, specifications and guidelines. Specialised access equipment for inspections is also only currently available in the State through MRWA.

The detailed inspection report is a significant first step in the management process but is not the end of the process, all of which require resources. An independent audit is undertaken as a follow up site visit for Level 2 detailed inspections. The verification of the inspection report is an essential part of the inspection process to assign condition state element ratings for overall bridge health assessment and monitoring.
There is a significant quantity of new documentation and data being continually received and processed which require data entry and data management resources.

Approximately 30% of the timber bridges inspected require load rating and 10% prompt intervention to ensure public safety. Only a very small percentage of non-timber bridges require load rating and repair options, assumed 2%.

To manage the process requires supervisory and management personnel to assist with the finalisation of reports, programming of maintenance, assessment of the condition states and derivation of the Bridge Condition Index.

Regional personnel review inspection reports and load rating assessments and arrange critical repairs for prompt intervention.

The Physical Works Management function incorporates processes for the selection of appropriate treatments, development of costs for completion of these treatments, design and documentation and delivery. This critical field of bridge asset management activity is predominantly resourced within the Regions.

Network Analysis includes monitoring of the network, forecasting needs and capital works and is an essential component of bridge management in order to provide a cost effective and reliable service over an extended period of time. Strategy, policy and guideline documentation, network analysis, training and accreditation are estimated to require one full-time senior engineer with assistance from a part-time engineer to fulfil these activities.

One assessment of the resources required ('*Staffing the Bridge Management System*' Kristin McKechie, 6th Austroads Bridge Conference 2006) calculated the need as approximately 1 FTE per 100 bridges excluding delivery management and this is considered to be a reasonably conservative indication. (Note: timber bridges were identified as requiring more resources and as such for MRWA this should be factored accordingly.) Using this documented calculated ratio, MRWA would need approximately 30 FTEs just to effectively asset manage its bridge infrastructure. This number recognises a higher proportion of timber bridges as well as the economies of scale that may be expected from some aspects of the operations.

APPENDIX A

DEVELOPMENT OF INSPECTION CRITERIA

DEVELOPMENT OF INSPECTION CRITERIA

A.1 Levels of Inspection

MRWA has adopted an inspection regime based on the Austroads *Guidelines for Bridge Management – Structure Information*, amended to suit MRWA specific practices. This regime includes:

- Level 1 – routine visual inspections
- Level 2 – detailed visual inspections, condition assessments
- Level 3 – special inspections and investigations

Each of the above inspection types will be discussed below.

Structures Engineering key manuals and Bridge Asset Management document hierarchy are outlined in Appendix D.

A.1.1 Level 1 – Routine Visual Inspections

Scheduled routine visual inspections are carried out only for bridges and gantries and on an annual cycle. They are visual in nature. They are intended to check on the overall safety and performance of the structure and the identification of any major accident damage or incident and any obvious failure of structural components. They are also important in ensuring maintenance works are being carried out.

Documentation requirements entail completion of a pro-forma with comments on key aspects of condition and include photographs of distress and defects. Data is generally qualitative in nature.

Routine inspections should be carried out on all structures (bridges, gantries, culverts and walls) following reports of impact damage, flood events, bush fires or other natural phenomena to ensure the structure is safe for its intended service level and function. This triggered inspection may serve as the scheduled (annual) inspection for bridges and gantries.

Refer:

- Document No. 6706-02-2234, *Routine Visual Bridge Inspection Guidelines (Level 1 Inspections) for Bridges*; and
- Document No. 6706-02-2239, *Sign Gantry Guidelines (Level 1 and Level 2 Inspections)*.

A.1.2 Level 2 – Detailed Visual Inspections, Condition Assessments

Detailed inspections for condition assessment are carried out according to a programme or schedule and are detailed in the information collected. Quantitative data on structural components are collected for use in engineering analyses and deterioration models, and every structural aspect is reported. Level 2 inspection is a detailed visual inspection where all components are inspected closely (within 1.0 m).

Documentation requirements entail the preparation of a detailed report on the condition and safety of the structure including photographs, and quantitative data for every individual structural component. Defects are assessed and the location and extent reported. Condition State ratings are also assigned for bridges and gantries to enable calculation of a ‘Bridge Condition Index’. Severity Levels are assigned for culverts to assist in prioritisation of maintenance works but there is no overall index calculated from these individual component values.

Refer:

- Document No. 6706-02-2233, *Detailed Visual Bridge Inspection Guidelines for Concrete and Steel Bridges (Level 2 Inspections)*;
- Document No. 6706-02-2239, *Sign Gantry Guidelines (Level 1 and Level 2 Inspections)*;
- Document No. 6706-02-2237, *Detailed Visual Inspection Guidelines for Culverts (Level 2 Inspections)*; and
- Document No. 6706-02-2231, *Detailed Visual Bridge Inspection Guidelines for Timber Bridges (Level 2 Inspections)*.

A.1.3 Level 3 – Special Inspections and Investigations

This is a special inspection which may be instigated by request for a specific reason. They are not scheduled but may be required due to concerns over the structure's safety, condition, load capacity or for structures subject to complex associated repair, strengthening or widening works. They may also result from scheduled follow-up material surveys or be required to inspect those components that are not accessible for a normal Level 2 inspection.

The documentation required will be adjusted to suit the needs but will include specific additional detail on individual aspects of the structure such as sampling and testing of materials. It will be to a similar standard as Level 2 for detail, quality and quantification.

Refer:

- Document No. 6706-02-2241, *Detailed Non-Destructive Bridge Inspection Guidelines for Concrete and Steel Bridges (Level 3 Inspections)*.

A.1.4 Problem Structures to be Monitored

Bridges and culverts that are load posted or otherwise restrictive in terms of their serviceability due to condition require special attention. Bridges and culverts that are propped to retain load capacity also require more attention. Likewise walls, particularly retaining walls and sea walls that are not in good condition, will require an amended management process. All structures that show accelerated deterioration or are nearing the end of their serviceable life will require more frequent inspections.

These structures can be termed 'problem' structures, in that they can cause network restrictions or absorb scarce funds for constant repairs or ongoing maintenance. Ongoing serviceability may be dependent on regular inspection (monitoring regime) to ensure structural integrity is maintained at a safe level.

The inspection type and frequency for these structures is dependent on the nature of the associated problems, but will generally be detailed and more frequent.

A.2 Inspection Frequency

A.2.1 General

Frequency of inspection is dependent on the type of structure, its location, its age and condition.

Structures constructed of materials known to deteriorate at a relatively rapid rate in unfavourable conditions require more frequent inspections to ensure the health and safety are maintained. Timber structures would fall into this category, along with known problem structures.

Conversely, structures constructed of more durable materials may not require detailed inspections as frequently. Some concrete and steel bridges may fall into this category, particularly in the years following construction.

A.2.2 Timber Bridges and Gantries

In addition to the annual Level 1 inspections, current practice is for all timber bridges and gantries to undergo a Level 2 inspection on a 5-yearly cycle.

MRWA completed its fourth cycle of 5-yearly inspections on timber bridges in 2009. Results to date indicate that this frequency is appropriate to monitor deterioration of timber bridges and to enable reasonable management of programming, maintenance and heavy loads management processes.

The frequencies and responsibilities for inspecting timber bridges and gantries are summarised below for the various types of inspection.

Inspection Type	Frequency	Responsibility
Level 1	Annual	Asset Owner
Level 2	5 year cycle	Structures Engineering
Level 3	As requested	Structures Engineering

A.2.3 Non-Timber Bridges and Gantries

In addition to the annual Level 1 inspections, current practice is for all non-timber bridges and gantries to undergo a Level 2 inspection on a 7-yearly cycle.

As there is still limited quantitative data that has been collected and assessed on non-timber bridges and gantries, an optimum frequency for inspection has not been finally determined. The frequency of inspections is influenced by the importance of the bridge or gantry, the complexity of its structural form, durability design, quality of construction, age of the asset and performance history. Consequently the target of a 7-yearly cycle will be subject to review when there is sufficient information available.

The frequencies and responsibilities for inspecting non-timber bridges and gantries are summarised below for the various types of inspection.

Inspection Type	Frequency	Responsibility
Level 1	Annual	Asset Owner
Level 2	7 year cycle	Structures Engineering
Level 3	As requested	Asset Owner or Structures Engineering

A.2.4 Culverts

Compared to bridges, culverts are smaller and less critical structures buried beneath the road embankment. However, failure of culverts can be a hazard to traffic and potentially fatal. Excessive settlement or collapse can result in closure of the network. They constitute an asset that is subject to deterioration and therefore they must be managed appropriately. The total investment in culvert structures is considerable and comparable in value to bridges. Inspection documentation for culverts is simpler compared to bridges as there are fewer structural components.

Typically culverts are of simple construction and the defects can be readily detected. These defects provide a sound basis for assessing the culvert condition.

The suitable inspection frequency is primarily a function of the material used in its construction. Current practice is for all culverts to undergo inspections as summarised in the following Tables:

Timber

Inspection Type	Frequency	Responsibility
Level 1	As required	Asset Owner
Level 2	5 year cycle	Asset Owner
Level 3	As requested	Asset Owner

Other

Inspection Type	Frequency	Responsibility
Level 1	As required	Asset Owner
Level 2	7-10 year cycle	Asset Owner
Level 3	As requested	Asset Owner

A.2.5 Walls

Walls are not traversed by vehicular traffic and their significance to the road network is not as critical as bridges and culverts. They are, however, infrastructure that serve an important function to the road network and appropriate management is needed.

Typically walls are of simple construction and the defects can be readily detected. These defects provide a sound basis for assessing the wall condition.

There is no current corporate formalised practice for the inspection of walls. However, it is acknowledged and agreed that all walls should undergo inspections as follows:

Sea Walls

Inspection Type	Frequency	Responsibility
Level 1	As required	Asset Owner
Level 2	5 year cycle	Asset Owner
Level 3	As requested	Asset Owner

Other

Inspection Type	Frequency	Responsibility
Level 1	As required	Asset Owner
Level 2	7-10 year cycle	Asset Owner
Level 3	As requested	Asset Owner

A.3 Level 2 Inspection Requirements by Structure Type & Material

The inspection requirements for structures will vary according to construction material, age and location. Construction material because of the different deterioration processes and rates, and age and location because of their effect on the deterioration.

A.3.1 Timber Bridges

Timber bridges require frequent inspection to detect and monitor the deterioration due to biological decay (rot), insect attack (termites, marine borer infestation) and weathering (splitting and checking).

Reference should be made to Document No. 6706-02-2231, *Detailed Visual Bridge Inspection Guidelines for Timber Bridges (Level 2 Inspections)* for detailed information on inspection requirements.

The minimum relevant data to be collected by inspection is as follows, for every structural component:

- Component sizes and configuration
- Type of timber
- Remaining solid timber
- Amount and location of rotted and friable timber
- Location and extent of splits
- Condition of fasteners

A.3.2 Concrete Bridges

Concrete bridges require regular inspection to detect and monitor deterioration such as cracking (structural and AAR), spalling and delamination, chemical attack and weathering.

Reference should be made to Document No. 6706-02-2233, *Detailed Visual Bridge Inspection Guidelines for Concrete and Steel Bridges (Level 2 Inspections)* for detailed information on inspection requirements.

The minimum relevant data to be collected by inspection is as follows, for every structural component:

- Component sizes and configuration
- Location, type, size and extent of cracks
- Location and extent of spalled concrete
- Location and extent of delaminated concrete
- Location and extent of exposed and rusting reinforcing steel
- Condition of any protective coatings
- Location and extent of any observed defects on the concrete surface
- Any signs of chemical attack, such as chloride penetration, carbonation or sulphate attack
- Type and condition of bearings
- Type and condition of expansion joints

In addition to the above inspection information requirements, there may also be a need to carry out Level 3 special testing of concrete core samples or steel reinforcement samples to provide quantitative data on strength and extent of deterioration.

A.3.3 Steel Bridges

Steel bridges require regular inspection to detect cracks in structural components, weld defects, corrosion and weathering.

Reference should be made to Document No. 6706-02-2233, *Detailed Visual Bridge Inspection Guidelines for Concrete and Steel Bridges (Level 2 Inspections)* for detailed information on inspection requirements.

The minimum relevant data to be collected by inspection is as follows, for every structural component:

- Component sizes and configuration
- Location, type, size and extent of cracks
- Location of any local buckling
- Location, type and extent of any weld defects
- Location, size and extent of fatigue cracking around structural connections
- Location and extent of corrosion
- Condition and performance of any corrosion protective coatings or systems
- Type and condition of bearings
- Type and condition of expansion joints
- Any effects of weathering

In addition to the above inspection information requirements, there may also be a need to carry out Level 3 special testing to provide quantitative data on extent of deterioration.

A.3.4 Gantries

Gantries require regular inspection to detect and monitor steel, concrete or timber deterioration and to detect cracks in structural components, weld defects and corrosion.

Reference should be made to Document No. 6706-02-2239, *Sign Gantry Guidelines (Level 1 and Level 2 Inspections)* for detailed information on inspection requirements.

The minimum relevant data to be collected by inspection is as follows, for every structural component:

- Component sizes and configuration
- Location, type, size and extent of cracks
- Location, type and extent of any weld defects
- Location, size and extent of fatigue cracking around structural connections
- Location and extent of spalled or delaminated concrete
- Location and extent of exposed and rusting reinforcing steel
- Remaining solid timber and amount and location of rotted and friable timber
- Location and extent of corrosion
- Condition and performance of any corrosion protective coatings or systems

A.3.5 Culverts

Culverts require regular inspection to detect and monitor deterioration.

Reference should be made to Document No. 6706-02-2237, *Detailed Visual Inspection Guidelines for Culverts (Level 2 Inspections)* for detailed information on inspection requirements.

The minimum relevant data to be collected by inspection is as follows:

- Component sizes and configuration
- Location, type, size and extent of any defect
- Condition and performance of any protective coatings or systems
- Condition and performance of joins between culvert units
- Undermining, settlement or movement
- Hydraulic performance and extent of scour

A.3.6 Walls

Walls require regular inspection to detect and monitor significant visible signs of distress or unusual behaviour.

The minimum relevant data to be collected by inspection is as follows:

- Location, type, size and extent of any defect
- Bowed, cracked and misaligned panels/units
- Condition and performance of joins between wall panels/units
- Undermining, settlement, tilting or movement
- Loss of material through the wall

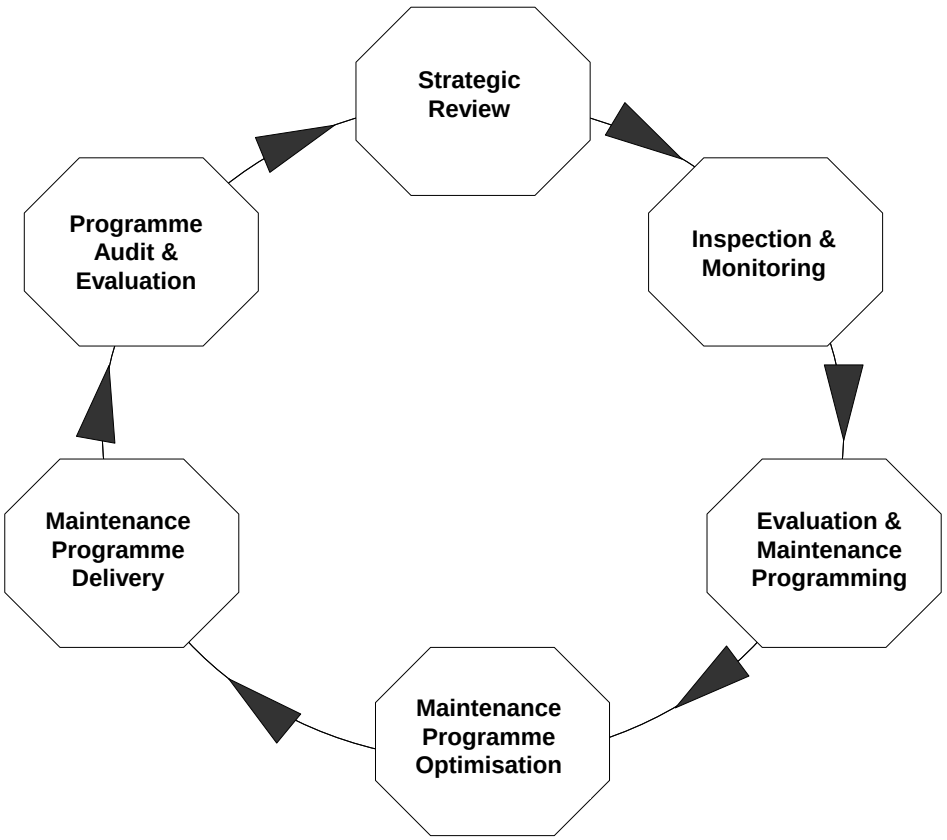
A.3.7 General Inspection Requirements

For any structure there are a range of items, as applicable, that must be included in the data collection phase of the inspection process. These are listed below:

- Scouring of foundations and guide banks
- Signs of overtopping by flood
- Type and condition of guardrail and handrail
- Type and condition of trafficable surfacing including approaches
- Extent of vegetation and fire risk
- Condition and performance of drainage systems and weep holes
- Provision and condition of signs or lights
- Type and location of attached services
- Check on inventory details for correctness

APPENDIX B

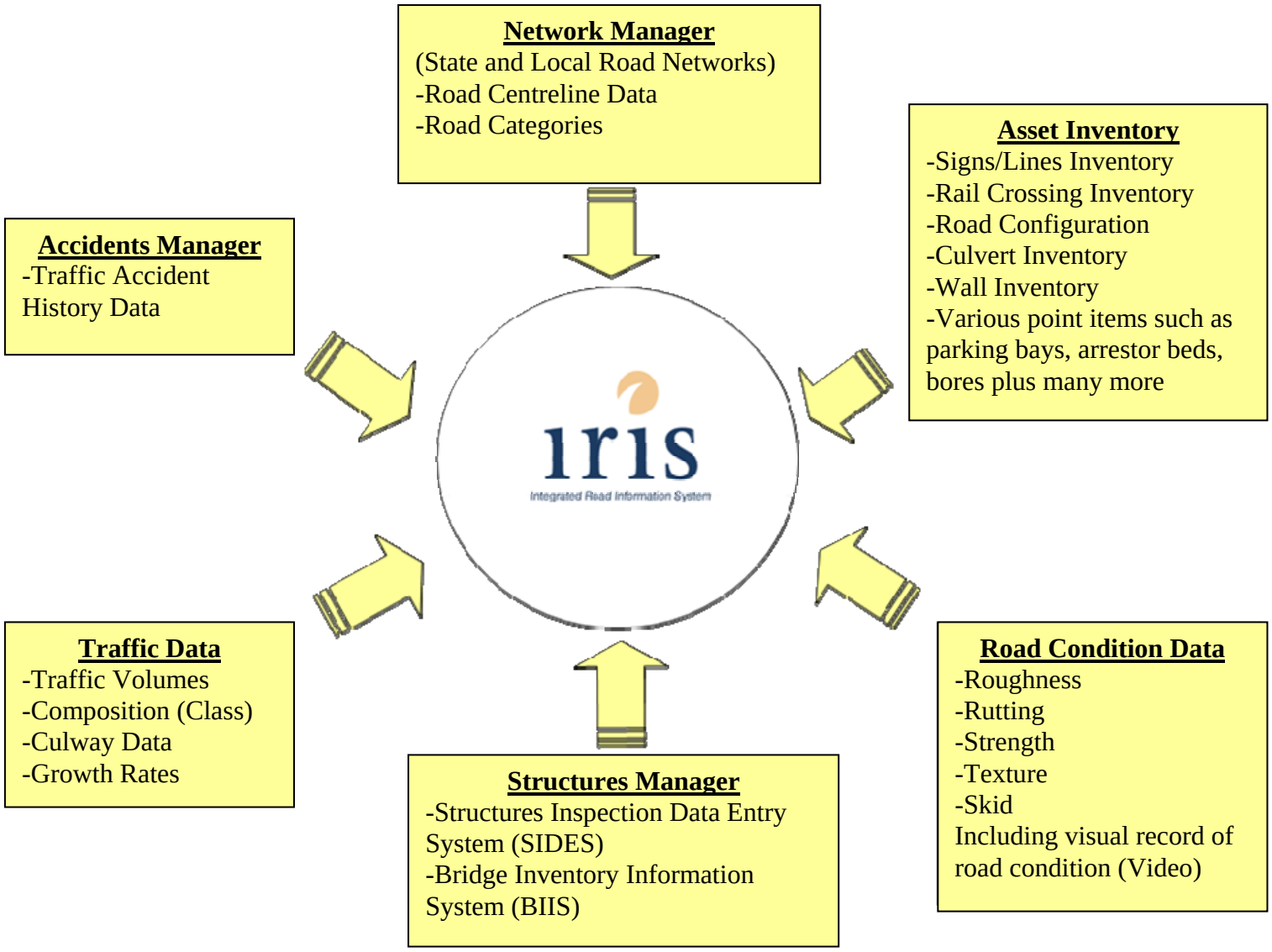
ASSET MANAGEMENT CYCLE



(Source: Austroads Guide to Asset Management Part 6 – Elements of the Bridge Management Cycle)

APPENDIX C

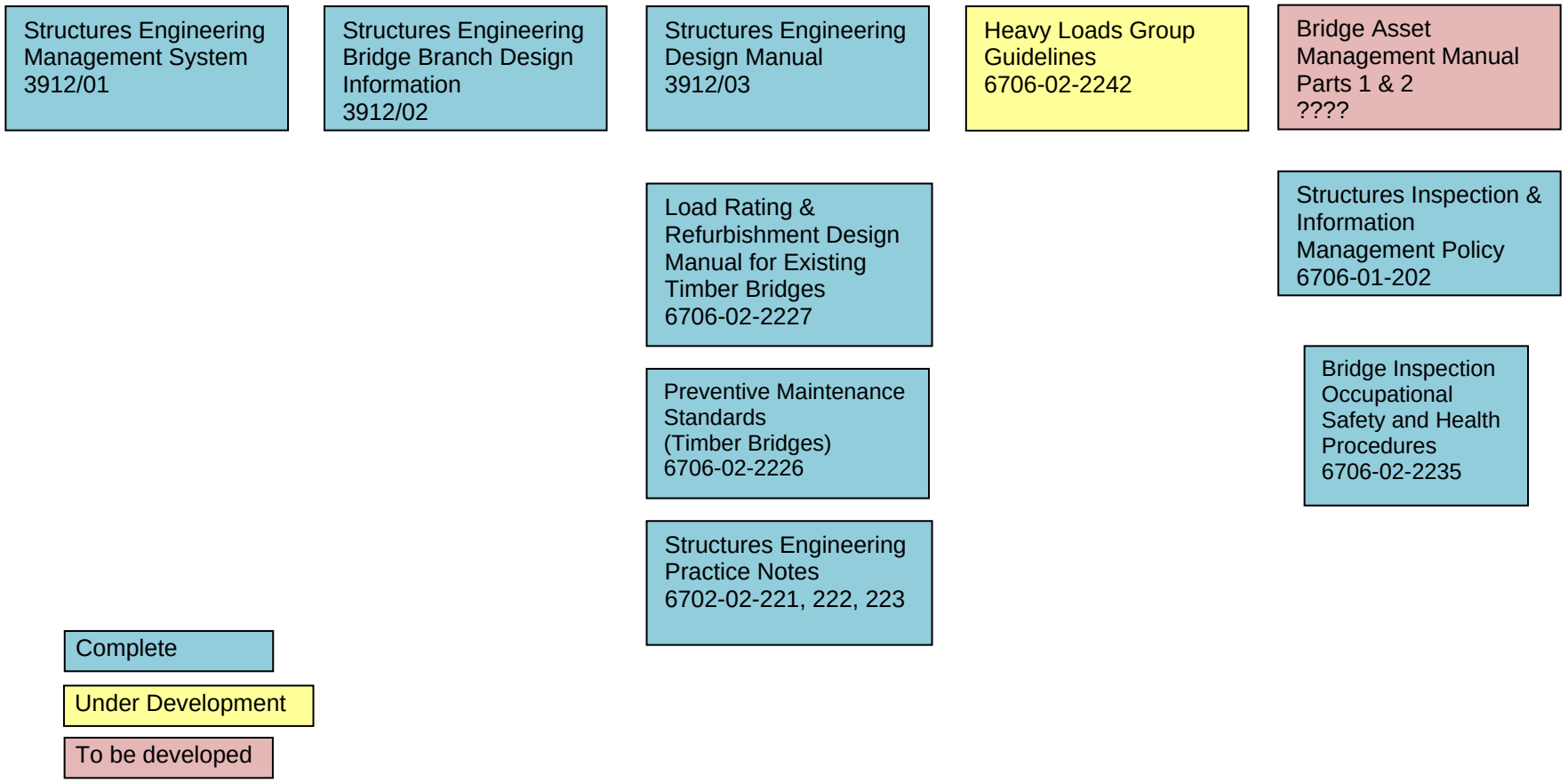
INTEGRATED ROAD INFORMATION SYSTEM (IRIS)


Network Manager
(State and Local Road Networks)
-Road Centreline Data
-Road Categories
Asset Inventory
-Signs/Lines Inventory
-Rail Crossing Inventory
-Road Configuration
-Culvert Inventory
-Wall Inventory
-Various point items such as parking bays, arrestor beds, bores plus many more
Accidents Manager
-Traffic Accident History Data
iris
Integrated Road Information System
Traffic Data
-Traffic Volumes
-Composition (Class)
-Culway Data
-Growth Rates
Road Condition Data
-Roughness
-Rutting
-Strength
-Texture
-Skid
Including visual record of road condition (Video)
Structures Manager
-Structures Inspection Data Entry System (SIDES)
-Bridge Inventory Information System (BIIS)

APPENDIX D

STRUCTURES ENGINEERING KEY MANUALS & BRIDGE ASSET MANAGEMENT DOCUMENT HIERARCHY

Structures Engineering – Key Manuals



Bridge Asset Management – Document Hierarchy