Office of Rail Regulation and Network Rail

Part A Reporter Mandate AO/007: Review Asset Policy, Stewardship and Management of Structures

Final Report – Review and Benchmarking

209830-07

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Contents

Appendices

1 Executive Summary

General

1.1.1 This report presents the findings from the review and benchmarking undertaken in response to Independent Reporter Mandate AO/007 'Review Asset Policy, Stewardship and Management of Structures'. The review has been undertaken by Arup in our role as Part A Independent Reporter.

1.1.2 A phased approach to the Mandate has been agreed and this report is our Final Report containing our detailed findings and recommendations. The recommendations will subsequently be developed into an Action Plan.

Purpose

1.1.3 The purpose of Mandate AO/007 was to work in collaboration with Network Rail (NR) and the Office of Rail Regulation (ORR) to develop an agreed and benchmarked view of NR's current position with respect to Civil Structures asset management processes and identify opportunities for improvement. The Mandate was drafted to complement previous work by AMCL[1], the Part B Independent Reporter for Asset Management, and specifically to focus on the technical aspects of managing Civil Structures. The Civil Structure categories included in the Mandate are comprised of bridges and culverts (including footbridges), retaining walls, tunnels, earthworks, coastal, estuarine and river defences. The Mandate asked us to focus on understanding NR's current management of Civil Structures and developing a plan for achieving best practice management of Civil Structures.

Approach

1.1.4 Our approach has been to follow the guidance set out in PAS 55[2], and to examine the key processes associated with NR's asset management of Civils Structures. This has been used as a means of assessing the degree of confidence in the current NR practice in the management of Civil Structures.

1.1.5 We have adopted a simplified asset management framework model which considers asset management in three broad stages namely: Policy and Strategy, Planning and Programming, and Definition and Delivery. These processes are central to the way an asset owning organisation decides:

a) what demands it has to serve and what outcomes are required;

b) how, where and in what to invest to meet those outcomes;

c) what assets are most critical, what risks need to be managed;

d) how investments and improvements will be delivered; and

e) how actual output performance will be demonstrated.

[1] Asset Management Consulting Limited
[2] BSI, 2008. PAS 55-1:2008 Asset Management – Part 1: Specification for the optimised management of physical assets. The Institute of Asset Management, British Standards Institute.

We have also considered the Enablers that support these core asset management processes and the Continual Improvement that is in place.

1.1.6 The asset management approach is seen as a way for asset intensive organisations to improve their effectiveness by promoting a clear 'line of sight' between the demands / outcomes that the asset owner has to deliver to customers, and the actions they are taking in terms of investments in their assets. This is important as the most significant opportunities for savings generally arise through improvements in effectiveness rather than simply improvements in efficiency and economy.

1.1.7 To reflect the collaborative nature of this review, our work has not involved a formal audit of NR systems and processes. We have however met and discussed systems and processes with a wide range of staff from NR and ORR. We have joined in over thirty meetings with NR/ORR staff at Headquarters and Route levels and we have spent two weeks with the Western Route Civils Team. In addition, we have researched a large number of external documents.

1.1.8 We have posed ourselves several key questions as a basis for our review:

Asset Processes

- *What is the evidence that an asset management approach is being adopted by NR?*

Asset Condition

- *What is the evidence that the volume of renewal and maintenance work is maintaining the value of the asset and preventing an inconspicuous decline?*

Asset Performance

- *What is the evidence that specific outcomes are being delivered effectively?*

Asset Risk

- *What is the evidence that risks (current and trajectory) associated with Civil Structures are understood, communicated and controlled?*

Key Conclusions and Recommendations

General

1.1.9 NR has a very extensive Civil Structures asset base to manage consisting of 35,127 underbridges and overbridges, 17,000 retaining walls, 14,186 km of earthworks, 327 km of tunnels and 300 km of coastal, estuarine and river defences. The quantity of assets is several times larger than that managed by the Highways Agency, for example. Primarily due to the age and level of historic investment, NR has a significantly lower percentage of assets in 'good' condition than most similar asset owners. NR is a company in

transition with a significant number of business changes being implemented associated with their Transformation Plan, many of which will have an effect on the management of Civil Structures. They have significant efficiency and economy targets to achieve to meet their Control Period 4 (CP4) obligations. We have found a strong drive centrally in NR to make changes rapidly. In the part of the organisation responsible for the day to day operation (Route level) we have found highly dedicated engineering staff focused on day-to-day activities associated with managing a complex legacy asset of Civil Structures. Much local practice is very good but this practice is not necessarily uniform across the Routes. To some extent the centrally driven transition is seen as a distraction to the day-to-day business of managing the assets. There is an opportunity to acquaint Routes of the purpose of change in a more effective manner. There is also considerable pressure on the Routes to attend to immediate urgent issues such as bridge strikes which take priority over longer-term asset management planning.

1.1.10 In terms of asset management, there is a very strong reliance on the engineering judgement of senior technical staff in the Routes and the CEFA[3] Contractor. Whilst this is not unusual with infrastructure operators, it does make it difficult to operate and then evaluate compliance in absolute terms. Asset data and asset systems (IT) available to the Routes are improving but currently do not fully support the current and changing business needs.

Asset Processes

1.1.11 NR is making significant progress towards a process led organisation, with well defined process maps for their Business Investment procedures. This is seen as a positive step. NR engineering standards, processes and procedures are currently fragmented and place a strong reliance on engineering judgement. Whilst this is not unusual with infrastructure operators, it does make it difficult to operate and then evaluate compliance in absolute terms. The move towards defining processes should support the reliance on engineering judgement and improve consistency of decision making. The detailed definition of such processes is vital before an Asset Information System purchase is made.

1.1.12 It is recommended that:

a) NR develops process maps for the management of Civil Structures to form part of an Asset Management Manual. The Manual and process maps would clearly:

   i) rationalise and simplify the suite of engineering standards, guidance, processes and procedures

   ii) articulate and improve the linkage between Central and Route Asset Management Teams;

   iii) articulate and improve the interaction between NR standards and guidance;

   iv) promote consistency of practice;

   v) allow improved audit and verification; and

[3] Civil Examination Framework Agreement

vi) provide a clear base-line for continuous improvement.

Asset Condition

1.1.13 Following recent events, such as Stewarton and Enterkin Burn, NR is making renewed effort to understand the nature, current condition and behaviour of their Civil Structures. However the sheer number of Civil Structures (for example there are over 35,000 bridges) makes this a significant task. NR holds extensive asset datasets held in various databases and are making significant progress in using this for developing RAMPs[4] for their 300 strategic route sections. It is our opinion that there needs to be improved focus on collecting the critical data that will allow effective management of each asset. This should also include data which demonstrates compliance with statutory and licence obligations.

1.1.14 It is recommended that:

a) NR more explicitly defines the critical elements of different types of Civil Structures and identifies suitable sub-groups such as different types of arch bridges, overconsolidated clay cuttings etc. based on their differences in engineering behaviour. The use of FMEA[5] and similar techniques should be considered by NR for this activity.

b) NR then collates existing asset information for these critical elements of Civil Structures and then jointly reviews and agrees with ORR the need for further inventory and condition data for the effective management of each asset sub-group. This work should be treated as a project with a specific full-time resource allocated.

c) Based on the outcome from the collation exercise, a specific asset knowledge gap filling project should be initiated to provide missing critical asset data.

d) NR should then consider obtaining this critical data more frequently and accurately to support deterioration modelling. Better integration of examination and assessment processes may assist in this respect.

e) NR should consider developing Asset Management Plans at an Operational Route level and at an Asset Specific Sub-Group Level. In our opinion, the RAMPs, whilst a good collation of existing diverse data, do not form a suitable asset management planning tool in themselves. The RAMPs should be complemented by asset specific plans which would include explicit technical lifecycle options which could be selected based on route priority and available funding. Lifecycle options would consider several asset policies such as:

i) do minimum;

ii) managed deterioration;

iii) lowest initial cost;

iv) lowest whole life cost;

v) enhancement; and

[4] Route Asset Management Plans
[5] Failure Mode and Effects Analysis

vi) heritage structures.

1.1.15 The lifecycle plans would consider preventive maintenance as well as renewal. The operational route asset planning would use collated RAMPs and select asset specific lifecycle options that suit the required performance requirements, for example certainty of delivery and available funding and safety.

Asset Performance

1.1.16 Our review has identified that the required performance (in terms of operation, safety etc.) from Civil Structures is not explicitly defined by ORR. Similarly we have not identified suitable NR explicit targets for the level of service required from Civil Structures or the certainty of delivery (risk tolerance) to be associated with such levels of service. In particular we have identified instances where the balance between safety and performance requirements could usefully be clarified. Having explicit linkages between strategic goals and objectives and asset management actions increases the likelihood that the right sort of work will be correctly identified in the first instance and then appropriately prioritised.

1.1.17 In terms of planning of renewal requirements, our meetings with NR have confirmed our initial view that the CECASE[6] modelling undertaken to date has very similar aims, objectives and approach to work being undertaken by the Highways Agency and London Underground Limited to estimate future medium / long-term renewal requirements for their civil engineering structures assets.

1.1.18 It is recommended that:

a) ORR with NR should consider including more explicit asset stewardship performance measures (in terms of operation, safety etc.) for Civil Structures in the Control Period 5 (CP5) Regulatory Targets. This is primarily to lend suitable importance to asset stewardship of Civil Structures.

b) ORR with NR should develop a more explicit definition of tolerable risk levels associated with each of the Civil Structures performance measures (operation, safety etc.) for the management of Civil Structures. Such a definition would assist NR in their development and prioritisation of a workbank for Civil Structures on a risk basis. Ideally for safety performance the tolerable risk levels would link directly back to a DfT[7] / HLOS[8] safety target / requirement.

c) NR should develop explicit level of service criteria at a sub-group level for Civil Structures.

d) NR should develop explicit guidance on prioritisation of maintenance and renewal activities for Civil Structures. This prioritisation should link back to the performance criteria discussed above.

e) ORR with NR should jointly develop a more robust set of performance indicators to support the effective management and stewardship of Civil

[6] Civil Engineering Cost and Strategy Evaluation
[7] Department for Transport
[8] High Level Output Statement

Structures. The indicators should cover those items within the management system that pose significant threat as well as areas with the greatest opportunity for improvement. Specific focus should be placed on indicators that can be directly related to asset condition, asset performance and the management of asset risk (operation, safety etc). In particular there should be an improved leading indicator for reporting on the condition of bridge structures.

f) Most infrastructure owners find estimation of future medium / long-term renewal requirements for Civil Structures to be a challenge. It is recommended that specific discussions with some of the key utility and infrastructure organisations about decision support tools and modelling should continue to be undertaken to benchmark and share experience in this area. It is recommended that ORR should be involved in such meetings and in reviewing the decision support tools and modelling as the work proceeds.

Asset Risk

1.1.19 In light of the above, our review has been unable to form an opinion as to the level of risk (current and trajectory) associated with the performance (operation, safety etc.) of Civil Structures. A better understanding of risk will require a number of the above identified actions to be undertaken. However in the immediate term it is recommended that:

a) NR develop and make available, internally and to ORR, an explicit workbank list based on technical need, unconstrained by funding availability, and how this relates to the CP4 workbank. This would assist the understanding of the current level of risk faced by the business before decisions are taken on financial resource allocation.

Enablers/ Continuous Improvement

1.1.20 NR specification NR/SP/CMT/017 sets out training, competence and assessment requirements for both earthworks and structures examiners. The specification sets out comprehensive competency requirements for specific posts in the examination regime which are generally assessed by the post holder's line manager. There are no explicit technical or professional qualifications in this specification or levels of experience required for any of the posts, including Structures Managers and Earthworks Examining Engineers. The current Tunnel Examination Code of Practice [9] requires Tunnel Examiners to be Chartered Civil Engineers, with experience in the examination and maintenance of tunnels.

1.1.21 The requirements for structures and earthworks examiners are less demanding than under previous standards, and also lower than current standards for Tunnel Examiners. We have not seen evidence which supports these changes and apparent anomalies.

1.1.22 We note that NR is undertaking significant collaborative research primarily focussed on current issues. Our review has also identified that the quantity of engineering resource available at operational route level for the asset

[9] Examination of Tunnels (NR/GN/CIV/026, Ref 230)

management of Civil Structures in relation to the number of assets appears to be significantly lower than in comparable organisations, such as the Highways Agency.

1.1.23 It is recommended that:

a) NR benchmark their resource levels for asset management planning and delivery against a number of other infrastructure operators and share their findings with ORR.

b) NR review their succession planning strategy for route level engineering support.

c) NR develop more formal knowledge sharing processes supported by simple tools.

d) NR undertake business process benchmarking with other infrastructure operators to help in defining their future needs in relation to asset management. This benchmarking should be led by the AM[10] route engineering team and supported by the IT function, so that the future information system fully supports the emerging business needs.

e) NR with ORR establish a broadly based Civil Structures Development Group to collaboratively consider the longer term strategy for risk management of Civil Structures. This would include foresighting, and similar, to explore possible future risks relating to Civil Structures. Such a forum would define future areas for research and development associated with Civil Structures and be a means of engagement with TSAG[11] and other research groups.

Acknowledgement

1.1.24 The Independent Reporter Team would like to thank both NR and ORR staff for their assistance with this study, for providing documents as requested and explaining the current procedures and future plans.

[10] Asset Management
[11] Technical Strategy Advisory Group

Glossary

AMCL	Asset Management Consulting Limited
AMEM	AMCL Asset Management Excellence Model ¬™
BCMI	Bridge Condition Marking Index (previously SCMI: Structure Condition Marking Index).
CARRS	Civil Asset Register and electronic Reporting System.
CECASE	Civil Engineering Cost And Strategy Evaluation
CEFA	Civil Examination Framework Agreement
CIRIA	Construction Industry Research and Information Association
CWBT	Constrained Workbank (Technical)
CP4	Control Period 4
DfT	Department for Transport
DST	Decision Support Tool
EM	Earthworks Manager
ESTEEM	'Engineering Strategy for Economic and Efficient Management tool' – LUL asset planning tool
FMEA	Failure Mode Effects Analysis
FP7	European Union's Seventh Framework Programme for Research and Technological Development.
GIS	Geographic Information System
GRIP	Guide to Railway Investment Projects
HLOS	High level Output Specification
ISBP	Interim Strategic Business Plan
LUL	London Underground Limited
NR	Network Rail
OPAS	Operational Property Asset System
ORR	Office of Rail Regulation
RSHI	Rock Slope Hazard Index
ROGS	Railways and Other Guided Transport Systems
RA	Route Availability
RSSB	Railway Safety and Standards Board
RUS	Route Utilisation Strategies
SCMI	Structures Construction Marking Index
SRM	Safety Risk Model
SSHI	Soil Slope Hazard Index
SSME	Senior Structure Maintenance Engineer
STAMP	Structure Asset Management Protocol
TCMI	Tunnel Condition Marking Index
TSR	Track Speed Restriction

2 Introduction

2.1.1 Arup have been appointed by the Office of Rail Regulation (ORR) and Network Rail (NR) as Independent Reporter to provide assurance as to the quality, accuracy and reliability of NR's data that is used to report performance to ORR, the Department for Transport (DfT) and the wider industry.

2.1.2 This report presents the findings from the review and benchmarking undertaken in response to Independent Reporter Mandate AO/007 Review of Asset Policy, Stewardship and Management of Structures (see Appendix A). The review has been undertaken by Arup in our role as Part A Independent Reporter.

2.1.3 A phased approach to the mandate has been agreed and this is our Final Report with our detailed findings and recommendations. The recommendations will subsequently be developed into an Action Plan.

2.1.4 To reflect the collaborative nature of this review, our work has not involved a formal audit of NR systems and processes. We have however met and discussed systems and processes with a wide range of staff from NR and ORR. We have joined in over thirty meetings with NR/ORR staff at Headquarters and Route levels and we have spent two weeks with the Western Route Team. In addition we have researched a large number of external documents.

2.1.5 Due to the limited duration of the review and pressures on NR route staff it was arranged by NR that we would spend the majority of time with Western and London North East (LNE) Routes. We have also met with some key staff from Scotland and London North West (LNW). Due to pre-existing pressures on NR staff within the Southern Route and the timing of our study it was agreed between NR and ORR that we would not meet with them. Accordingly the NR practice presented in this report is based on a limited sample.

2.1.6 The findings detailed herein represent our current understanding based on our work to date. The findings have been reviewed with NR and ORR following a submission in draft of this report.

3 Scope and Approach to Review

3.1 Purpose

3.1.1 The purpose of Mandate AO/007 is to work in collaboration with NR and ORR to develop an agreed and benchmarked view of NR's current position with respect to the Civil Structures asset management processes together with proposed opportunities for improvement. The Civil Structure categories included in the Mandate comprise of:

a) bridges and culverts (including footbridges)

b) retaining walls

c) tunnels

d) earthworks

e) coastal

f) estuarine, and

g) river defences.

3.1.2 The two primary purposes are to:

- *understand NR's current management of Civil Structures; and*
- *develop a plan for achieving best practice management of Civil Structures.*

3.2 Scope

3.2.1 The scope is to understand the totality of NR's policies for the management of structures from top to bottom, compare with relevant [asset management] good practice and comment on their effectiveness and fitness for purpose.

3.2.2 Specifically the collaborative review was to be undertaken to:

a) establish a coherent understanding of NR Civils end to end asset management process;

b) benchmark the current position against relevant good practice and comment on its fitness for purpose. Highlight any immediate opportunities for improvement;

c) define a quantitatively defined target future position for the management of civil assets during Control Period 4 (CP4), and CP5 and beyond, and define a route map, action plan, costs and benefits to move from the current to future positions;

d) provide supporting analysis which will support both ORR and NR to be well informed with respect to Periodic Review 13 (PR13) including ORR drafting of the reporting requirements; and

e) identify lowest whole life cost options to deliver performance and safety.

3.2.3 The review activity has specifically not sought to cover aspects already reviewed by Asset Management Consulting Limited (AMCL) in their role as Independent Reporter for Asset Management (AM).

3.3 Approach to Review

3.3.1 Our approach has been to examine the key processes associated with the asset management of Civils Structures. The aim has been to expose, observe and understand the key process attributes such as input, process and output (see Figure 3.1). This has been used as a means of assessing a degree of confidence levels in the current NR practice in the management of Civil Structures.

Figure 3.1: Simplified Process Model

3.3.2 We have adopted a simplified asset management framework model (see Figure 3.2) which broadly aligns with the model currently adopted by NR (Ref 027 and 041) (see Figure 3.3).

3.3.3 We have divided the overall processes into three broad stages namely: Policy and Strategy, Planning and Programming, and Definition and Delivery. We have also considered the Enablers that support these core asset management processes and Continuous Improvement that is in place.

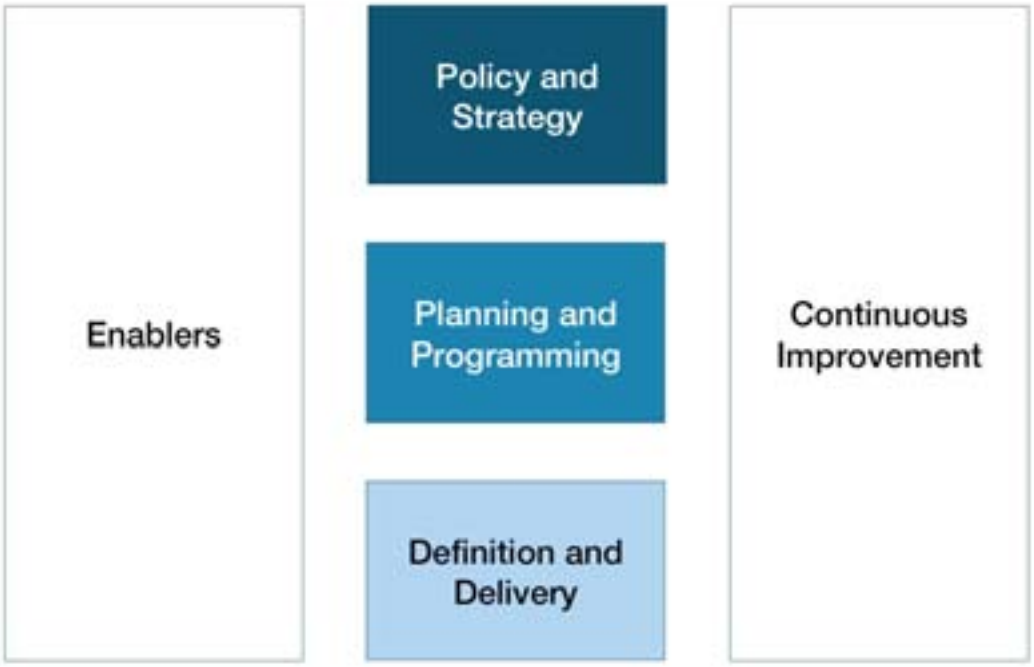


Figure 3.2: Simplified Asset Management Framework

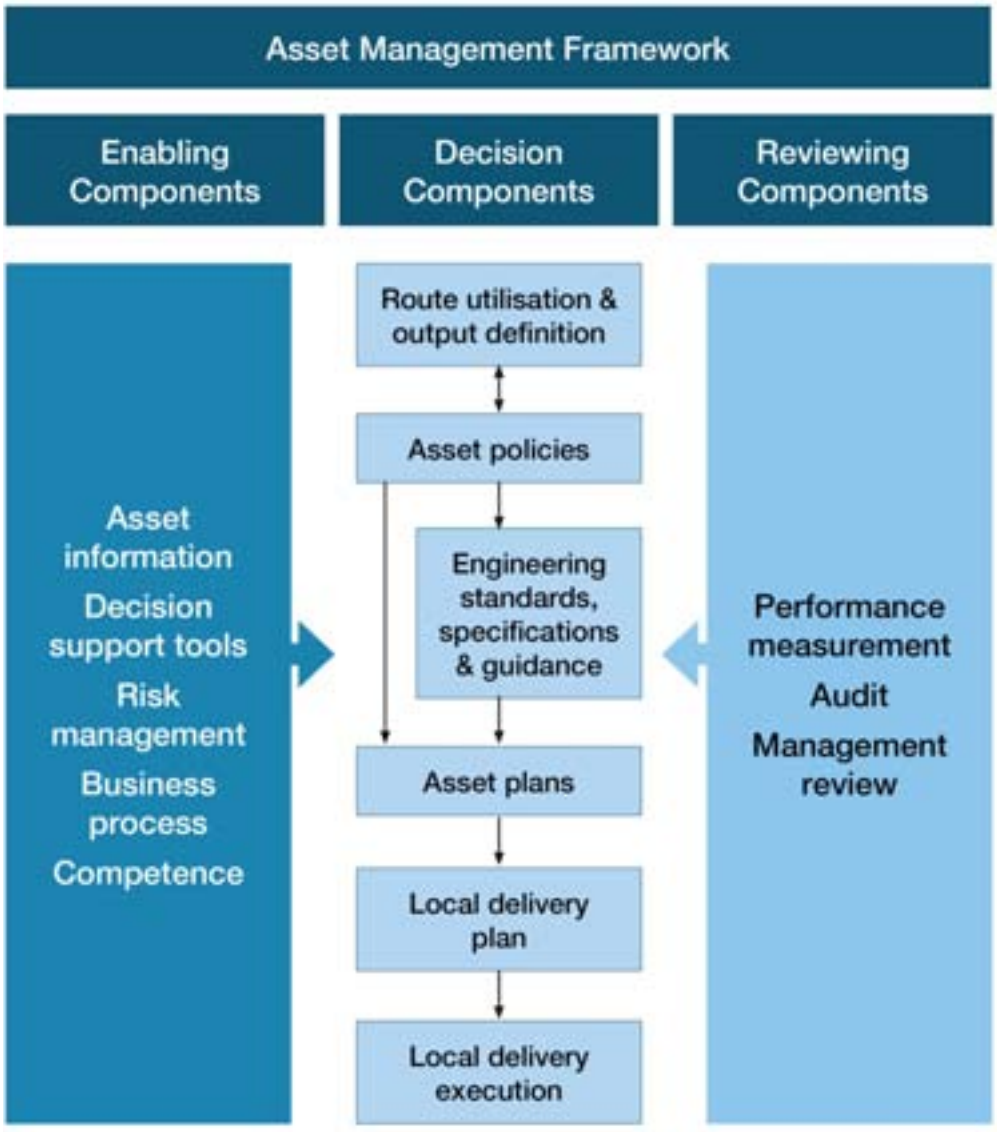


Figure 3.3: NR Asset Management Framework (Ref 041)

3.3.4 Particular focus has been placed on Planning and Programming, as this is the area where effective practice should be visible, and we have sought objective evidence that the right work is being identified, selected and financed. We have specifically explored the '*what is not being done'* side of the equation as well as *'what is being done'* as this is central to management of risk going forward.

3.3.5 Fundamentally the focus of our review has been on volume of work being undertaken and the way in which that work is selected and managed. We have not considered the level of funding or the cost of renewal and maintenance work. This is covered by other ongoing work by the Independent Reporter and others (for example DfT Rail Value for Money studies).

3.3.6 We have focused on the maintenance and renewal of Civil Structures from Policy and Strategy stages though Planning and Programming to a stage where a remit is issued to NR Investment Projects (IP) to deliver a scheme.

3.3.7 We have not reviewed delivery or implementation aspects, such as whether the selected renewal work is being delivered efficiently or to the required standards. This Definition and Delivery stage is defined in the NR Guide to Railway Investment Projects (GRIP) processes which are common to all NR project delivery.

3.3.8 We have considered all Civil Structure categories in our review, namely bridges and culverts (including footbridges), retaining walls, tunnels, earthworks, coastal, estuarine and river defences. However, we have applied different levels of review based on recent events, our opinion and the opinion of NR and ORR as to which categories potentially represent the most significant risks to the railway. On this basis, we have concentrated on the management of bridges and earthworks.

3.3.9 In addition to the Mandate, we have posed ourselves several overall questions related to a hierarchy of asset management maturity:

Asset Processes

- *What is the evidence that an asset management approach is being adopted by NR?*

Asset Condition

- *What is the evidence that the volume of renewal and maintenance work is maintaining the value of the asset and preventing an inconspicuous decline?*

Asset Performance

- *What is the evidence that specific outcomes are being delivered effectively?*

Asset Risk

- *What is the evidence that risks (current and trajectory) associated with Civil Structures are understood, communicated and managed?*

3.3.10 Our review has sought objective evidence on these as well as the specific aspects in the Mandate. Where we have identified opportunities for improvement and development, we have made recommendations for consideration by NR and ORR.

3.4 Structure of Report

3.4.1 Sections 4 to 9 of this 115 page report set out a summary of the key factual findings supported by observations, and summarise the main points identified by our review. Our text is based around the simplified asset management process model shown in Figure 3.2 above.

3.4.2 Section 10 summarises our recommendations arising out of the work. Recommendations have been given an indicative priority on a scale of 1 to 10 with 1 being the highest priority. The main text is supported by the following Appendices:

- Appendix A reproduces the full Mandate A0/007.
- Appendix B contains a glossary of terms and definitions.
- Appendix C provides a listing of key references we have used and is in three sections:
    i) Document Register
    ii) Standards
    iii) Bibliography
- Appendix D provides enlarged copies of selected figures.

4 Context

4.1 Introduction

4.1.1 This section presents a simplified description of NR Civil Structures assets to allow a basic comparison to be made with some other Civils Structures infrastructure owners.

4.1.2 NR Civil Structures assets are compared with Highways Agency[12] (HA) and Warwickshire County Council[13] (WCC) and Transport for London[14] (TfL) assets in Figures 4.1 to 4.3. All the information used is from public domain sources, typically published Asset Management Plans (AMPs).

4.1.3 We are aware of further more detailed information held by the HA that would be pertinent to this study and help provide a benchmark for NR to compare asset condition. We have formally approached the HA Asset Management Office but at the time of writing (February 2011), permission to refer to this data is awaited. ***[F4.1]***

4.2 Quantity and Condition of Assets

4.2.1 Figure 4.1 presents a tabulated comparison of the number of Civils Structures assets owned and managed by NR, HA, TfL and WCC.

4.2.2 Key points to note are:

- NR have 35,127 underbridges and overbridges compared with 8,250 (HA), 1,800 (TfL) and 1,059 (WCC).
- NR have 17,000 retaining walls compared with 700 (WCC).
- NR have 14,186 km of earthworks compared with 12,130 km (HA).

[12] National Audit Office (2009) 'Highways Agency – Contracting for Highways Maintenance' London October 2009
[13] Warwickshire County Council (2008) 'Warwickshire Local Transport Plan 2006, Transport Asset Management Plan', version 1.1 April 2008
[14] Transport for London (2007) ' Transport for London Highway Asset Management Plan (HAMP)', September 2007

Figure 4.1: Comparison of Civil Structures asset numbers between Infrastructure Owners (see Appendix D for enlarged figure)

Bridges

4.2.3 The HA, TfL and WCC adopt bridge condition rating systems not dissimilar to the Structures Condition Marking Index (SCMI) rating system used by NR. Figure 4.2 provides a broad comparison between the four infrastructure owners in terms of asset condition of their bridge structures.

4.2.4 Figure 4.2 indicates that that the majority of HA bridges are rated to be in 'good' condition and that the majority of NR bridges are in 'fair' condition.

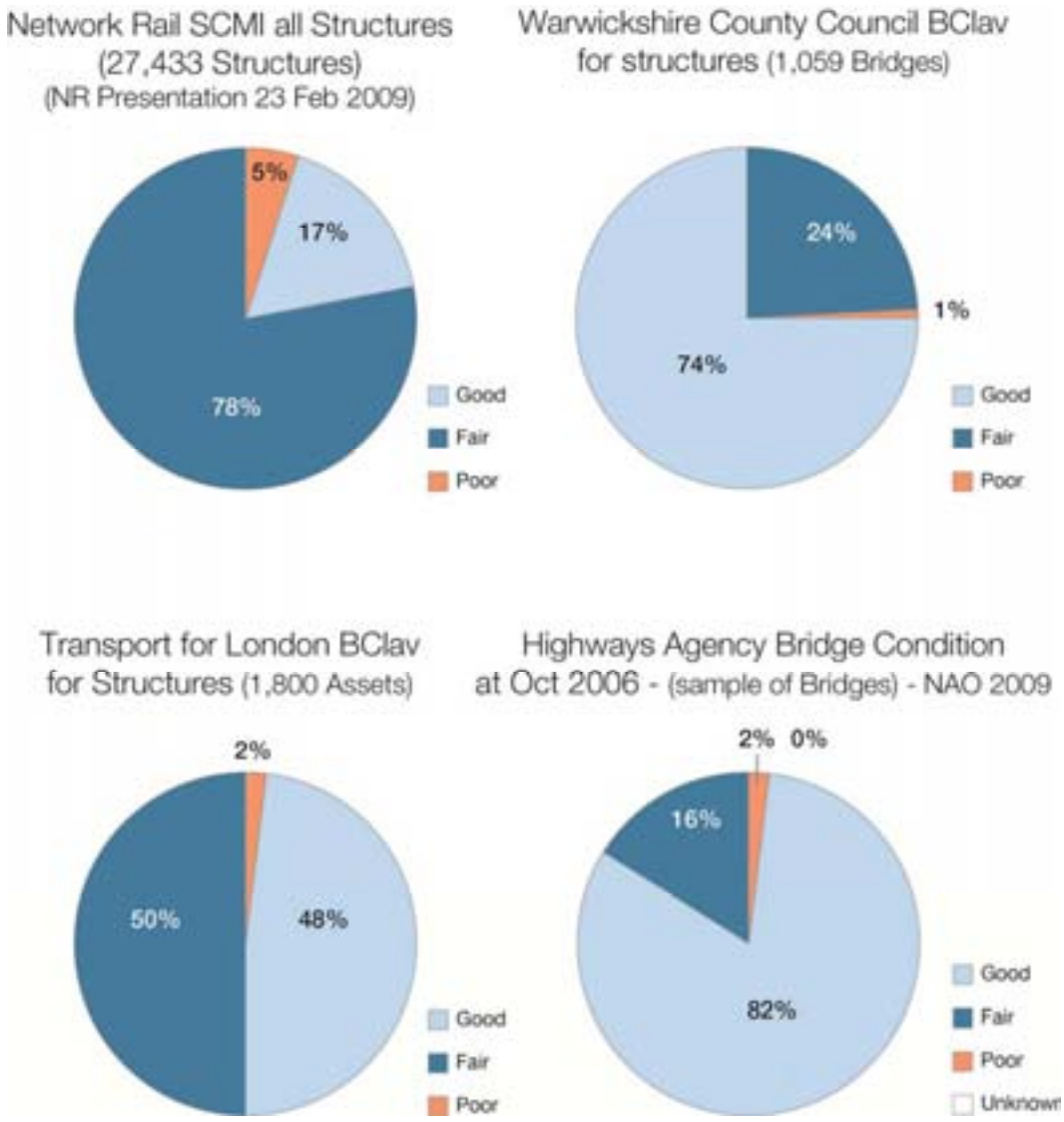


Figure 4.2: Comparison of Bridge Condition between Infrastructure Owners

Earthworks

4.2.5 The HA and NR have a similar total length of earthworks (12,130 km versus 14,186km). NR and the HA undertake broadly similar condition inspections of their earthworks, deriving condition scores. The HA then develop these condition scores into risk levels. To a first approximation, NR condition classification and HA risk classification of earthworks can be compared. This comparison is presented as Figure 4.3.

4.2.6 A breakdown of the percentage of the asset in each of the HA risk categories has not been made available, however it could be interpreted that NR currently has a significantly higher percentage of earthworks in the 'marginal' to 'poor' categories than the HA. To a large extent, this difference probably reflects the fact that the majority of the HA earthworks

are relatively recent and were designed to modern standards in contrast to the older NR earthworks. This is discussed in Section 6.8.

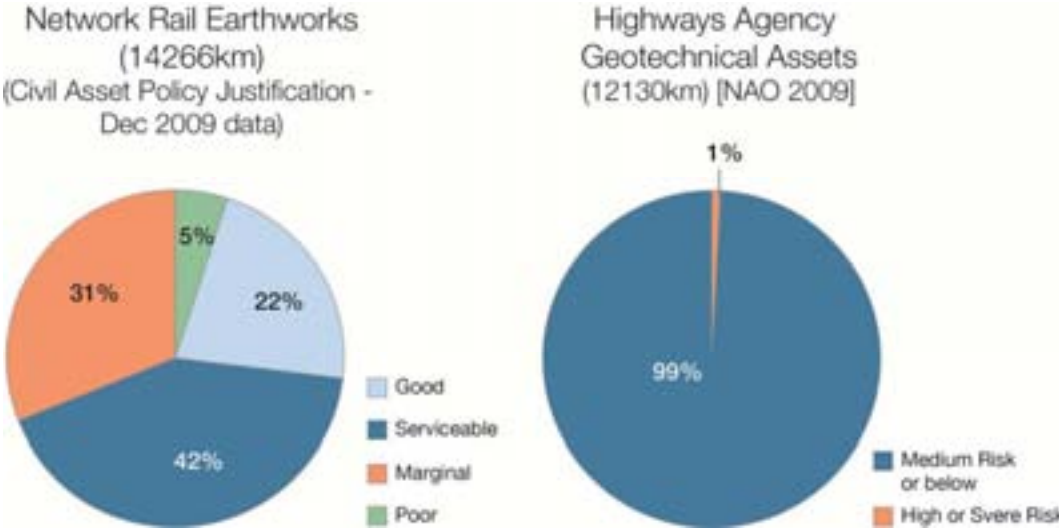


Figure 4.3: Comparison of Earthworks Condition / Risk between NR and HA

4.3 Current Expenditure

4.3.1 It is specifically not part of our Mandate to consider appropriate levels of funding for NR management of Civil Structures. However, we consider it is instructive to understand the CP4 planned level of spend on civils assets (NR Delivery Plan 2010 update) and broadly compare that with other infrastructure owners.

4.3.2 The CP4 Delivery Plan update 2010 (Ref 029) indicates that NR plans to spend between £300m and £389m per annum on Civil Structures renewals during CP4 (see Figure 4.4 below).

Appendix 13 CP4 civils expenditure

£m (2010/11 prices)	2009/10	2010/11	2011/12	2012/13	2013/14	CP4 total
Underbridges	135	123	143	148	153	702
Overbridges	17	27	14	16	11	85
Bridgeguard 3	19	7	9	6	2	44
Earthworks	108	99	92	85	86	470
Embankments	41	58	50	45	56	250
Other earthworks	67	42	42	39	30	220
Major structures	47	75	49	34	21	225
Tunnels	13	19	18	16	16	82
Other assets	21	22	24	23	5	94
Culverts	7	7	7	4	2	27
Footbridges	6	6	6	11	2	32
Coastal and estuarine defences	4	5	5	2	–	17
Retaining walls	4	3	6	5	1	18
Other	7	18	14	8	5	53
Total	368	389	363	335	300	1,755

Figure 4.4: Summary of NR planned renewals costs for Civil assets (from NR CP4 Delivery Plan 2010 update Ref 029)

Summary of estimated renewals costs (Civils) by Route (£m)

YEAR	ROUTE																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	Total
2010/11	11	12	14	17	1	2	36	77	17	19	18	36	10	12	3	70	15	370
2011/12	18	8	14	7	1	1	36	76	30	12	24	25	14	6	3	56	18	349
2012/13	13	14	9	5	4	7	29	51	11	11	18	50	14	20	1	50	20	327
2013/14	14	21	22	27	4	8	37	41	12	5	9	6	6	9	0	69	5	295
Total	56	55	59	56	10	18	138	245	70	47	69	117	44	47	7	245	58	1341

Figure 4.5: Summary of NR planned renewals costs for Civil assets by Strategic Route (Source: NR Route Plans 2010 e.g Route Plan G East Coast & North East - Figure 21 Summary of estimated renewals costs and activity volumes Ref 381)

4.3.3 Approximate figures for the HA[15,16] indicate that they expect to spend approximately £200m per annum on maintenance and renewals of their 17,000 structures and between £15m and £20m per annum on maintenance and renewals of their 12,100km earthworks asset.

4.3.4 WCC[17] had a budget of £2.7m for annual bridge maintenance in April 2008 for its 1059 bridges. The Warwickshire Transport Asset Management Plan notes: *'A widely accepted target figure for annual bridge maintenance is 1% of the gross replacement cost. In Warwickshire, this would equate to approximately £5m per annum compared to the current budget of £2.7m.'*

[15] Highways Agency presentation to Geotechnical Asset Owners Forum 15 Oct 2009
[16] Highways Agency presentation 'Highway Structures: Optimum Maintenance Strategies and Network Model Atkins dated 17 November 2008
[17] Warwickshire County Council (2008) 'Warwickshire Local Transport Plan 2006, Transport Asset Management Plan', version 1.1 April 2008

4.3.5 TfL[18] had a planned budget of £7.6 - £10m per annum in Sept 2007 for their five year forward works programme for their 1,800 structures including bridges, footbridges, retaining walls, subways, culverts and tunnels.

4.4 Further Work

No.	Further Work	Location in Text	Priority
Context			
F4.1	We are aware of further more detailed information held by the HA that would be pertinent to this study and help provide a benchmark for NR to compare asset condition. We have formally approached the HA Asset Management Office but at the time of writing (February 2011), permission to refer to this data is awaited.	4.1.3	

[18] Transport for London (2007) 'Transport for London Highway Asset Management Plan (HAMP)', September 2007 (Ref 283)

5 Policy and Strategy

5.1 Introduction

5.1.1 As noted in Section 3.3 we have divided the overall asset management process into three broad stages namely:

- Policy and Strategy;
- Planning and Programming and Performance Targets; and
- Definition and Delivery.

5.1.2 The text in this section relates to the Policy and Strategy stage (see Figure 5.1).

Figure 5.1 Simplified Asset Management Framework

5.1.3 This Section is divided into:

- Performance Management Hierarchy;
- Strategic Goals and Objectives;
- Levels of Service; and
- Asset Policy and Strategy.

5.1.4 Best practice and current practice are compared in each sub-section, with recommendations. Performance indicators for Civil Structures are discussed in a later part of the report (Section 9.6).

5.2 Overall Process

5.2.1 In the Policy and Strategy stage overall Strategic Goals and Objectives, defined by stakeholders and statutory requirements, are translated into levels of service. These levels of service and their associated Performance Targets provide a context for Planning and Programming for the management of the assets. A simplified process flow is represented below as Figure 5.2.

Figure 5.2: Simplified Process Model for Policy and Strategy

5.3 Performance Management Hierarchy

5.3.1 A key concept of good asset management is to have a clear performance hierarchy that links the service provided to the ultimate customer (e.g. rail users and other stakeholders including statutory compliance), the strategic goals, and the outcomes and outputs to be delivered by specific individual asset types. This is recognised in the AMCL Road Map (Ref 002 sections 1.2 and 1.7).

5.3.2 A typical performance hierarchy is shown below in Figure 5.3.

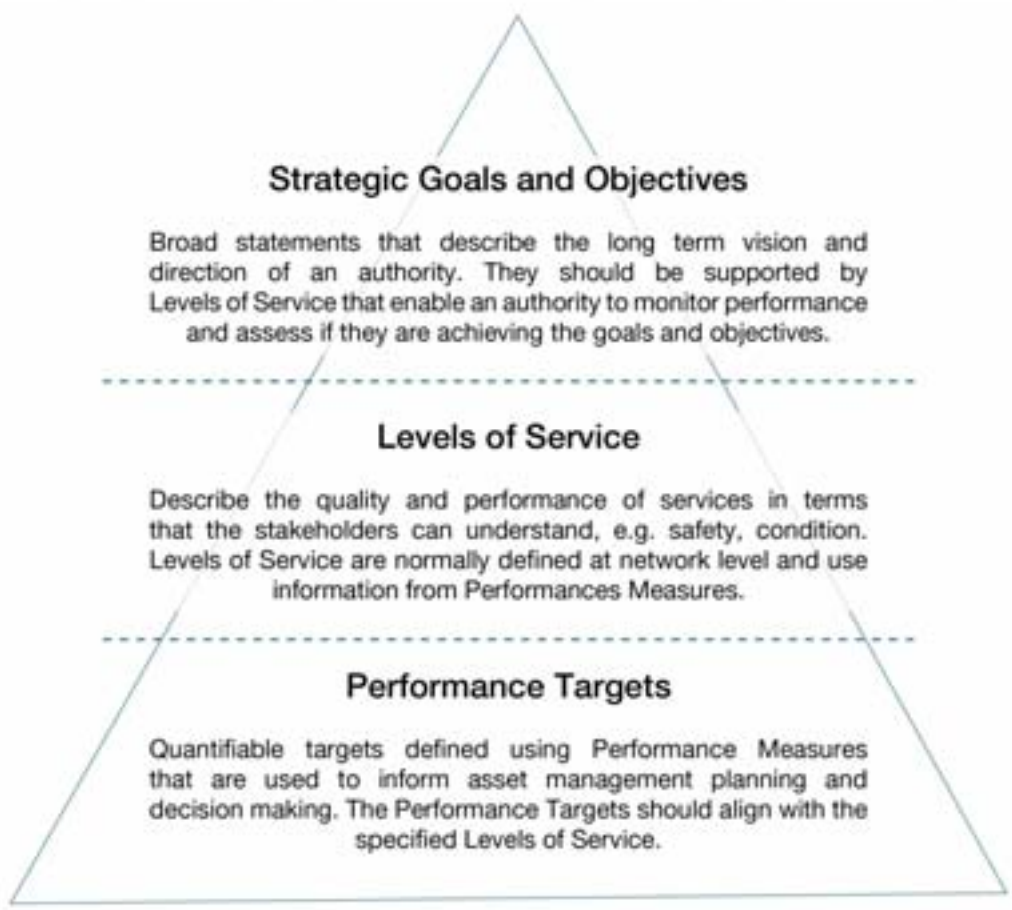


Figure 5.3: Performance Hierarchy (Source:- Roads Liaison Group[19])

5.4 Strategic Goals and Objectives

5.4.1 Strategic Goals and Objectives are broad statements that describe the long term vision and direction of an organisation.

5.4.2 By adopting general process improvement definitions, good asset management promotes performance improvement at three levels:

- Defining the right objectives (Effectiveness);
- Doing the right things at the right time to achieve those objectives (Efficiency); and
- Doing the right things the right way (Economy).

The relationship between economy, efficiency and effectiveness is shown in Figure 5.4 below.

[19] Roads Liaison Group 'Management of Highway Structures – A Code of Practice' September 2005 (Ref 379)

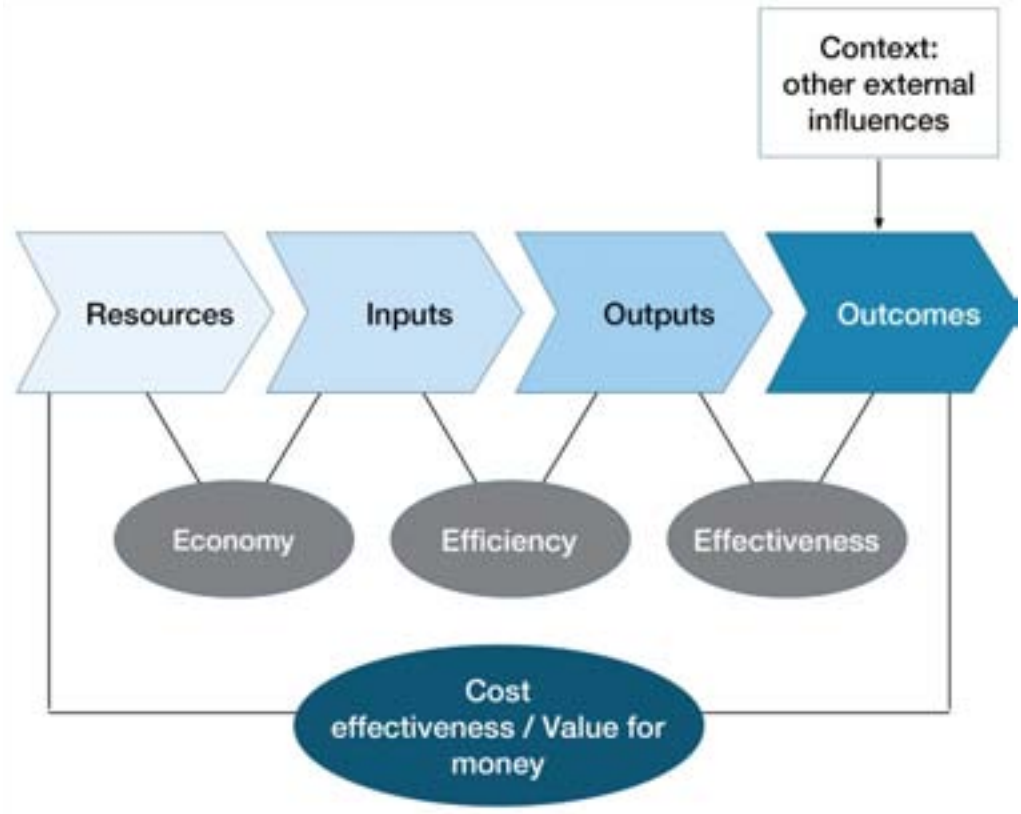


Figure 5.4: Economy, Efficiency, Effectiveness (source HM Treasury[20])

5.4.3 These three opportunities for improvement broadly relate to the three key asset management areas:

- *Policy and Strategy (≙ Effectiveness);*
- *Planning and Programming (≙ Efficiency); and*
- *Definition and Delivery (≙ Economy).*

5.4.4 The most significant opportunities for savings generally arise through improvements in effectiveness rather than simply improvements in efficiency and economy.

5.4.5 Explicit linkages between strategic goals and objectives and asset management actions increase the likelihood that the right sort of work will be correctly identified in the first instance, then appropriately prioritised into a workbank for delivery that will support achievement of the overall desired outcomes.

[20] HM Treasury and others (2001) 'Choosing the Right FABRIC – A Framework for Performance Information' HM Treasury, Cabinet Office, National Audit Office, Audit Commission, Office For National Statistics (Ref 411)

Current Practice

5.4.6 The overall high-level rail industry structure is shown in Figure 5.5 below and is succinctly explained by DfT[21] as follows:

5.4.7 "… for each five year Control Period the Government sets out its high level requirements of Network Rail and the rail industry (for example in terms of capacity, reliability and safety) in the High Level Output Specifications (HLOS), and the funding available. The ORR translates the HLOS into detailed Network Rail outputs and funding requirements through the periodic review process. The ORR monitors and enforces Network Rail's output requirements through the Network Licence."

5.4.8 NR has a general duty under Licence condition 1.2 to 'achieve the purpose in condition 1.1 to the greatest extent reasonably practicable', where condition 1.1 states:

> *"Purpose*
>
> *1.1 The purpose is to secure:*
>
> *a) the operation and maintenance of the network;*
>
> *b) the renewal and replacement of the network; and*
>
> *c) the improvement, enhancement and development of the network.*
>
> *in each case in accordance with best practice and in a timely, efficient and economical manner so as to satisfy the reasonable requirements of persons providing services relating to railways and funders, including potential providers or potential funders, in respect of:*
>
> *i) the quality and capability of the network; and*
>
> *ii) the facilitation of railway service performance in respect of services for the carriage of passengers and goods by railway operating on the network."*

5.4.9 This constitutes a broad duty on NR in relation to Asset Stewardship.

5.4.10 The DfT High Level Output Specification (HLOS) for CP4 (Ref 380) sets out the improvements in safety, reliability and capacity (the outcomes) that the Government wants to buy in the period to 2014. There are no explicit requirements in relation to Asset Stewardship. These required outcomes are accompanied by a Statement of Funds Available (SoFA) which was developed into a Determination for the Control Period. The Determination for CP4 amounted to a total for Civil Structures Renewals of £1,895 (pre-efficient figure at 2006-07 prices from Ref 413, Table 5.4) which we have equated to £1,802m (post efficient figure uplifted to 2010-11 prices) of which NR included £1,719m in their 2009 CP4 Delivery Plan subsequently amended to £1,755m in their CP4 Delivery Plan 2010 update.

[21] DfT/ORR Rail Value for Money Study – Scoping Study Report Version 1.1 dated 31 March 2010 (Ref 412)

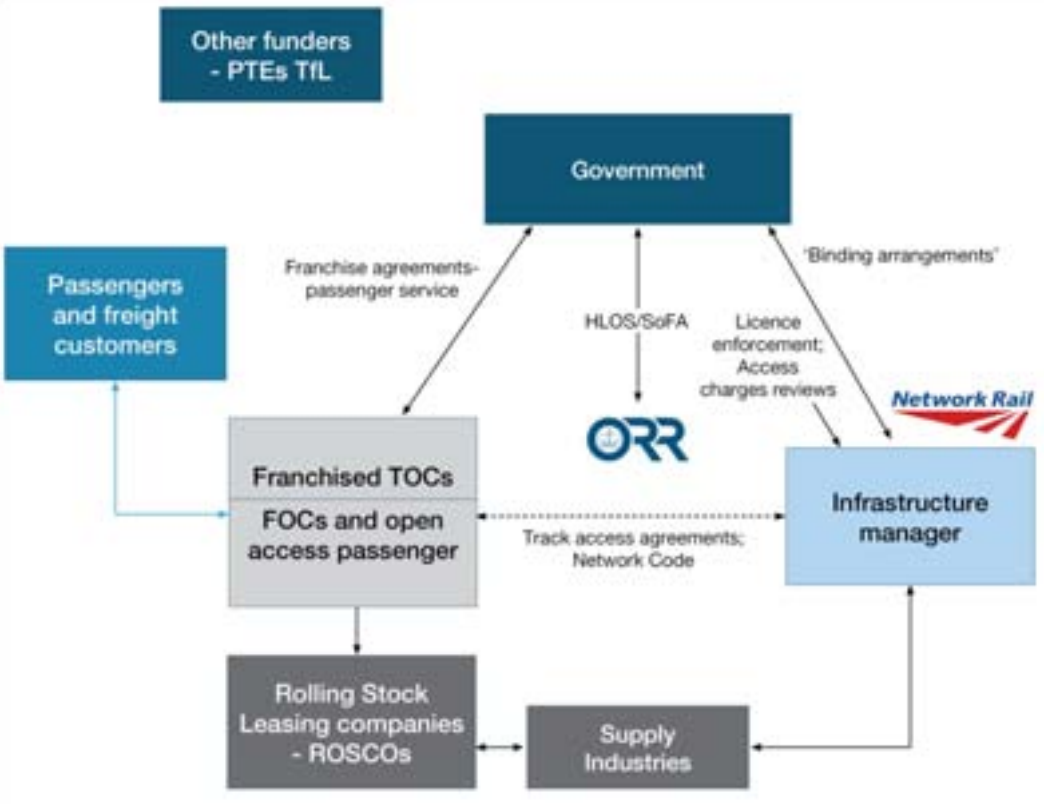


Figure 5.5: Source DfT/ ORR Rail Value for Money Study, (Ref 412)

5.4.11 NR has a statutory duty under the Health and Safety at Work Act (1974) to manage safety risks to a level as low as reasonably practicable (ALARP), that is that safety improvements should be implemented unless the costs are grossly disproportionate to the safety benefits. In addition the HLOS target for safety is based on the RSSB's Safety Risk Model (SRM) for which the specified target is:

'… to achieve a three per cent reduction over the control period in the risk of death or injury from accidents on the railway for passengers and rail workers. The measurement of this risk will be by reference to the Rail Safety and Standards Board's (RSSB) Safety Risk Model (SRM).'

5.4.12 Notwithstanding the fact that there are no explicit targets related to Civil Structures Asset Stewardship in the HLOS, an implicit requirement for the management of Civil Structures can be interpreted from the HLOS target for safety in that the contribution to safety risk from Civil Structures is explicitly measured in the RSSB SRM. This relationship and its potential application in the prioritisation or future work are discussed in Section 6.5.

5.4.13 The ORR Strategy[22] for 2009-14 provides further context to the DfT requirements (see Figure 5.6 below). Specifically this indicates a vision for a *'zero industry caused fatality'* target.

[22] ORR - Promoting safety and value in Britain's railways – Our Strategy for 2009-14

Figure 5.6: Source ORR Strategy for 2009-14 (Ref 012)

5.4.14 The ORR PR08 Determination Table 4.7 (Ref 413) sets out the principal asset condition monitoring measures and targets for 2009-2014. NR's CP4 Delivery Plan for CP4 (Ref 029) explains how these required outcomes are intended to be delivered by NR for t during the Control Period (2009-2014) for the PR08 funding level. The NR Delivery Plan targets are summarised in Figure 5.7 below.

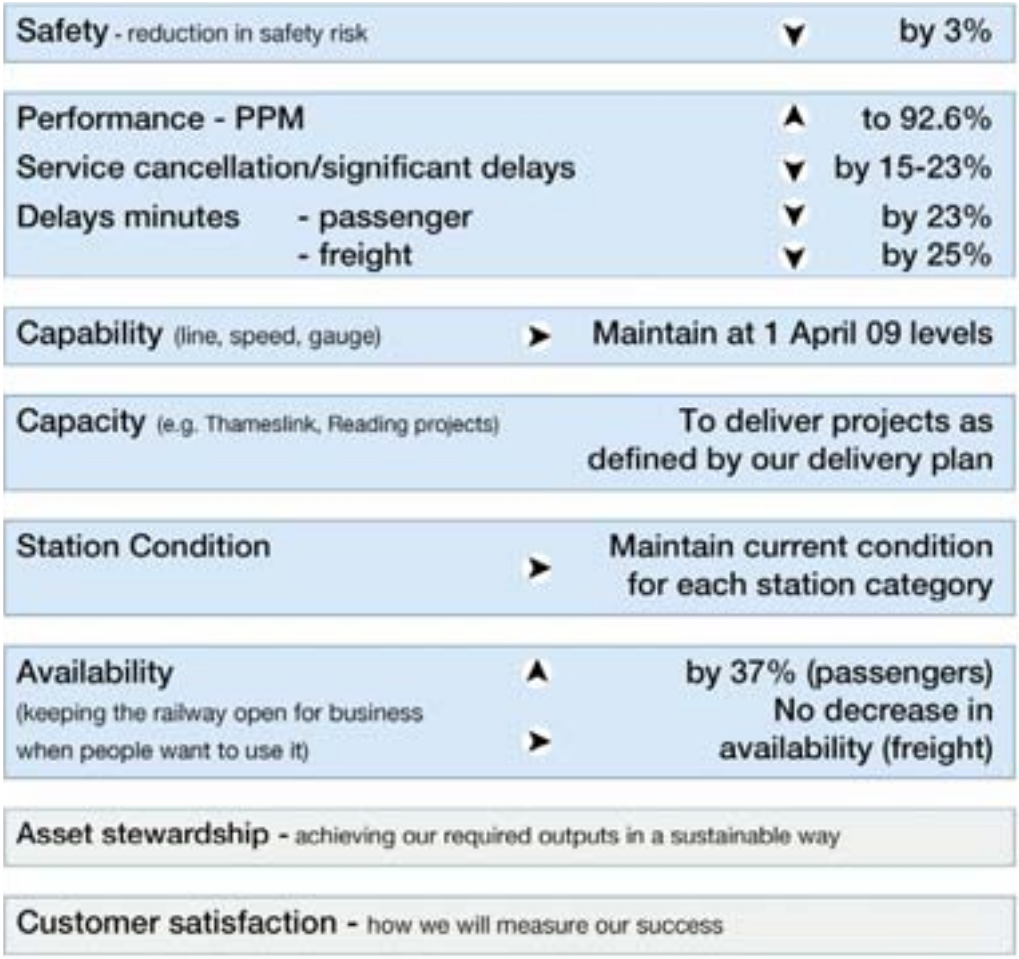


Figure 5.7: Transformation and The CP4 Challenge (Source:- NR B&C IP (incl. Transformation) presentation.[23] Ref 249, Slide 16)

5.4.15 The specific regulatory targets set by ORR for CP4 are reproduced in Figure 5.8 below.

5.4.16 The NR CP4 Delivery Plan (Ref 029, page 15) notes:

5.4.17 "Apart from two specific output measures for stations and depots, the condition and reliability of our (NR) infrastructure does not form part of the regulated outputs and we (NR) are not required to deliver a specified level of asset renewal activity…"

5.4.18 In CP3 ORR used the NR asset stewardship index (ASI) as a high level measure of how well NR was managing sustainable stewardship of the network.

5.4.19 For CP4 it is understood that ORR decided instead to focus on the individual elements that make up the measure and rather than setting regulated outputs for asset engineering, to encourage NR to set internal targets (Ref 088, ORR CP4 Monitoring Handbook). Both regulatory and internal targets are reported by NR in their Annual Return (e.g. 2009 Annual Return Ref 039).

[23] NR Building and Civils Improvement Programme (Ref 249)

Table 1: Performance against CP4 regulatory targets		
Measure	**Regulatory target 2009/10**	**Performance in 2009/10**
Passenger safety index (MAA)	0.248	0.215
Workforce fatalities and weighted injuries (MAA)	0.098	0.178
PPM (% MAA) England & Wales long distance	88.6	88.7
PPM (% MAA) England & Wales London & South East	91.5	91.5
PPM (% MAA) England & Wales Regional	90.5	92.5
PPM (% MAA) England & Wales Total	91.0	91.6
PPM (% MAA) Scotland Total (ScotRail)	90.9	90.6
Cancellations & significant lateness (% MAA) England & Wales long distance	4.9	4.6
Cancellations & significant lateness (% MAA) London & South East	2.3	2.5
Cancellations & significant lateness (% MAA) Regional	2.6	2.1
Delay mins - passenger (000's) England & Wales	6,270	6,152
Delay mins - passenger (000's) Scotland (ScotRail)	436	548
Delay mins per 100 train km - freight	3.68	4.02
PDI - passenger (MAA)	1.02	0.63
PDI - freight (MAA)	1.00	0.82
Station Stewardship Measure (by category)		
A	2.48	2.28
B	2.60	2.40
C	2.65	2.47
D	2.69	2.53
E	2.74	2.52
F	2.71	2.54
Scotland (all stations)	2.39	2.24
Network Capacity	Generally good progress - see Section 9 for progress with CP4 enhancement programme	
Network Capacity	See Section 2 on progress	

Figure 5.8: CP4 Regulatory Targets and Performance (Source: NR Ref 042)

5.4.20 In relation to Civil Structures, NR's key performance indicators explicitly include the indicators *'Main assets in good condition'*, measured via the ASI (see Figure 5.9 below).

5.4.21 The ASI overall stewardship measure is a weighted average of stewardship indicators for, track (40%), structures (10%), ops property (10%), signalling (25%), electrification and plant (E and P) (10%) and telecoms (5%) but it is based solely on *'Civils' assets subject to additional examinations (number)'*. (KPI 237 – Ref 102, Ref 090).

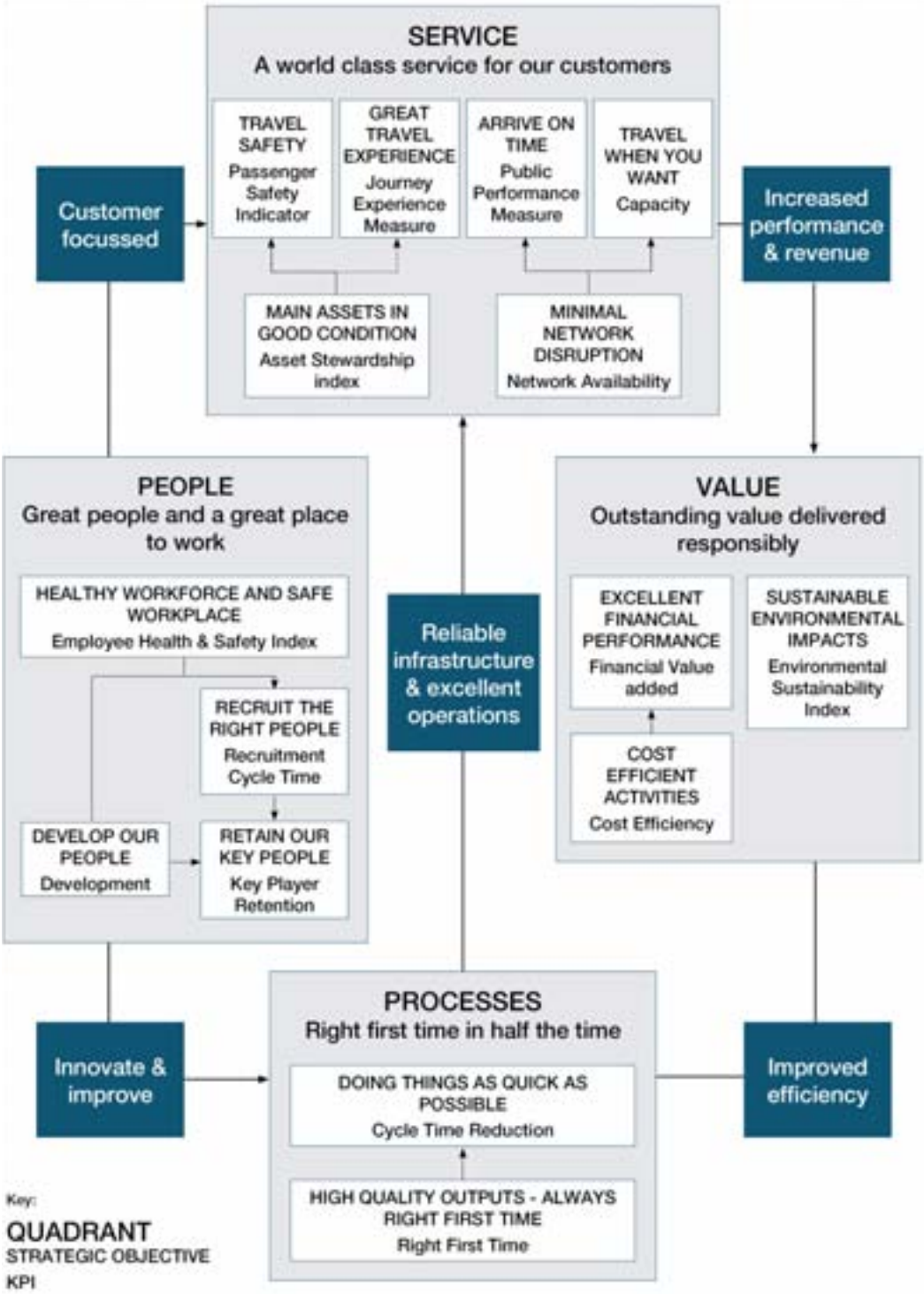


Figure 5.9: Network Rail's Key Performance Indicators (Source: - NR Delivery Plan 2009, Ref 029)

5.4.22 The NR Delivery Plan for CP4 (Ref 029) includes forecasts for two indicators of Civil Structures asset condition: '*Assets subject to special investigation or inspection'*, and '*TSRs* (Temporary Speed Restrictions) *imposed as a result of condition (severity index)*'.

5.4.23 A trajectory for the *'Asset Stewardship Indicator (Network)'* is also presented (see Figure 5.10 and 5.11 below).

Appendix 16 Condition forecasts for the network

	Control Period 3		Control Period 4			
Track						
	2008/9	2009/10	2010/11	2011/12	2012/03	2013/14
Good track geometry	135.3%	135.3%	135.3%	135.4%	135.5%	135.6%
Poor track geometry	2.63%	2.62%	2.58%	2.54%	2.50%	2.47%
Intervention/immediate action geometry faults per 100km	44.7	43.0	41.2	39.5	37.7	35.9
Rail breaks and immediate action defects per 100km	9.04	8.96	8.89	8.82	8.74	8.64
Civils						
Assets subject to special investigation or inspection	1,458	1,458	1,444	1,429	1,415	1,401
TSRs imposed as a result of condition (severity index)	113	113	112	111	110	108

Figure 5.10: Network Rail's Condition forecasts for the network (NR Delivery Plan 2009, Ref 029)

Appendix 17 Asset stewardship indicator (Network)

	2009/10	2010/11	2011/12	2012/03	2013/14
Track	0.012	0.025	0.039	0.053	0.067
Structures	0.000	0.010	0.020	0.031	0.045
Operational property	0.000	0.000	0.000	0.000	0.000
Signalling	0.069	0.085	0.099	0.113	0.122
Electrification and plant	0.061	0.081	0.097	0.112	0.128
Telecoms	0.000	0.013	0.036	0.056	0.068
Asset stewardship indicator	**0.026**	**0.039**	**0.051**	**0.063**	**0.075**

Figure 5.11: Network Rail's Asset Stewardship Indicator (NR Delivery Plan 2009, Ref 029)

5.4.24 With targets there is always an element of *'what gets measured gets done …'* and we believe that the ORR should consider including more explicit asset stewardship performance measures (in terms of operation, safety etc.) for Civil Structures in the CP5 Regulatory Targets to confer suitable importance to asset stewardship of Civil Structures. These measures would be supported by a balanced set of performance indicators to assist NR in their management of the assets. The performance indicators would be derived from effective business information systems that would allow the easy derivation of current performance. This is discussed further in Section 9.6 ***[R5.1]***

5.5 Levels of Service and Performance Targets

5.5.1 Levels of service provide the linkage between strategic goals and asset management actions. Levels of service can be defined as: "*A statement of the performance of the asset in terms that the stakeholder can understand. They cover the condition of the asset and non-condition related demand aspirations, i.e. a representation of how the asset is performing in terms of both delivering the service to the stakeholder and maintaining its physical integrity at an appropriate level. Levels of Service typically cover condition, availability, accessibility, capacity, amenity, safety, environmental impact and social equity*." (Ref 379, Roads Liaison Group – Management of Highway Structures).

5.5.2 Levels of service are supported by performance targets which are quantifiable measures that are used to inform asset management planning and decision making (see Figure 5.3).

5.5.3 In times of austerity, interest in asset management tends to increase with it being seen as a means of improving the effectiveness of expenditure as well as simply efficiency and economy. This focus on effectiveness leads to a consideration of the functionality of the asset or '*what service the asset is there to provide'*.

5.5.4 Asset management is often characterised as balancing level of service with available funding. However, the third factor to be balanced is risk.

5.5.5 In this context, risk relates to the uncertainty around achievement of each of the level of service objectives, and each level of service objective (such as safety) will have an associated tolerability criteria. Risk can also be expressed as the confidence that a level of service objective will be met all the time.

5.5.6 Asset management principles suggest that the focus should be on achieving the best value compromise between the conflicting factors of level of service, cost of service and risk to service. The conflicting factors are shown diagrammatically on Figure 5.12 below.

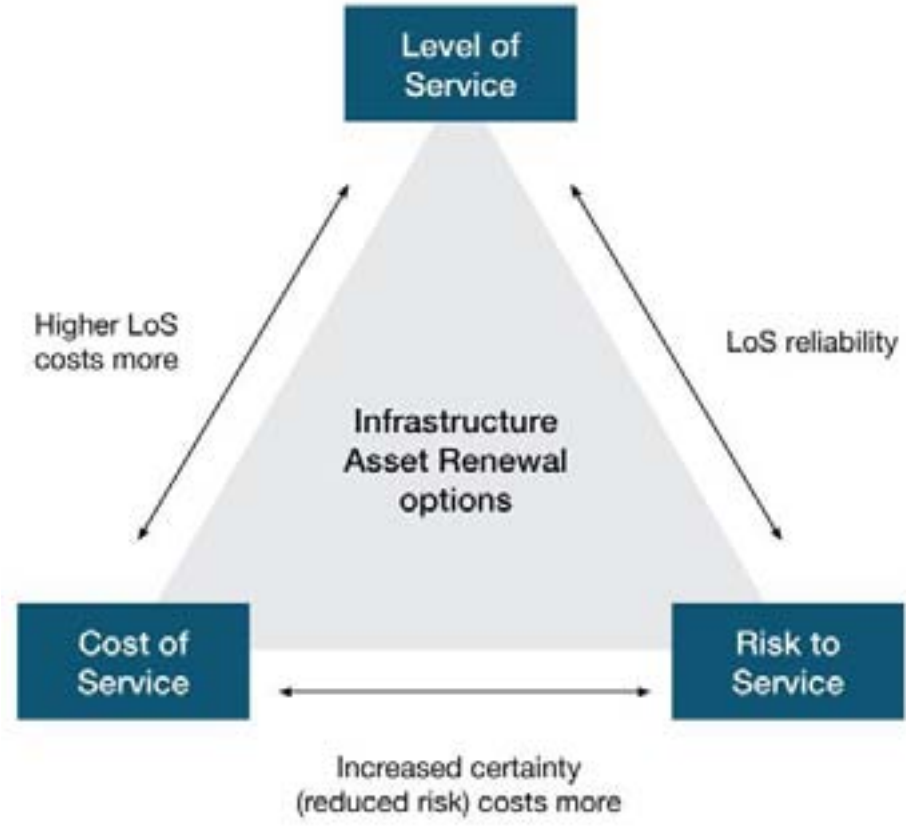


Figure 5.12: Conflicting Factors in Asset Management (After Woodhouse[24])

5.5.7 Different functions / objectives will have different levels of uncertainty of delivery that can be tolerated and a more reliable (reduced risk) service is likely to be more costly than a service which is less reliable.

5.5.8 We recommend that ORR with NR should develop a more explicit definition of tolerable risk levels for the management of Civil Structures. Such a definition would assist NR in their development and prioritisation of a workbank for Civil Structures on a risk basis. Ideally the tolerable risk levels would link directly back to a DfT HLOS safety target. There is also an opportunity to link safety risk into the revised Civil Asset Intervention Policies currently being developed by NR. ***[R5.2]***

Good Practice

5.5.9 Typically levels of service will include asset measures such as safety, performance and value. The level of service criteria will have a relative weighting and each will have an associated confidence of delivery that can be tolerated. For example, criteria adopted by Surrey County Council (SCC)[25] are:

[24] Woodhouse (2005) 'Decision-support: technology and people in solving problems and making better Asset Management decisions' Paper to ERTC conference, Berlin, March 2005.
[25] UK Roads Board 'Highway Asset Management Quick Start Guidance Note – Lifecycle Planning' April 2009

5.5.10 The high level targets for the stock of highway structures are as follows:

- *Reduce the backlog of maintenance work on highway structures*
- *Improve the overall condition of the stock of highway structures*
- *All bridges should be capable of carrying 40 tonne vehicles (unless specifically determined otherwise by local committee)*

5.5.11 Specific quantifiable performance targets are as follows:

- *Reduce the backlog of maintenance work from £4million to £2million by 2010*
- *Improve the Condition Performance Indicator score from 88 to 92 by 2010*
- *Strengthen all SCC owned sub-standard structures by 2012*

5.5.12 An additional level of service performance measure also used by many infrastructure owners is asset value. This is usually linked to a requirement to *'maintain steady state'* or similar for the overall asset stock. Further guidance is given in a number of publications by the County Surveyors Society[26] and (Ref 379). Valuation is generally based on modern equivalent asset when the asset is technologically obsolete and likely to be replaced with a modern equivalent.

Current Practice

5.5.13 The NR Civil Engineering Policy (Ref 023) recognises that civil engineering assets contribute directly to the agreed suite of outputs for CP4, in terms of:

- *Safety;*
- *Performance;*
- *Capability;*
- *Availability;*
- *Maintained performance; and*
- *Investment that contributes towards the sustainability of the Network.*

5.5.14 Specifically the Policy notes (ref 023) that civils assets contribute towards these objectives as follows:

- *PERFORMANCE - sustained level of performance by the control of temporary speed restrictions, allowing the timetable to be delivered.*
- *CAPABILITY - maintained performance of the network by ensuring that assets have load carrying capacity which is at least equal to the heaviest load permitted to travel on each route at 2001, or the published route availability, whichever is the greater, or otherwise subject to network change.*
- *SUSTAINABILITY - extension of the useful life of assets by the use of whole life evaluation and the implementation of cost-effective*

[26] Guidance Document for Highway Infrastructure Asset Valuation, County Surveyors Society, The Stationery Office, July 2005.

maintenance strategies. Renewal of assets is undertaken only when it is proven to have whole life cost benefits. Our approach to whole life stewardship evolves through continuous improvement on the basis of new / better asset knowledge.

- *AVAILABILITY - avoidance of unplanned performance interruptions through loss of functionality or unacceptable risk levels by using a 'predict and prevent' approach to examinations and work specification which will enable work to be implemented before performance restrictions or interruptions occur.*
- *SAFETY - reduction in the instances of unplanned performance and safety incidents involving hazards that arise from outside of the railway boundary, this includes road vehicle incursion, bridge strike and flood water.*

5.5.15 As part of our review we have held a number of meetings with NR and Mouchel (developers of CECASE) to discuss possible future direction for the longer-term asset management planning for Civil Structures. A key aspect discussed in the meetings has been the overall 'level of service performance measures' to be delivered for Civil Structures. These 'level of service performance measures' are a key requirement for the Planning and Programming process as they provide the 'success criteria' that will need to be delivered.

5.5.16 We have not seen these high-level statements translated into specific levels of service / performance targets similar to those adopted by SCC and others. Accordingly our view is that there is an opportunity to more clearly define the success criteria for the asset stewardship and management of Civil Structures (e.g. level of service objectives, relative weightings between criteria) between ORR and NR. These level of service criteria should be derived from and be consistent with the Strategic Goals and Objectives set for CP5. ***[R5.3]***

5.6 Asset Policy and Strategy

5.6.1 PAS55-1 (Ref 384) defines:

- Asset Management Policy as *'principles and mandated requirements derived from, and consistent with, the organisational strategic plan, providing a framework for the development and implementation of the asset management strategy and the setting of the asset management objectives'.*
- Asset Management Strategy as *'long-term optimized approach to management of the assets, derived from, and consistent with, the organisational strategic plan and the asset management policy'.*

5.6.2 NR AM Policy document v4 (Ref 382) sets out the relationship between their asset management documentation, shown in Figure 5.13.

5.6.3 The NR AM Policy document and Asset Management Strategy (Ref 383) follow PAS55 requirements and provide a general high-level view as to how NR intends to approach AM. Both documents are in draft form and are clearly work in progress.

5.6.4 The Policy mentions a System, Process and Monitoring document which identifies how compliance with BSI PAS 55 is achieved. A competency framework is indicated in this diagram which has not been seen.

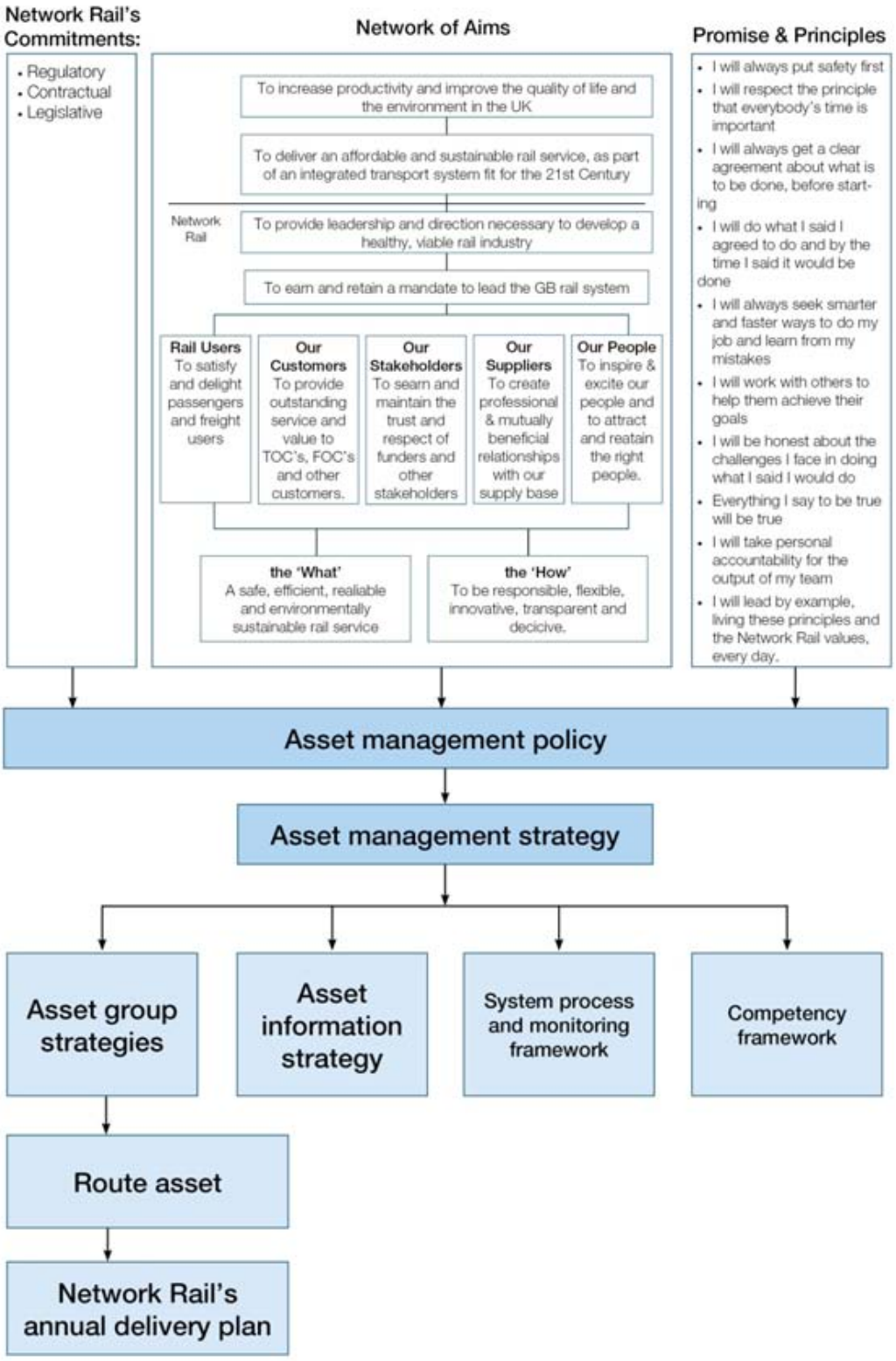


Figure 5.13: NR Asset Management Document Hierarchy (Ref 358), also located in Appendix D.

5.6.5 There is some confusion in the documentation about asset policies. It is understood that asset policies, such as the Civil Engineering Policy / asset management policy for civil engineering assets dated March 2010, is now to be referred to as an Asset Group Strategy (see Figure 5.13 above).

5.6.6 The NR Asset Management Strategy does not explicitly explain the relationship of the strategy to the NR strategic goals and objectives, key performance indicators and similar aspects. This makes it difficult to understand how the overall strategy aligns with delivery of these and should be taken into account in the management of Civil Structures.

It is recommended that the connection between the NR high-level Asset Management Policy and the Asset Management Strategy and tactical management of the Civil Structures asset is defined more fully in future revisions of the documents. ***[R5.4]***

Summary

5.6.7 In summary :

a) The DfT HLOS has no direct requirements relating to asset stewardship.

b) NR has a broad general duty in relation to Asset Stewardship its Licence but no specific requirements

c) The only asset condition monitoring measures for NR Civil Structures included in the CP4 Determination (Ref 413, Table 4.7) are :

   i) 'Civils assets subject to (special) examination (number)'; and

   ii) 'TSRs imposed (severity index)'.

d) Plus measures that NR can define themselves in their CP4 Delivery Plan for:

   i) 'No. of TSRs applied to structures in poor condition'; and

   ii) 'Asset volume renewal measures'.

e) NR do not have explicit levels of service for Civil Structures.

5.6.8 NR Key Performance Indicators include:

a) Asset Stewardship Index (KPI 237).

Recommendations

No.	Recommendation	Location in Text	Priority
Policy and Strategy			
R5.1	With targets there is always an element of *'what gets measured gets done …'* and we believe that the ORR should consider including more explicit asset stewardship performance measures (in terms of operation, safety etc.) for Civil Structures in the CP5 Regulatory Targets to confer suitable importance to asset stewardship of	5.4.24	2

No.	Recommendation	Location in Text	Priority
	Civil Structures. These measures would be supported by a balanced set of performance indicators to assist NR in their management of the assets. The performance indicators would be derived from effective business information systems that would allow the easy derivation of current performance. This is discussed further in Section 9.6.		
R5.2	We recommend that ORR with NR should develop a more explicit definition of tolerable risk levels for the management of Civil Structures. Such a definition would assist NR in their development and prioritisation of a workbank for Civil Structures on a risk basis. Ideally the tolerable risk levels would link directly back to a DfT HLOS safety target. There is also an opportunity to link safety risk into the revised Civil Asset Intervention Policies currently being developed by NR.	5.5.8	2
R5.3	We have not seen these high-level statements translated into specific levels of service / performance targets similar to those adopted by SCC and others. Accordingly our view is that there is an opportunity to more clearly define the success criteria for the asset stewardship and management of Civil Structures (e.g. level of service objectives, relative weightings between criteria) between ORR and NR. These level of service criteria should be derived from and be consistent with the Strategic Goals and Objectives set for CP5.	5.5.16	3
R5.4	The NR Asset Management Strategy does not explicitly explain the relationship of the Strategy to the NR Strategic Goals / Objectives and key performance indicators, and similar. This makes it difficult to understand how the overall strategy aligns with delivery of these and should be taken into account in the management of Civil Structures. It is recommended that the connection between the NR high-level AM Policy and AM Strategy and tactical management of the Civil Structures asset is defined more fully in future revisions of the documents	5.6.6	3

6 Planning and Programming

6.1 Introduction

6.1.1 This section is divided into:

- Performance Gaps;
- Group of Assets;
- Asset Intervention Policies;
- Lifecycle Planning;
- Workbank Development;
- Prioritisation/Value Management; and
- Asset Management Plans.

6.1.2 Good practice and current practice are compared in each sub-section, and recommendations are made.

6.2 Overall Process

6.2.1 In the Planning and Programming stage, levels of service and target asset performance should be compared with current asset performance to identify gaps and produce a workbank. Ways of resolving these asset performance gaps are then considered against available funding and priorities. A financially constrained workbank is developed ready for delivery of asset maintenance and renewal (in the short-term) and to inform future longer term funding requirements.

Figure 6.1: Simplified Process Model for Planning and Programming

6.3 Performance Gaps

Good Practice

6.3.1 The purpose of this step is to determine the current performance of the assets such that the performance of groups or sub-groups of assets can be compared with the required performance set in the Policy and Strategy process.

Current Practice

6.3.2 As noted in section 5.5, we have not seen specific levels of service / performance targets for groups or sub-groups of NR assets. This makes it difficult to explicitly identify clear performance gaps and target subsequent actions.

6.4 Grouping of Assets

Good Practice

6.4.1 The stock of assets should be divided into groups and sub-groups that have similar characteristics, e.g. structural form, material, maintenance needs etc. These asset groups and sub-groups are then used throughout the asset management planning process make to the process manageable.

6.4.2 The number of different sub-groups should reflect the key differences in behaviour of different types of Civil Structures. This is to allow lifecycle planning at a level of 'sub-group' (e.g. clay cuttings, metallic bridges, unlined tunnels etc.). A typical schema for asset classification (Ref 379) is shown in Figure 6.2 below.

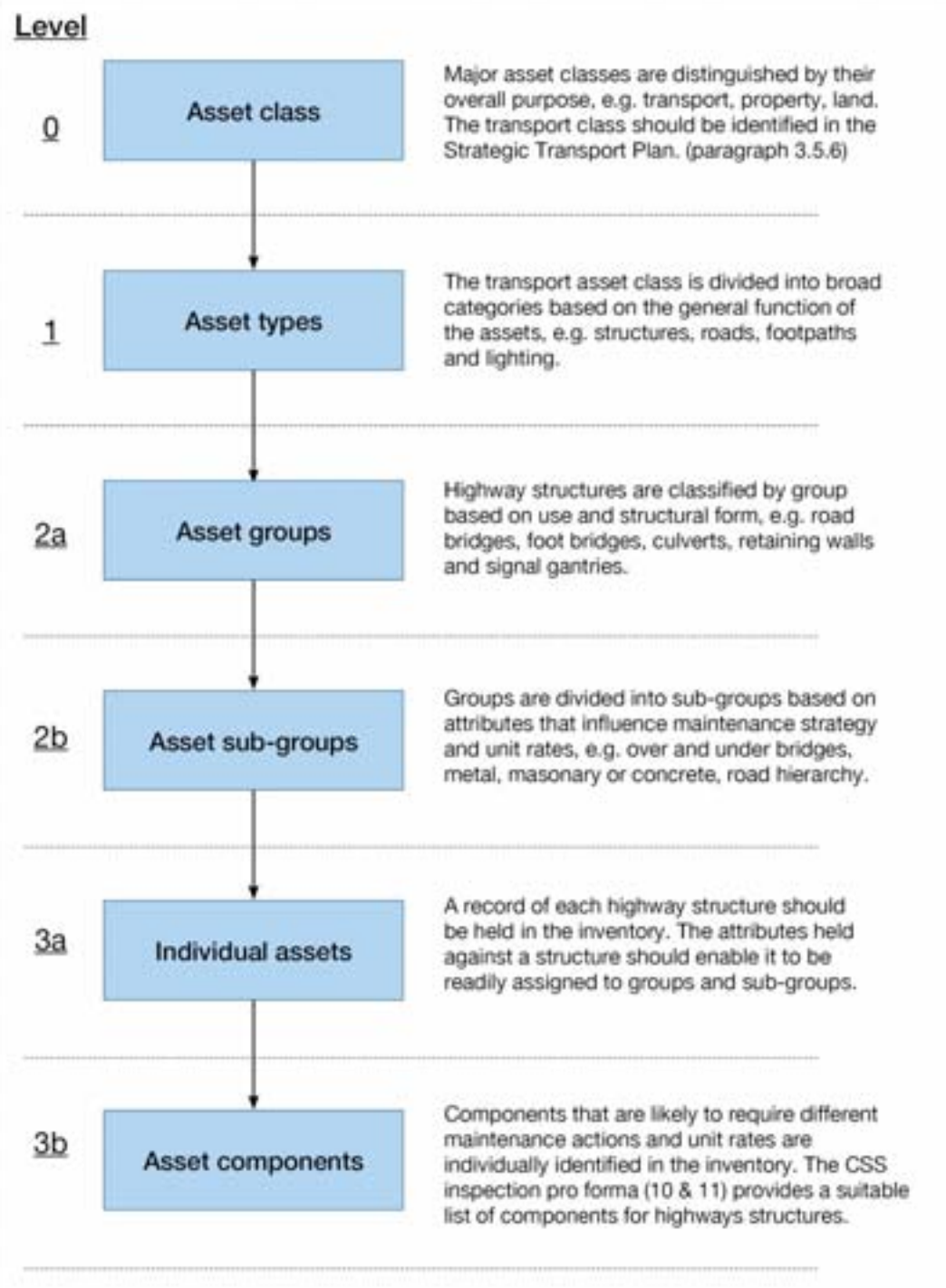


Figure 6.2: General schema for asset classification (Source:- Roads Liaison Group (Ref 379))

Current Practice

6.4.3 The NR CECASE work undertaken to support CP4 planning adopted specific sub-groupings of Civil Structures related to behaviour. However, we have not seen the same or similar sub-groups used by NR in their short-term asset management planning.

6.4.4 It is recommended that asset groups for lifecycle planning are made more specific. This will allow lifecycle plans to be developed at a sub-group level and the more effective management of assets. ***[R6.1]***

6.5 Asset Intervention Policies

Good Practice

6.5.1 In theory there are an unlimited number of intervention options available to resolve identified performance gaps. To simplify matters, in asset management planning a series of 'generic' asset intervention policies are often adopted. This approach also allows some level of comparison between different asset groups.

6.5.2 Typically asset intervention policies such as the following are adopted:

- *Do Minimum*
- *Managed Deterioration*
- *Lowest Initial Cost*
- *Lowest Whole Life Cost*
- *Enhancement*

Current Practice

6.5.3 We have reviewed the current NR Civil Asset Policies issued in March 2010 (Ref 023).

6.5.4 In summary, we have two key issues with the current Civil Asset Policies:

- firstly, that they do not provide the opportunity to select a range of lifecycle intervention options; and
- secondly, that Policy 2, the main policy to be applied to civil assets, fundamentally relies on a suitable intervention point being identified before safety or performance is compromised. This point is expanded below.

6.5.5 Policy 1 states: *'**Policy 1**: Return and maintain the asset to steady state by the use of maintenance activities that will retain performance levels and extend the remaining life of existing assets. This is the closest approach to a whole life cost optimum.'*

6.5.6 Policy 2 states: *'**Policy 2** Allow assets to deteriorate until intervention is essential to maintain safety standards or raise performance levels to an acceptable level. At the time of intervention carry out works that represent best value for money and exceptionally where the demand of the route section in question warrants such consider further improved performance where exceptional value will be delivered, this will particularly apply to the heavy volume and heavy tonnage routes.'*

6.5.7 Policy 3 states: *'**Policy 3**: Applies to closed lines only - maintain at a level to comply with essential public health and safety obligations.'*

6.5.8 SCMI is one of the factors used in prioritising structures for intervention (Ref 265). In our opinion, a suitable intervention point cannot be clearly derived from SCMI as currently recorded and we have seen no clear process or procedures for ensuring that such a suitable intervention point is identified for individual structures. Rather the selection of a suitable intervention point for a structure appears to depend on engineering judgement at a Route level based on their knowledge of:

a) the structural form of each structure;

b) the current condition of each structure, based primarily on the SCMI score and the examination report;

c) the rate of deterioration and form of deterioration of each structure;

d) the availability of funding for an intervention; and

e) the time taken to go through the investment process to start work on site.

6.5.9 The primary decision point related to intervention is during the evaluation of the detailed examination reports. This process is described in more detail in section 8.5. The evaluation takes into account several factors, including SCMI, (Structures Conditions Marking Index) which is designed as a collective condition indicator for the bridge stock, but is the only numerical comparator available to route engineering teams.

6.5.10 We have identified organisations such as LUL and TfL who report condition scores for the critical elements in addition to the average for the structure. The SCMI base data and structural component scores, which are already being recorded, potentially could be used to improve identification of suitable intervention points alongside other factors. This is discussed further in section 8.5.

6.5.11 NR Specification NR/SP/CMT/017, dealing with competency, refers to SCMI as a standard indicator of condition (STE1 grade). NR/L1lCIV/006/1C (Handbook for the examination of Structures Part 1C: Risk Categories and Examination Intervals) also uses SCMI as part of the risk categorisation of individual bridges. This is evidence that SCMI is used as an indicator of the condition of a bridge, rather than the bridge stock, and highlights the need for a better indicator of the condition of an individual bridge.

6.5.12 Major and heritage structures are considered as irreplaceable assets and are generally maintained in accordance with Policy 1 (see 6.5.5) and generally do not fall within the normal Route maintenance and renewal budgets. For further discussion of Major Structures see section 6.10.22 - 29.

6.5.13 It is recommended that NR asset intervention policies are developed to reflect a wider range of intervention options. These policies would then be used as a basis for lifecycle option development. ***[R6.2]***

6.5.14 It is also recommended that Asset Intervention Policies such as the following are adopted:

- *Do Minimum*
- *Managed Deterioration*
- *Lowest Initial Cost*

- *Lowest Whole Life Cost*
- *Enhancement*
- *Heritage Structures*

with lifecycle plans being developed at a sub-group level to reflect the individual needs of particular sub-groups of Civil Structures assets. ***[R6.3]***

6.6 Lifecycle Planning

Good Practice

6.6.1 The Roads Liaison Group publication on the Management of Structures (Ref 379) defines lifecycle planning as:

- *'…a long term strategy for managing a group of assets with the aim of providing the required levels of performance while minimising whole life costs.'*
- *'…. A lifecycle plan for a group/sub-group of structures should take into account the expected deterioration mechanisms and rates of deterioration for the material type concerned, component service lives, the required performance of assets, maintenance techniques, influence of maintenance on future deterioration rates, and maintenance unit costs.'*

6.6.2 The plan should consider:

a) "Regular maintenance – covers inspections, structural assessments, routine maintenance and management of substandard structures;

b) Programmed maintenance – preventative maintenance, component renewal, upgrading, improvements and component replacements; and

c) Reactive maintenance – emergency work and essential maintenance"

6.6.3 Lifecycle planning should take into account various types of maintenance as well as component renewal. Various lifecycle options may be presented, such that particular strategies may be selected for particular individual structures to take account of relative priorities.

6.6.4 The aim of lifecycle planning is to derive a set of various technical options for managing a particular type or sub-group of structures. These technical options would be produced for most or all of the defined asset intervention policies and 'pick list' of options that could be selected from in the subsequent prioritisation / value management process.

Current Practice

6.6.5 We have seen some Civil Structures Asset Plans which contain elements of lifecycle planning, such as the Major Structures Maintenance Strategy May 2007 (Ref 111) and the Major Structures Management Plan for the Goole_Swing_Bridge (Ref 109) plus the Tunnel Management Strategies for the Llangyfelach Tunnel (Ref 366) and Stalybridge Tunnel (Ref 121).

However, we have not seen lifecycle plans for the majority of NR Civil Structures assets either at an asset group or sub-group level.

6.6.6 Our review has not identified that general maintenance work is considered for Civil Structures as a lifecycle option. For example, we have not seen any evidence of a programme of general maintenance work such as bridge painting, de-vegetation and cleaning, drainage cleaning and repair and brickwork pointing. The value of such a programme is demonstrated in the following extract from the CIRIA Report 'Iron and steel bridges: condition appraisal and remedial treatment' (Ref 403). The following extract is from section 4.1 of the CIRIA Report:

'Figure 4.1 shows an indicative maintenance cost curve. This curve can be applied equally to an element of a structure, a structure, or a group of structures. The explanation below is given in terms of a single structure.

If the structure is properly managed from new, with small but consistent funding provided to undertake regular inspection and routine maintenance, continued good performance may be expected, shown by the dashed line in the diagram. The increase in slope of the line is indicative of the need to allow for the effects of cost inflation.

If maintenance of a structure is ignored following construction, despite lower financial outgoings, long-term deterioration processes will be ongoing. Eventually the lack of attention to routine maintenance will lead to acceleration in the processes of deterioration, and significant escalation in the costs of restoring the structure to an acceptable condition. This is shown by the dotted line in Figure 4.1.

At some point (shown as X), the costs of repairing the structure will equal or overtake the costs of complete replacement. Note that this illustration presumes that the structure has an adequate (but deteriorating) margin of safety until point X is reached. In some instances there may be a need for earlier intervention on the grounds of safety of a critical element.'

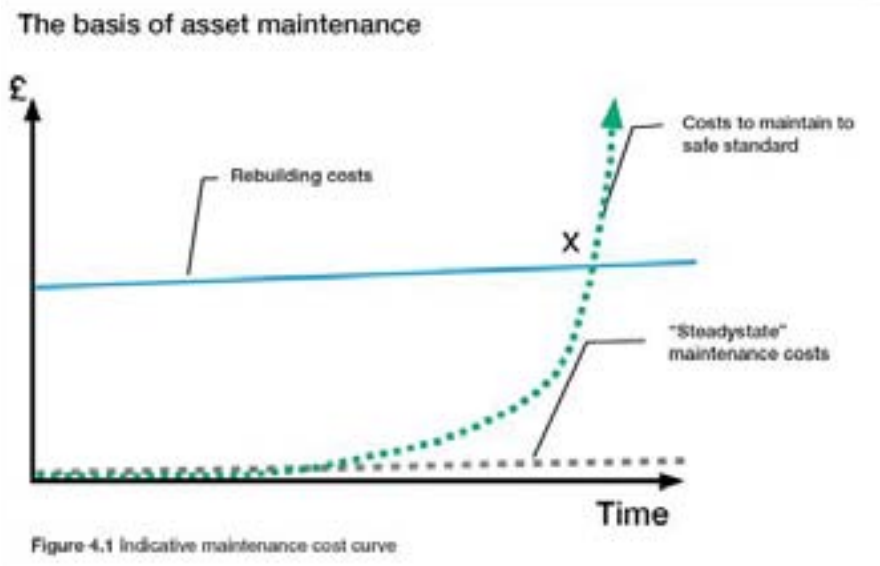


Figure 6.3: Indicative maintenance cost curve, CIRIA (ref:403)

6.6.7 We note that LNW have approximately 12,000 bridges, and 5,000 retaining walls. From our discussions with the Route Structures Engineer, we understand that there are typically about 100 major interventions (Investment Projects) and about 1000 Minor Works instructions per annum. NR has confirmed these numbers are typical of other Routes of the network. We estimate that, on average, structures are currently subject to a major intervention about once every 170 years, with minor works being carried out at a rate of once every 17 years. Some minor works are likely to be unrelated to the condition or integrity of a structure. The frequency of intervention seems surprisingly low. It is recommended that intervention rates for similar infrastructure operators are obtained and compared with these figures. ***[R6.4]***

6.6.8 In our review we have found little evidence that programmed maintenance activity such as preventive maintenance is considered for Civil Structures. Accordingly, there appears to be an opportunity to consider the potential benefits from increased routine maintenance (planned, regular programmed interventions e.g. pointing, painting, de-vegetation etc.) as part of the lifecycle options. A secondary benefit of such activities is that they also provide an opportunity to view structure condition and identify unexpected defects. It is recommended that preventive maintenance is explicitly considered as part of the lifecycle planning options for Civil Structures at a group / sub-group level. ***[R6.5]***

6.6.9 It is recommended that lifecycle plans are developed at a sub-group level to reflect the individual needs of particular sub-groups of Civil Structures assets and that a series of technical options considering both maintenance and renewal are produced for most or all of the defined Asset Intervention Policies. ***[R6.6]***

6.7 Workbank Development

Good Practice

6.7.1 In this step of the asset management planning process the aim is to derive both ‘Short-term’ and ‘medium-long term’ workbanks. These are workbanks purely based on technical need and are not influenced by funding availability. Funding constraint is subsequently applied in the value management / prioritisation process.

6.7.2 The Civil Structures Workbank [27] (Ref 379) should be a database of all work that is currently outstanding on the network, including estimated costs for doing the work. The workbank should typically provide the following information for each item of work:

a) name and number/reference of the structure;

b) element where work is required;

c) defect, including severity and extent (if appropriate);

d) required work;

[27] Roads Liaison Group ‘Management of Highway Structures – A Code of Practice’ September 2005

e) work type;

f) recommendation for when the work should be undertaken, i.e. which year; and

g) estimated cost.

6.7.3 In our review we have defined 'short-term' planning as relating to the current Control Period or up to about 5 years ahead. We have defined Medium-Long Term planning as greater than 5 years ahead. Typically infrastructure owners will try to plan about 30 years ahead. The relationship between short, medium / long-term planning is shown schematically in Figure 6.4.

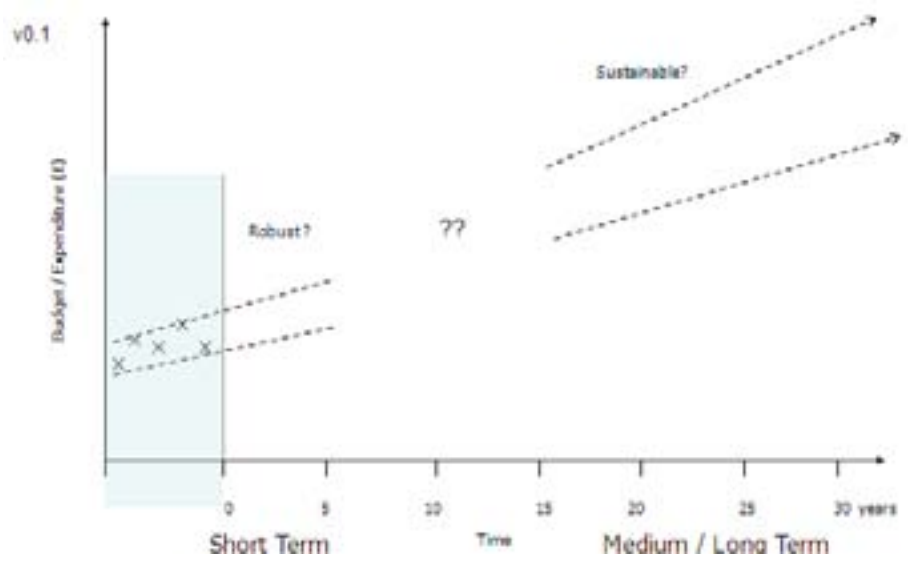


Figure 6.4 Short and Medium / Long-Term Planning

6.7.4 It is important to note that a workbank is fundamentally about 'what needs to be done' (i.e. volume of work) not about the cost of that work. The aim is to have a full explicit listing of the technical needs unaffected by the available funding. This listing is useful to asset management business planners as they can see what is / is not going to be delivered by various proposed funding levels. It also avoids the potential complexity of unit costs and anticipated efficiency gains.

Current Practice

'Short-term' Asset Management Planning *(0-5 years ahead)*

6.7.5 Based on our meetings with Western and LNE Operational Routes, it is our view that the route teams are primarily focused on short term planning, with little explicit consideration of 'medium/long-term' asset management requirements.

6.7.6 There is a strong engineering led focus in route teams managing business as usual activity. The teams are focused on managing the Civil Engineering Framework for Assessments (CEFA) contractor (planning and processing

visual and detailed examinations) and developing and prioritising minor works and IP's workbanks.

6.7.7 The short-term (CP) workbank appears to be primarily derived from bottom-up structures examination data at route level plus the requirements from enhancement projects indentified in the NR CP4 Delivery Plan.

6.7.8 NR explicitly recognises the concept of a 'Constrained Workbank (Technical) CBWT'. This defined in the Civil Asset Register and Electronic Reporting System (CARRS) Renewal Process manual defined as:

"Constrained Workbank (Technical) CBWT - All work items that satisfy the definition of Structures renewal Item and have been accepted by the RSE as in-keeping with the Territory's overall priorities. {This does NOT necessarily mean that it's in the Business Plan – ie it is only "technically" constrained, not financially constrained}"

6.7.9 This definition implies some level of filtering:

- *'…satisfy the definition of Structures renewal Item…'*
- *'… as in-keeping with the Territory's overall priorities…'*

6.7.10 Our discussions with the Routes have identified that there is not an explicit structures workbank of all work that is currently outstanding on a Route.

6.7.11 To some extent we believe that CARRS may contain a listing of most items but this listing is not explicitly produced or reviewed when funding allocations and prioritisation choices are being made.

6.7.12 We also have evidence that some work items may not be being extracted from examination reports as work items simply because the routes / CEFA contractor knows that the work is not *'…in-keeping with the Territory's overall priorities'*. For example, at Bridge ECM1/307 Chesterfield Canal (Report dated 12 Oct 2004), the Ystrad Mynach Bridge in South Wales, Nelson Road 13 Miles 77.5 chains (Reports dates 2004 and 2009), and Bridge ECM2/168m 1236 yards (examined 7 Jan 2008), the requirement for painting was not recorded as a recommendation on the detailed examination reports despite being clearly visible in the accompanying photographs.

6.7.13 NR has advised that they are unable to demonstrate the cost effectiveness of maintenance painting. We understand that this conclusion was reached by comparing the net present value of bridge deck replacement with the current cost of maintenance painting, and therefore it is not done under normal circumstances. We have not reviewed the evidence which supports this conclusion. Given the large number of metal bridges under NR stewardship, there is an opportunity to work with the supply chain to develop improved specifications, materials and techniques which will enable this work to be carried out efficiently and cost effectively. It is recognised that this is a complex technical issue because there are many legacy paint systems in use. ***[R6.7]***

6.7.14 It is recommended that NR develops a formal explicit structures workbank of all currently outstanding work on a route. This should include any existing defects which are not currently been recorded. This unconstrained workbank should be independent of funding constraints / overall priorities.

It should be made available and reviewed when funding levels are being set. ***[R6.8]***

6.7.15 As part of the CECASE work, NR have been considering lifecycle planning for specific sub-groups of Civil Structures assets. We consider that a number of the principles adopted for that planning could be usefully applied to NR short-term asset management planning (~ 5 years ahead), in particular:

a) sub-grouping of Civil Structures by their behaviour;

b) development of a range of possible management plans for each group of assets (lifecycle plans with intervention options); and

c) costing of the of possible management plans for each group of assets.

This is discussed further in the previous section on lifecycle planning.

'Medium/Long Term' Lifecycle Planning *(> 5 years ahead)*

6.7.16 Our meetings with NR and Mouchel (as developers of the NR CECASE planning tool) have confirmed our initial view that the CECASE modelling undertaken to date, is very similar in principle to work undertaken by the HA and London Underground Limited to estimate future 'medium / long-term' renewal requirements.

6.7.17 Most infrastructure owners find estimation of future medium / long-term renewal requirements for Civil Structures to be a challenge. As part of our review work, initial discussions with some of the key utility and infrastructure organisations has been initiated. It is recommended that specific discussions about decision support tools and modelling should continue to be undertaken to benchmark and share experience in this area. ***[R 6.9]***

6.7.18 In our meetings with NR and Mouchel we have discussed the possible future direction for the longer-term asset management planning for Civil Structures.

6.7.19 Based on the above meetings, we consider that ORR/NR should jointly develop a set of explicit business rules to be used by NR in their asset planning and future development of a medium / long-term asset investment planning tool. These should be aligned to lifecycle planning principles as outlined above. ***[R6.10]***

6.7.20 It is recommended that the development of these business rules and their implementation in to a medium / long-term asset investment planning tool should be independently reviewed in parallel with the development to ensure clarity of assumptions made in the planning. ***[R6.11]***

6.7.21 As part of the development process, consideration should be given to identifying Civil Structures asset data sets likely to be required for the medium / long-term modelling so that any additional data sets can start to be collected as part of the inspection and examination process. ***[R6.12]***

6.7.22 Decision support tools can be particularly useful for developing medium / long-term workbanks and optimising different conflicting factors such as

direct costs, penalty costs, costs from lost performance and amortised costs. The inclusion of an optimisation function may be a specific area to consider in the future tool. ***[R6.13]***

6.7.23 The effective medium / long term modelling of structures performance requires an understanding of the relationship between the three asset management variables: cost of service, level of service and reliability of service (or risk of service interruption). The application of risk based decision support tools is a developing area and it is recommended that this is a specific area for future research and development. ***[R6 14]***

6.7.24 It is noted that over a number of years NR have actively participated and supported in Construction Research and Information Association's (CIRIA) continuing research on infrastructure asset management. It is recommended that collaborative research would be a very appropriate way to develop the application of risk based decision support tools. ***[R6.15]***

6.8 Prioritisation / Value Management

Good Practice

6.8.1 The fundamental aim of prioritisation / value management[28] is to relate funding to needs and identify the most effective way of spending available funds.

6.8.2 It is a formalised process for assessing the benefits of undertaking maintenance / renewal work and the associated risks of not undertaking such work. It is used to prioritise the needs for work indentified in the structures workbank.

6.8.3 Various prioritisation criteria should be considered, at a minimum the Roads Liaison Group (RLG) (Ref 379) suggest the following three categories (adapted from RLG guidance):

"1. Safety and functionality *– criteria in this category should seek to use information from the asset inventory and database to rank the importance of the need. Examples of criteria that could be considered are structure type, structure location, route carried, obstacle crossed, element condition, assessed capacity, height restriction and traffic flow restrictions. Condition, Availability and Reliability Performance Indicators may be appropriate prioritisation criteria for this category.*

2. Benefits and dis-benefits *– criteria in this category should seek to quantify in a simplified manner, the benefits and dis-benefits produced by addressing and not addressing a need. It may be more appropriate to use engineering judgement rather than an automated procedure. If the former approach is used it should be guided by a simple classification procedure, e.g. High, Medium or Low benefit/dis-benefit. Examples of benefits/dis-benefits that should be considered include lower or higher whole life costs,*

[28] Value Management is defined as *'Assessment and prioritisation of identified maintenance needs'*.This is different to Value Engineering which is defined as '*Development of optimal solutions for prioritised maintenance using option appraisal, whole life costing, scheme development, and synergies with other highway schemes.'(Ref 379)*

reduced or increased journey times, minimisation of network disruption, and integrating work items to achieve cost savings.

***3. Socio-economic and environmental** – criteria in this category should cover the softer issues that cannot be readily quantified by an automated prioritisation process, e.g. local policies, user/customer perception, impact on local communities and businesses, environmental impact and sustainability considerations. A formalised approach should be developed that allows the reviewer, or workshop attendees, to quantify criteria easily, e.g. High, Medium or Low impact."*

6.8.4 A formalised risk analysis and risk assessment approach may be used to trade-off the various prioritisation criteria.

6.8.5 A good example of a formalised value management process is the approach adopted by the HA[29]. The HA process has formal value management manuals and involves workshops with Regional teams to review their technical submissions for consistency. The final structures workbank submissions are then provided to a central asset management office for prioritisation and allocation of funding.

Current Practice

6.8.6 We have seen the overall NR business planning procedures and guidelines (Ref 244), the various standards e.g. CIV/032 (Ref 237), Civil Structures prioritisation spreadsheets (Ref 265), and CARRS manuals (Ref 060).

6.8.7 However we have not seen a formalised Value Management Manual with defined scoring criteria that are to be adopted in assessing the relative merits of different works proposed in a workbank. Such a manual or guidance is important to ensure consistency and selection of the works that contribute most to the achievement of the performance targets.

6.8.8 During our visits to Western and LNE Operational Routes, we have discussed the prioritisation process and the following sections set out our understanding of the process.

6.8.9 We have reviewed an extract from a RAMP (Ref 095) for one strategic route section relating to Civil Structures assets. The route section provided was G.05 Peterborough to Doncaster, which has 142 route km, 318 bridges and 164 km of earthworks. Our observations are set out below in relation to bridges and earthworks.

Bridges

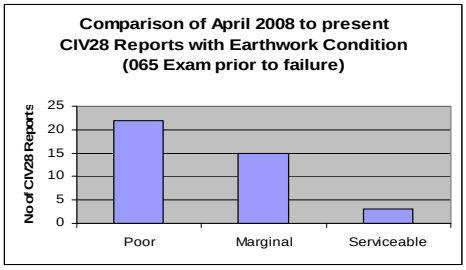
6.8.10 We understand that prioritisation of Structures schemes is done using a standard spreadsheet (Ref 265). According to discussions with the Routes the Constrained Work Bank Technical (CWBT) is composed of the items from CARRS, to which prioritisation scoring is applied to decide on the items that should make it into the fully constrained workbank. The method of prioritisation used is based on a spreadsheet. This was developed in Western Route by Ian Frostick and is now used by all Routes.

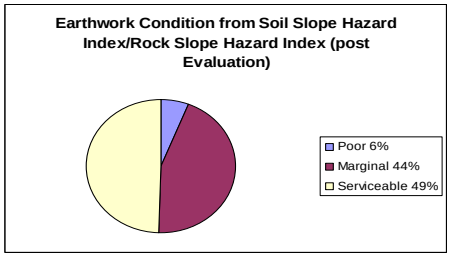
[29] Highways Agency Value Management of the Structures Renewal Programme

Earthworks

6.8.11 We have considered the effectiveness of the NR condition classification as a means of predicting which earthworks have the greatest likelihood of failure. Figure 3 from the NR Civil Asset Policy Justification (Ref 025) is reproduced below. The NR analysis indicates that of 40 failures, 55% were of earthworks previously classified as 'poor', 37.5% were of earthworks previously classified as 'marginal', and 7.5% were of earthworks previously classified at 'serviceable'. This indicates that NR condition classification is not an unreasonable way of categorising earthworks.

6.8.12 Using the definition that 'at risk' earthworks are the part of the population of earthworks classified as 'poor' or 'marginal' (i.e. the part of the population where historically the most significant proportion of failures have emanated from), a comparison with HA earthworks can be made. The HA has 1% of the HA earthworks (120km) 'at risk' whereas 36% of NR earthworks are classified as either 'poor' or 'marginal' (see Figure 4.3), which equates to some 5100km of earthworks at 'at risk'.





Earthwork Condition	Mean distance between failures (annual)
Poor	1 failure/25 miles 90% of all Failures
Marginal	1 failure/ 270 miles 9% of all failures Half of failures directly due to wash out / drainage
Serviceable	1 failure/ 1500 miles 1% of all failures Half of failures directly due to wash our / drainage

Figure 6.5: Earthwork Failure by Condition. Source Civil Asset Policy Justification (Ref 025)

6.8.13 We have been provided with a copy of the earthworks prioritisation spreadsheet (Ref 120). This indicates that a priority score for earthworks is produced based on the Soil Slope Hazard index / Rock Slope Hazard Index and route criteria (such as line speed, type, track layout). We have not reviewed the relative criteria or tested whether the relative scorings produced are logical, but in principle the scoring mechanism seems reasonable. However, we are unclear how these priority scores are then used in selecting specific schemes for delivery in CP4. This is discussed further below.

6.8.14 The historic spend on earthworks is set out in the Railway Accident Investigation Branch (RAIB) Report (Ref 364) namely:

'In 2007/8 the Network Rail spend on earthworks was approximately £80 million. Approximately 3.5 % was spent on inspection, evaluation and assessment processes. Of the rest, 8.8 % was used for emergency and reactive works, but the majority, approximately 87.7 %, was used for planned proactive preventative measures.

The annual average Railtrack/Network Rail total spend on earthworks for the period from 2004/5 to 2008/9 is £83 million. The equivalent annual average spend for the period from 1999/2000 to 2003/4 was £53 million. In 2004/5 £17 million was spent on emergency and reactive works. In 2007/8 this had reduced to £7 million'

6.8.15 The RAIB report (Ref 361) makes reference to a 'Soil Slope Consequence Index' as a mechanism to provide a further level of risk differentiation between slopes assessed as being in otherwise similar condition. The RAIB report indicates that it uses parameters associated with the operating railway to assess the risk to trains and that the overall Soil Slope Risk Factor is the multiple of Slope Stability Hazard Index and Soil Slope Consequence Index.

6.8.16 In our discussions with the routes we have seen use of Slope Stability Hazard Index but no evidence of use of Soil Slope Risk Factor or the Soil Slope Consequence Index. We understand that these were included in NR/L3/CIV/065 Issue 1, dated April 2005, and subsequently deleted from Issue 2 of the standard, which was published in December 2008. It is not clear to us why this was done.

6.8.17 We have not seen a commentary or similar document explaining how the recommendations made in the RAIB Report in December 2008 have been progressed by Network Rail. It is recommended that this is reviewed. ***[R6.16]***

Retaining Walls

6.8.18 NR have 17,000 retaining walls. Based on limited discussions and our review of NR Standards, we understand that retaining walls do not have an SCMI score from inspections and that their capacity is not routinely assessed. It is recommended that a condition scoring system for retaining walls is initiated together with a formal capacity assessment***. [R6.17].*** Further work to understand the level of asset knowledge (inventory and condition etc.) and risks posed by of NR retaining walls is recommended.

6.8.19 In the light of ***R6.17*** above, it is recommended that the prioritisation process is reviewed in some detail to understand how the relative merits of different asset renewal projects are evaluated. ***[R 6.18]***

6.8.20 Our remit did not include consideration of drainage issues. We note that the CP4 settlement included a sum of £200m to be spent on drainage matters. However, it is recommended that consideration is given to the prioritisation of slope drainage schemes as part of the wider review of relative priorities for maintenance works. ***[R6.19]***

6.8.21 Figure 6.6 is an extract from the RAMP (Ref 095).

2.3.2 Priority Earthworks for Remediation

Earthwork	Type	ELR	From Mileage	To Mileage	Driver	Priority Score	Spend in CP4 (£k)
Embankments	Earthworks Embankments	ECM1	98.065	98.128	2a - Performance	744	1000
Embankments	Earthworks Embankments	ECM1	94.116	95.009	2a - Performance		36
Other Earthworks	Earthworks Un Planned	ECM1	92.1755	93.035	1a - Safety - Response	727	160
Embankments	Earthworks Embankments	ECM1	94.0153	94.0507	2a - Performance	768	495
Embankments	Earthworks Embankments	ECM1	97.1637	98.031	2a - Performance	570	513
Other Earthworks	Earthworks Drainage	ECM1	98	98.011	2a - Performance	n/a	167
Other Earthworks	Earthworks Cutting	ECM1	99.0956	99.121	1a - Safety - Response	864	260
Other Earthworks	Earthworks Cutting	ECM1	111.132	111.143	1a - Safety - Response	864	40

Figure 6.6: Extract from Route Asset Management Plan (RAMP) (Ref 095) for Route Section G.05 Peterborough to Doncaster

6.8.22 The RAMP (Ref 095) indicates for CP4:

- *10 priority structures for remediation to a value of £6.125m*
- *8 priority earthworks for remediation to a value of £2.671m.*
- *Of the £2.67m the funding split was as follows:*
  - *Embankments £2.044m (4 projects)*
  - *Cuttings £0.3m (2 projects)*
  - *Drainage £0.167m (1 project)*
  - *Unplanned earthworks £0.16m*

The driver noted that for earthworks embankments and drainage projects is*'2a Performance'*. The driver noted that for earthworks cuttings projects is *'1a Safety Response'*.

6.8.23 A review of the RAMP (Ref 095) indicates a range of priority scores for the earthworks from 570 to 864. Scores for the four proposed embankment schemes ranged from 570 to 768 and scores for the two cutting projects were both 864. The range of scores indicates that 'priority score' is not the only feature in deciding which schemes should be prioritised. It is surprising that embankment schemes with lower priority scores than cuttings are listed.

6.8.24 Planned spend on earthworks for CP4 is £470m (See Figure 4.4) with an annual expenditure of £108m in 2009/10 reducing to £86m in 2013/14. This compares with a planned spend on underbridges and overbridges of £702m in CP4 and an annual expenditure of between £123m and £153m during the control period.

6.8.25 We have not been provided with the justification for the reduction in annual earthworks expenditure over the control period, or information as to how this

expenditure relates to condition, performance and risk associated with the earthworks asset. It is recommended that this is clarified with NR. ***[R6.20]***

6.9 Safety Risk Model

6.9.1 As noted above, NR has a duty under the Health & Safety at Work etc. Act (1974) to manage safety risks to a level as low as reasonably practicable (ALARP). Our interpretation of this is that safety improvements should be implemented unless the costs are grossly disproportionate to the safety benefits.

6.9.2 We understand that the NR Cost-Benefit analysis (CBA) tool (Ref 271) with underlying data from the Railway Safety and Standards Board (RSSB) Safety Risk Model (SRM) is intended to be used for evaluation of proposed safety related investment decisions.

6.9.3 Notwithstanding our recognition that CBA cannot be the sole determinant of a safety investment decision we have used the NR CBA tool and the RSSB SRM data to investigate the proportionality and relative merits of investment decisions for Civil Structures. Our simple calculations based on the Railway Safety and Standards Board (RSSB) Safety Risk Model data would indicate that the safety risk from earthworks is in the order of three times greater than for bridges, and that cuttings pose a safety risk 37 times that of embankments. Based on this it is perhaps surprising that the expenditure on bridges is higher than earthworks and that the expenditure on embankments is higher than on cuttings.

6.9.4 It is understood that the SRM is primarily populated using relevant historical accident data but that where little data exists particularly for the low frequency but potentially high consequence accidents, the model makes use of predictive fault and event-tree modelling, structured expert judgement from technical specialists, and statistical methods. It is recommended that the applicability of such data to low frequency, high consequence events associated with Civil Structures (such as bridge deck failure or cutting failures) is reviewed. ***[F6.1]***

6.9.5 The RSSB SRM would also indicate that the safety risk from earthworks failures is low (Embankments & Cuttings of 0.39 FWI / year) relative to other hazards (such as Level Crossings - High Level Cause of 11.811 FWI/yr) - (From Table C1, RSSB Risk Profile Bulletin, v6.1, June 2009) suggesting that expenditure on reducing the safety risk from cuttings may not be proportionate. We find this surprising and of potential concern taking into account the fact that the HLOS target for safety is based on the RRSB SRM. Fundamentally, we are unclear as to the extent to which the RSSB SRM correctly represents the likelihood and consequence associated with low frequency, high consequence events associated with Civil Structures (such as bridge deck failure or cutting failures) that have been to date rare.

6.10 Asset Management Plans (AMP's)

Good practice

6.10.1 AMPs are the key tactical documents that link the practical management of the network through to strategic objectives. A key aim of an AMP is to set out the way in which the infrastructure assets are to be managed so as to cost-effectively achieve the long-term strategic goals. This relationship is shown in Figure 6.7 below.

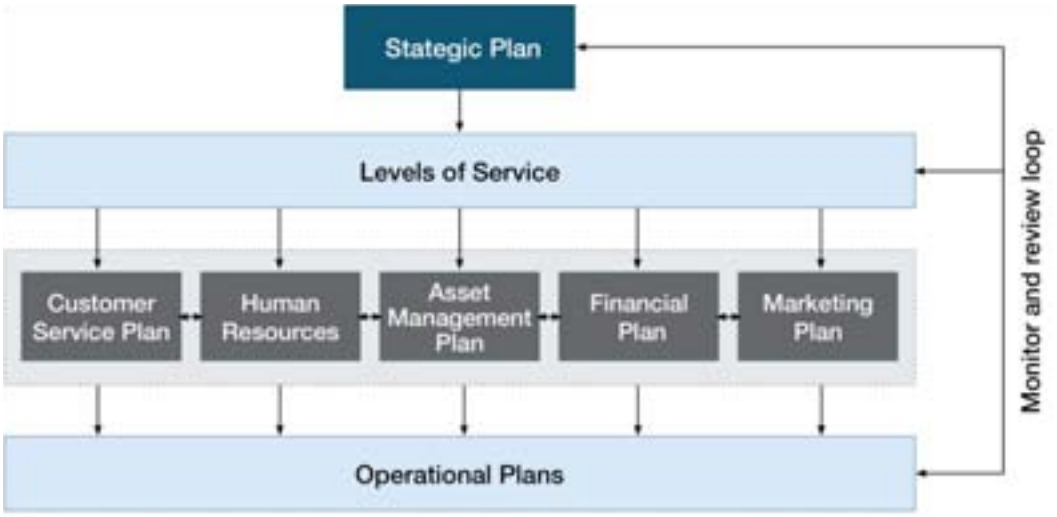


Figure 6.7: Relationship of Asset Management Plans to Levels of Service and Operational Plans (Source: Ingenium (Ref 387))

6.10.2 AMPs provide an end to end view of the planned management of assets. Typically content (Ref 379) is:

- *Executive Summary;*
- *Introduction;*
- *Goals, objectives, levels of service and performance targets;*
- *Asset Base and Characteristics;*
- *Future Demand;*
- *Lifecycle Plans;*
- *Work Plan;*
- *Financial Plan;*
- *Asset management Improvements;*
- *Risks to the Plan and their Management; and*
- *Monitoring, Review and Continual Improvement.*

6.10.3 In the highways area, Local Transport Plan guidance[30] encourages local authorities to develop Transport Asset Management Plans (TAMPs) to guide management of their transport assets.

6.10.4 In practice AMPs often comprise a suite of documents to suit different requirements. These may typically comprise:

- *National Level Asset Management Plan which:*
  - *covers whole network.*
  - *provides an overview of assets to support a spending / funding submission.*
  - *summarises how allocated funding will be used to deliver an agreed level of service within an acceptable risk profile on whole network.*
  - *is refreshed every 3-5 years.*
- *Network section level AMP which:*
  - *is a suite of documents covering each section of a network.*
  - *is typically associated with operational boundaries.*
  - *summarises how allocated funding will be used to deliver an agreed level of service within an acceptable risk profile on that section of the network.*
  - *includes work plans.*
  - *is refreshed every 1-3 years.*
  - *promotes ownership of each part of the network.*
  - *explains how the management of that section relates to its specific needs.*
  - *allows some level of comparison /benchmarking between sections.*
- *Asset group / sub-group specific AMP which:*
  - *is a suite of documents covering specific assets.*
  - *is related to the management needs for that asset type.*
  - *has a strong focus on lifecycle options.*
  - *explains how that asset group/ sub-group will be managed from a technical point of view and how that relates to its specific needs / risks.*
  - *may include short-term and medium-long-term workbank for that asset group/ sub-group.*

6.10.5 PAS 55 (Ref 384) does not provide explicit guidance on asset management plans, however the International Infrastructure Management Manual (Ref 387) does provide useful guidance and there are a number of examples of mature asset management plans.

[30] Full Guidance on Local Transport Plans, London: Department for Transport, December 2004

6.10.6 Some good examples of Asset Management Plans (National, Section and Asset Group Level), which are not necessarily 'best practice' are listed below:

National level

- *New Zealand Transport Agency - National Land Transport Programme 2009–2012 (Ref 389).*

Network Section Level

- *Auckland City Council, Transport Asset Management Plan (Ref 388).*
- *Suffolk County Council, Transport Asset Management Plan (Ref 390).*

Asset group / sub-group specific

- *Carriageway, Leicestershire County Council – Dec 2007.*
- *Structures, Surrey County Council – March 2008.*
- *Traffic Signal and Management Systems, Staffordshire County Council - Oct 2008.*
- *UK Roads Board 'Highway Asset Management Quick Start Guidance Note – Lifecycle Planning' (Ref 391)*
- *Geotechnical AMPs – HA*[31].

6.10.7 The following sections compare NR documentation with the above good asset management practice.

Current Practice

National

6.10.8 We have not seen an individual NR document that provides a national picture of asset management.

6.10.9 Some elements of a National AMP are included in the NR Annual Return (Ref 039), the CP4 Delivery Plan (Ref 029), Network Condition Report (Ref 091) and the Infrastructure Condition Report (Ref 090).

6.10.10 It is recommended that NR consider producing a National Level Asset Management Plan to support requests for funding and to summarise how allocated funding will be used to deliver an agreed level of service within an acceptable risk profile. This National Level Asset Management Plan should also include an explicit planned volume of work. ***[R6.21]***

Route - Route Asset Management Plans

6.10.11 We understand from the AMCL report (Ref 041) that RAMPs are being prepared by NR for all Strategic Route Sections (approximately 300) with

[31] www.standardsforhighways.co.uk/dmrb/vol4/section1/hd4103.pdf

the intention that the RAMPs will contain a 5-year view sufficient to describe the current control period, with a longer-term aspiration to include the plans for the following control periods but at a lesser degree of detail.

6.10.12 We have been provided with an extract from a RAMP (Ref 095) for one strategic route section relating to Civil Structures assets. The route section provided was G.05 Peterborough to Doncaster, which has 142 route km, 318 bridges and 164km of earthworks.

6.10.13 The RAMP provides:

- an overview of the route section in terms of performance, utilisation and characteristics;
- a summary of current performance and condition for all asset types with condition trends;
- a summary of demand and enhancement;
- CP4 investments and outputs; and
- civils: policy, asset volumes, key structures, asset condition, priority structures for remediation, renewals volumes and expenditure and output forecast.

6.10.14 In our visit to LNE Operational Route, we examined the origin of one priority structure listed for renewal works namely Underbridge Asset 307 (ECM1/307 Chesterfield Canal, Retford). This renewal was being driven by a performance requirement associated with a freight enhancement project. This is discussed further in sections 8.5.15 to 8.5.18

6.10.15 We consider the RAMP development to be highly beneficial and we fully recognise the significant effort expended by NR to draw together various data sources and to create the RAMP documents even in their current format.

6.10.16 In their current state of development the RAMPs provide a useful summary document of the delivery plans for a strategic route down to a listing of priority structures and earthworks for remediation in CP4.

6.10.17 A key purpose of an AMP is to quantify any gap between current performance and the desired target performance. The current RAMP does not define a target performance for Civil Structures or current performance of Civil Structures on the route. This means that the RAMP is more of an inventory listing than a tool to direct future expenditure to achieve targets / outcomes. This is a key area for future development. ***[R6.22]***

6.10.18 We have not had sight of the planned development trajectory for RAMPs, and recommend that (if not done so already) a clear vision / blueprint for the 'to be' RAMP and how it will be used by the business is developed. ***[R6.23]***

6.10.19 In particular it would be useful for the RAMP in the future to include more about the planning and programming stage rather than simply being a summary of planned renewals delivery. ***[R6.24]***

6.10.20 This would recognise that the development will be incremental but provide a clear overall direction for the asset management planning process. Specifically it would be useful for the 'to be' process, defining how the RAMPs will support the Interim Strategic Business Plan (ISBP) for CP5, to

be articulated and shared with the ORR. This would link across to the business process mapping required for overall asset management for Asset Management Information System development. ***[R6.25]***

6.10.21 A key aim of a network section level AMP such as a RAMP, is to promote ownership and to be a practical aim to decision making. We have concerns that the sheer number of RAMPs (305) is too many to allow this to happen. In other organisations such as the HA, they have between 7 and 14 network section level AMP. We would recommend that NR consider producing AMPs at an operational route level. ***[R6.26]*** These could be based on the RAMPs but collated into operational route level documents.

Route - Asset Specific Plans

6.10.22 NR produce asset specific management plans for some groups of Civil Structures. We have been provided with example asset specific plans relating to major structures, and tunnel assets.

Route - Major Structures

6.10.23 A major structure is defined in NR/L1/CIV/032 as 'a Structure that requires its own bespoke Management Strategy, which defines the specific process and requirements for managing the structure'.

6.10.24 The Major Structures Maintenance Strategy May 2007 (Ref 111) indicates that NR has over 300 major structures. We have been provided with a full listing by NR (Ref 409) Major Structures are not identified separately in CARRS.

6.10.25 NR Policy Civil-21 states that '*A maintenance manual shall be produced for each major structure*.' (Ref 025). We assume that a maintenance manual is the same as the major structure management plan which we have seen examples of.

6.10.26 The Major Structures Maintenance Strategy May 2007 (Ref 111) document sets out the current cost profiles associated with the 26 selected major structures that require work during CP4.

6.10.27 We understand that this short list of 26 / 27 major structures was created specifically for CP4 and that only 13 of the 27 structures on the short list will incur expenditure during the 5 year period (Ref 108, SBP Major Structures Executive Summary-22 2 08-Draft).

6.10.28 We find it surprising that only 13 out of the 300 major structures are planned to require maintenance expenditure in the 5 year CP4 period. It is recommended that this is investigated further. ***[R6.27]***

6.10.29 Specifically we have seen the Major Structure Management Plan for the Goole Swing Bridge in LNE Route (Ref 109). The plan includes:

- *description and context*
- *defects*
- *proposed work; and*

- *overall strategy.*

Route - Tunnel Assets

6.10.30 NR Standards require that Tunnel Management Strategies are produced for each tunnel.

6.10.31 Specifically we have seen the Tunnel Management Strategy Report for the Llangyfelach Tunnel produced by Halcrow in February 2008 for Western Route. (Ref 366) and Stalybridge Tunnel produced by Donaldson Associates in October 2004 for LNW Route (Ref 367)

6.10.32 These both include comprehensive summaries of:

- *geological setting;*
- *construction / survey / archive drawings;*
- *condition and defects data;*
- *hazard information; and*
- *planned examination and maintenance regime.*

6.10.33 The Tunnel Management Strategy reports appear to be very useful documents, collating information on the management of the asset in one location and providing a good basis for future planning. This view was confirmed by our discussions with the LNW Route Structures team.

Route - Structure Group / Sub-Group Specific Plans

6.10.34 We have not seen any NR document that provides a picture of the asset management approach on a structure group or sub-group specific basis such as metallic bridges, masonry arches and geotechnical assets.

6.10.35 Some elements of a structure group/ sub-group specific plan are included in NR Civil Policy Justification (Ref 025) and NR Strategic Business Plan supporting document - Asset Management October 2007 (Ref 250).

6.10.36 It is recommended that NR consider producing structure group / sub-group level AMP to help improve the sharing of best practice for Civil Structures management, promote uniformity of practice, and provide clarity as to the technical needs for on a structure group / sub-group level ***[R6.28]***. Lifecycle planning would be a significant element in such structure group / sub-group level AMPs.

6.10.37 Discussions with routes noted that the teams had recognised that various individual separate processes and procedures were being adopted for managing risk at bridge structures, for example:

- management of scour;
- management of bridge strikes;
- Bridgeguard 3; and
- vehicle incursions.

6.10.38 In addition, it was suggested that a more holistic view should be taken at an individual bridge structure level. Initially, this potentially would require significant resource to develop individual plans but is something that NR should consider. ***[R6.29]***

6.10.39 NR should also consider combining the various individual separate processes and procedures as part of their 'to be' asset management process definition activity. ***[R6.30]***

6.10.40 Based on our meetings with Western and LNE Operational Routes, it is our view that the route teams are primarily focused on short term planning, with little explicit consideration of medium to long-term requirements.

6.10.41 There is a strong engineering led focus in route teams managing business as usual activity but consideration of the potential future impact of changing demands on the network (e.g. traffic loading, climate change, structural degradation etc.) was not evident. These aspects would typically be considered and presented in AMPs.

6.10.42 It is recommended that NR explicitly consider future demand in their asset management planning process. ***[R6.31]***

Route - Asset Management Plans Summary

6.10.43 The following summary and recommendations include some findings that are discussed further in section 8. They are included here because they fundamentally affect Planning and Programming.

6.10.44 In summary:

a) The rate of gathering new data, which principally occurs when carrying out detailed examinations and examinations for assessments at a typical frequency of six years and eighteen years respectively, has to be sufficient to manage structures and to improve understanding of degradation rates. The data collection frequency needs to be reviewed, particularly for critical elements.

b) Where the quality of asset information is inadequate, it can lead to reliance on unverified critical information (RAIB Stewarton (Ref 362).

c) The risk profile, degradation rates and position on the 'degradation curve' of the structures and their critical elements is unknown.

d) We have been provided with a listing of Major structures, (304 No.), but we have seen little evidence of asset management plans. The level of expenditure on these assets in general appears low, with most currently concentrated on three structures.

e) Prioritisation – there are prioritisation processes in place at Route level; however, we are unclear how priority structures for remedial work are finally selected, other than by the judgement of the Asset Engineers.

6.10.45 We recommend that:

a) The process of prioritisation is revised to show a clear decision making process which is based on coherent systems, supported by knowledge (e.g. RAMP Chesterfield Canal). ***[R6.32]***

b) Conditions score for bridges are enhanced to include both the overall SCMI score and a set of SCMI crit scores for critical elements. ***[R6.33]***

c) A more effective means of updating SCMI is developed. ***[R6.34]***

d) A system of grouping / sub-grouping of assets by type and behaviour is developed. ***[R6.35]***

e) The prioritisation process is made more explicit and transparent to include level of service considerations. ***[R6.36]***

No.	Recommendation	Location in Text	Priority
Planning and Programming			
R6.1	It is recommended that asset groups for lifecycle planning are made more specific. This will allow lifecycle plans to be developed at a sub-group level and the more effective management of assets.	6.4.4	3
R6.2	It is recommended that NR asset intervention policies are developed to reflect a wider range of intervention options. These policies would then be used as a basis for lifecycle option development.	6.5.13	1
R6.3	It is also recommended that Asset Intervention Policies such as the following are adopted: • *Do Minimum* • *Managed Deterioration* • *Lowest Initial Cost* • *Lowest Whole Life Cost* • *Enhancement* • *Heritage Structures* with lifecycle plans being developed at as sub-group level to reflect the individual needs of particular Sub-Groups of Civil Structures assets.	6.5.14	1
R6.4	We note that LNW have approximately 12,000 bridges, and 5,000 retaining walls. From our discussions with the Route Structures Engineer, we understand that there are typically about 100 major interventions (Investment Projects) and about 1000 Minor Works instructions per annum. NR has confirmed these numbers are typical of other Routes of the network. We estimate that, on average, structures are currently subject to a major intervention about once every 170 years, with minor works being carried out at a rate of once every 17 years. Some minor works are likely to be unrelated to the condition or integrity of a structure. The frequency of intervention seems surprisingly low. It is recommended that intervention rates for similar infrastructure operators are obtained and compared with these figures.	6.6.7	2
R6.5	In our review we have found little evidence that programmed maintenance activity such as preventive maintenance is considered for Civil Structures. Accordingly, there appears to be an opportunity to consider the potential benefits from increased routine maintenance (planned, regular	6.6.8	1

No.	Recommendation	Location in Text	Priority
	programmed interventions e.g. pointing, painting, de-vegetation etc.) as part of the lifecycle options. A secondary benefit of such activities is that they also provide an opportunity to view structure condition and identify unexpected defects. It is recommended that preventive maintenance is explicitly considered as part of the lifecycle planning options for Civil Structures at a group / sub-group level.		
R6.6	It is recommended that lifecycle plans are developed at a sub-group level to reflect the individual needs of particular Sub-Groups of Civil Structures assets and that a series of technical options considering both maintenance and renewal are produced for most or all of the defined Asset Intervention Policies.	6.6.9	3
R6.7	NR has advised that they are unable to demonstrate the cost effectiveness of maintenance painting. We understand that this conclusion was reached by comparing the net present value of bridge deck replacement with the current cost of maintenance painting, and therefore it is not done under normal circumstances. We have not reviewed the evidence which supports this conclusion. Given the large number of metal bridges under NR stewardship, there is an opportunity to work with the supply chain to develop improved specifications, materials and techniques which will enable this work to be carried out efficiently and cost effectively. It is recognised that this is a complex technical issue because there are many legacy paint systems in use.	6.7.13	4
R6.8	It is recommended that NR develops a formal explicit structures workbank of all currently outstanding work on a route. This should include any existing defects which are not currently been recorded. This unconstrained workbank should be independent of funding constraints / overall priorities. It should be made available and reviewed when funding levels are being set.	6.7.14	2
R6.9	Most infrastructure owners find estimation of future medium / long-term renewal requirements for Civil Structures to be a challenge. As part of our review work, initial discussions with some of the key utility and infrastructure organisations has been initiated. It is recommended that specific discussions about decision support tools and modelling should continue to be undertaken to benchmark and share experience in this area.	6.7.17	4
R6.10	Based on the above meetings, we consider that ORR/NR should jointly develop a set of explicit business rules to be used by NR in their asset planning and future development of a medium / long-term asset investment planning tool. These should be aligned to lifecycle planning principles as outlined above.	6.7.19	4
R6.11	It is recommended that the development of these	6.7.20	3

No.	Recommendation	Location in Text	Priority
	business rules and their implementation in to a medium / long-term asset investment planning tool should be independently reviewed in parallel with the development to ensure clarity of assumptions made in the planning.		
R6.12	As part of the development process, consideration should be given to identifying Civil Structures asset data sets likely to be required for the medium / long-term modelling so that any additional data sets can start to be collected as part of the inspection and examination process.	6.7.21	3
R6.13	Decision support tools can be particularly useful for developing medium / long-term workbanks and optimising different conflicting factors such as direct costs, penalty costs, costs from lost performance and amortised costs. The inclusion of an optimisation function may be a specific area to consider in the future tool.	6.7.22	8
R6.14	The effective medium / long term modelling of structures performance requires an understanding of the relationship between the three asset management variables: cost of service, level of service and reliability of service (or risk of service interruption). The application of risk based decision support tools is a developing area and it is recommended that this is a specific area for future research and development.	6.7.23	9
R6.15	It is noted that over a number of years NR have actively participated and supported in Construction Research and Information Association's (CIRIA) continuing research on infrastructure asset management. It is recommended that collaborative research would be a very appropriate way to develop the application of risk based decision support tools.	6.7.24	9
R6.16	We have not seen a commentary or similar document explaining how the recommendations made in the RAIB Report in December 2008 have been progressed. It is recommended that this is reviewed.	6.8.17	1
R6.17	NR have 17,000 retaining walls. Based on limited discussions and our review of NR Standards, we understand that retaining walls do not have an SCMI score from inspections and that their capacity is not routinely assessed. It is recommended that a condition scoring system for retaining walls is initiated together with a formal capacity assessment. Further work to understand the level of asset knowledge (inventory and condition etc.) and risks posed by of NR retaining walls is recommended.	6.8.18	3
R6.18	In the light of the R6.17, it is recommended that the prioritisation process is reviewed in some detail to understand how the relative merits of different asset renewal projects are evaluated.	6.8.19	2

No.	Recommendation	Location in Text	Priority
R6.19	Our remit did not include consideration of drainage issues. We note that the CP4 settlement included a sum of £200m to be spent on drainage matters. However, it is recommended that consideration is given to the prioritisation of slope drainage schemes as part of the wider review of relative priorities for maintenance works.	6.8.20	6
R6.20	We have not been provided with the justification for the reduction in annual earthworks expenditure over the control period, or information as to how this expenditure relates to condition, performance and risk associated with the earthworks asset. It is recommended that this is clarified with NR.	6.8.25	1
R6.21	It is recommended that NR consider producing a National Level Asset Management Plan to support requests for funding and to summarise how allocated funding will be used to deliver an agreed level of service within an acceptable risk profile. This National Level Asset Management Plan should also include an explicit planned volume of work.	6.10.10	3
R6.22	A key purpose of an AMP is to quantify any gap between current performance and the desired target performance. The current RAMP does not define a target performance for Civil Structures or current performance of Civil Structures on the route. This means that the RAMP is more of an inventory listing than a tool to direct future expenditure to achieve targets / outcomes. This is a key area for future development.	6.10.17	4
R6.23	We have not had sight of the planned development trajectory for RAMPs, and recommend that (if not done so already) a clear vision / blueprint for the 'to be' RAMP and how it will be used by the business is developed.	6.10.18	4
R6.24	In particular it would be useful for the RAMP in the future to include more about the planning and programming stage rather than simply being a summary of planned renewals delivery.	6.10.19	4
R6.25	This would recognise that the development will be incremental but provide a clear overall direction for the asset management planning process. Specifically it would be useful for the 'to be' process defining how the RAMPs will support the Interim Strategic Business Plan (ISBP) for CP5 to be articulated and shared with the ORR. This would link across to the business process mapping required for overall asset management and for Asset Management Information System development.	6.10.20	4
R6.26	A key aim of a network section level AMP, such as a RAMP, is to promote ownership and to be a practical aim to decision making. We have concerns that the sheer number of RAMPs (305) is too many to allow this to happen. In other organisations such as the HA, they have between 7 and 14 network section level AMP. We would	6.10.21	4

No.	Recommendation	Location in Text	Priority
	recommend that NR consider producing AMPs at an operational route level. These could be based on the RAMPs but collated into operational route level documents.		
R6.27	We find it surprising that only 13 out of the 300 major structures are planned to require maintenance expenditure in the 5 year CP4 period. It is recommended that this is investigated further.	6.10.28	3
R6.28	It is recommended that NR consider producing structure group / sub-group level AMP to help improve the sharing of best practice for Civil Structures management, promote uniformity of practice, and provide clarity as to the technical needs for on a structure group / sub-group level. Lifecycle planning would be a significant element in such structure group / sub-group level AMPs.	6.10.36	3
R6.29	In addition, it was suggested that a more holistic view should be taken at an individual bridge structure level. Initially, this potentially would require significant resource to develop individual plans but is something that NR should consider.	6.10.38	3
R6.30	NR should also consider combining the various individual separate processes and procedures as part of their 'to be' asset management process definition activity.	6.10.39	3
R6.31	It is recommended that NR explicitly consider future demand in their asset management planning process.	6.10.42	4
R6.32	The process of prioritisation is revised to show a clear decision making process which is based on coherent systems, supported by knowledge (e.g. RAMP Chesterfield Canal).	6.10.45 (a)	4
R6.33	Conditions score for bridges are enhanced to include both the overall SCMI score and a set of SCMI crit scores for critical elements.	6.10.45 (b)	1
R6.34	A more effective means of updating SCMI is developed.	6.10.45 (c)	1
R6.35	A system of grouping / sub-grouping of assets by type and behaviour is developed.	6.10.45 (d)	2
R6.36	The prioritisation process is made more explicit and transparent to include level of service considerations.	6.10.45 (e)	4

Further Work

No.	Findings	Location in Text	Priority
Definition and Delivery			
F6.1	It is understood that the SRM is primarily populated using relevant historical accident data but that where little data exists particularly for the low frequency but potentially high consequence accidents, the model makes use of predictive fault and event-tree modelling, structured expert judgement from technical specialists, and statistical methods. It is recommended that the applicability of such data to low frequency, high consequence events associated with Civil Structures (such as bridge deck failure or cutting failures) is reviewed.	6.8.26	

7 Definition and Delivery

7.1 Overall Process

7.1.1 In the Planning and Programming stage the following products are produced which form the key input to the Definition and Delivery stage:

- *a short-term constrained workbank is developed as a basis for delivery of asset maintenance and renewal (project delivery process); and*
- *a longer-term constrained workbank to inform future funding requirements (financial planning process).*

7.1.2 These are discussed in the following sections.

Figure 7.1: Simplified Process Model for Definition and Delivery

7.2 Project Delivery Process

7.2.1 The route SMEs review the recommendations for works that are noted in the examination reports. Works that are agreed to be necessary and which have an estimated cost that is less than £50,000 are added to the minor works list (workbank). Recommended works that are considered to be unnecessary are marked on the examination report as 'no further action' (this decision may be reviewed with an SSME or the RSE if there is uncertainty).

7.2.2 The minor works list is executed through a framework with a number of minor works framework contractors. Routes manage minor works projects differently, LNE using CARRS whereas Western do not.

7.2.3 When the RSE has decided that a major renewal (i.e. greater than £50k) is required, an Authority Request is prepared by the Route Structures Engineer (RSE) acting as Sponsor which then goes into the project delivery process.

7.2.4 When the RSE has decided that a major renewal (i.e. greater than £50k) is required, an Authority Request is prepared by the Route Structures Engineer (RSE) acting as Sponsor which sets out:

- Project aims;
- Deliverables;
- Compliance requirements (in accordance with the NR Guide to Railway Investment Process (GRIP) (NR website);
- Risks and opportunities; and
- Financial summary.

7.2.5 When this authority request has been approved, the project is handed over to the IP team for delivery. The IP team is a separate NR Directorate, operating within the route structure and across the NR technical functions, for example track, signalling, and civils.

7.2.6 Discussions with LNE route indicate that generally the asset team is not extensively involved with delivery of renewal projects, they are usually more involved with repair and maintenance projects where the scope may require further definition as the project progresses.

7.2.7 When a project moves into the GRIP process, responsibility for the structure passes from AM to IP, who will hand back at GRIP Stage 7.

7.2.8 The IP team are responsible for procuring and managing all aspects of the project; the RSE's team will be involved at specific formal stage gate reviews which are undertaken by the IP team. The investment lifecycle shows how a project is broken down into eight stages, which are:

- *GRIP 1 – Output definition (Statement of Need);*
- *GRIP 2 – Pre-feasibility (Investigate options);*
- *GRIP 3 – Option selection - shortlist options and identify preferred one or more (hence the need for external consultation during this stage);*
- *GRIP 4 – Single option selection – generally the outline design phase when the Form A is produced;*
- *GRIP 5 - Detailed design;*
- *GRIP 6 – Construction, test and commission;*
- *GRIP 7 – Scheme handback; and*
- *GRIP 8 – Project close out.*

7.2.9 The overall approach is product rather than process driven and each stage is required to deliver an agreed set of products to defined quality criteria. Possession availability and strategy can have major impact on timings for civils work, particularly large bridge renewals or other intrusive civils works, for example embankment reconstruction.

7.2.10 We have not reviewed the Definition and Delivery stage (GRIP processes etc.) as these processes are common to all NR project delivery. However, it is recommended that the application of GRIP to the renewal of Civil Structures could be an area for further review by ORR in conjunction with NR. In particular the application of Asset Intervention Policies and the application of value engineering to the options selection and evaluation process should be reviewed. ***[F7.1]***

7.2.11 We have attended a 'Deliverability Review' meeting with a route and been provided with copies of the presentation material tabled at reviews in LNE and Western. These meetings are focussed on reviewing progress with identified structures and earthworks projects. Risk to delivery forms a key item on the agenda.

7.3 Financial Planning Process

7.3.1 This is the development of a financial plan for the medium – long term based on a structures workbank. As noted above, we have not seen a medium – long term structures workbank.

7.3.2 We understand that the NR CP4 planning process has been extensively reviewed and revised for CP5. We have not reviewed the CP4 process and we have not seen details of the proposed CP5 process.

Summary

7.3.3 In summary we have not reviewed the Definition and Delivery stage (GRIP processes etc.) as these processes are common to all NR project delivery.

Further Work

No.	Findings	Location in Text	Priority
Definition and Delivery			
F7.1	We have not reviewed the Definition and Delivery stage (GRIP processes etc.) as these processes are common to all NR project delivery. However, it is recommended that the application of GRIP to the renewal of Civil Structures could be an area for further review by ORR in conjunction with NR. In particular the application of Asset Intervention Policies and the application of value engineering to the options selection and evaluation process should be reviewed..	7.2.10	8

8 Enablers

8.1 General

8.1.1 As well as core business process elements, an organisation will require supporting elements to enable it to operate effectively. These are generically called enablers.

8.1.2 We have divided these organisational enablers into four groupings namely:

- Processes (models of operations and functions etc.);
- Organisation (staffing levels, roles, skills, culture etc.);
- Technology (IT systems and tools, equipment etc.); and
- Information and data requirements.

8.2 Processes

8.2.1 NR is making significant progress towards a Process led Organisation, for example the Asset Management Building and Civils Business Planning Guidelines v1.2 (Ref 244). However, not all the relevant standards and guidance for asset management of Civil Structures are yet included on the process maps.

8.2.2 NR Standard NR/L1/ CIV/032 Issue 2 'The Management of Structures' (Ref 286) sets out the core procedures for structures management. In summary, there are a number of standards that set out various procedures associated with the management of structures, including, CIV/044 (Ref 285), CIV/035(Ref 308), CARRS Process Manual (Ref 060) etc. The relationships are shown schematically in Figures 8.1 and 8.2. In our review we did not find clear NR guidance on workbank prioritisation / value management. It is recommended that formal guidance is developed by NR. ***[R8.1]***

8.2.3 There is an opportunity to develop an *'Asset Manual for Management of Civil Structures'* to clearly link and present a line of sight, based on a process led basis to promote consistency and provide a clear base-line for future improvements. This would include a clear description of the connection between the processes at route level and the relevant standards. ***[R8.2]***

8.2.4 The manual would use the process maps that are currently under development by NR and provide and explicit and unambiguous linkage to existing standards and guidance. It would also serve to present the relationship between level of service targets (safety and service etc.) and the management of civil structures.

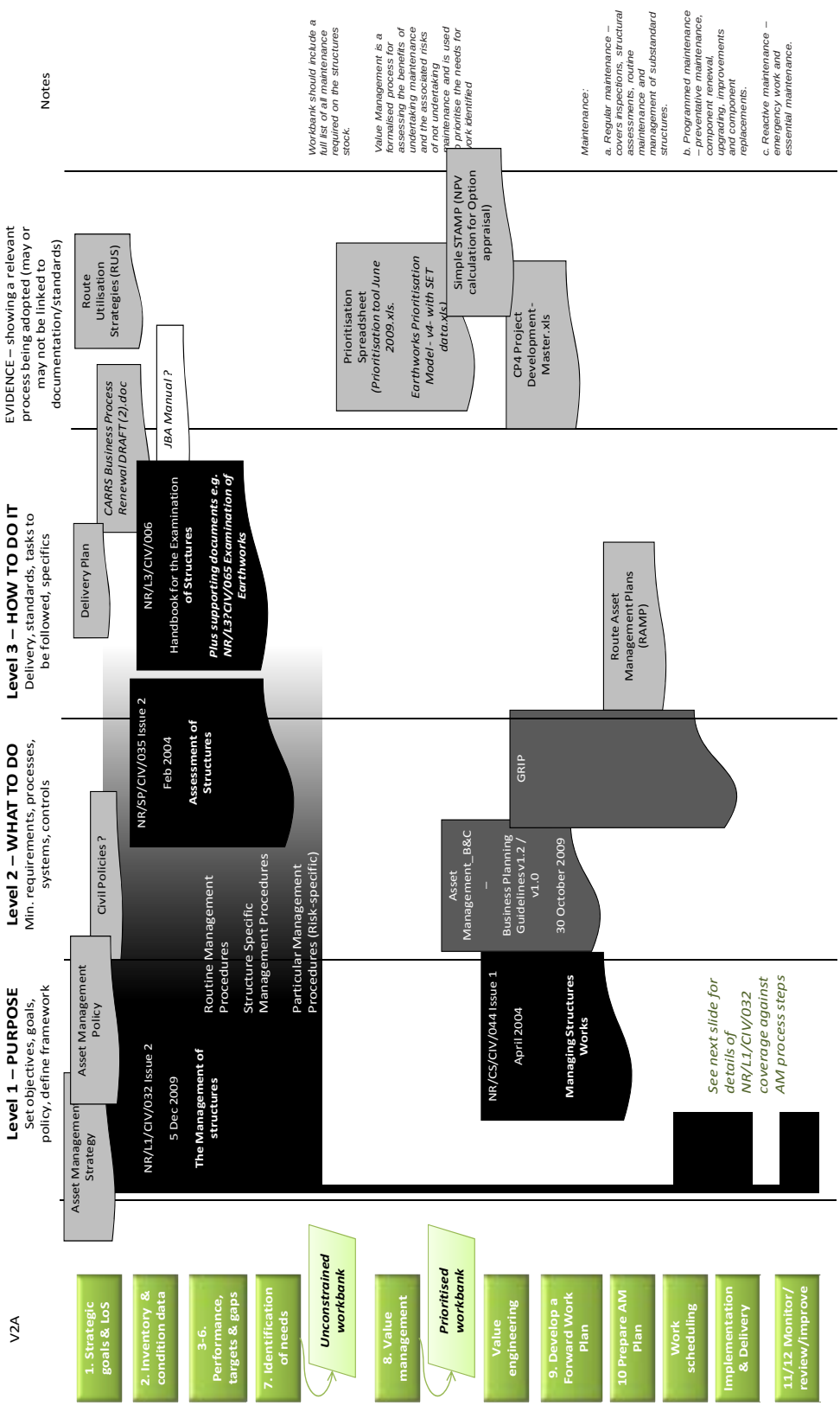


Figure 8.1: Mapping of Civil Structures Asset Management Standards and Guidance, also located in Appendix D.

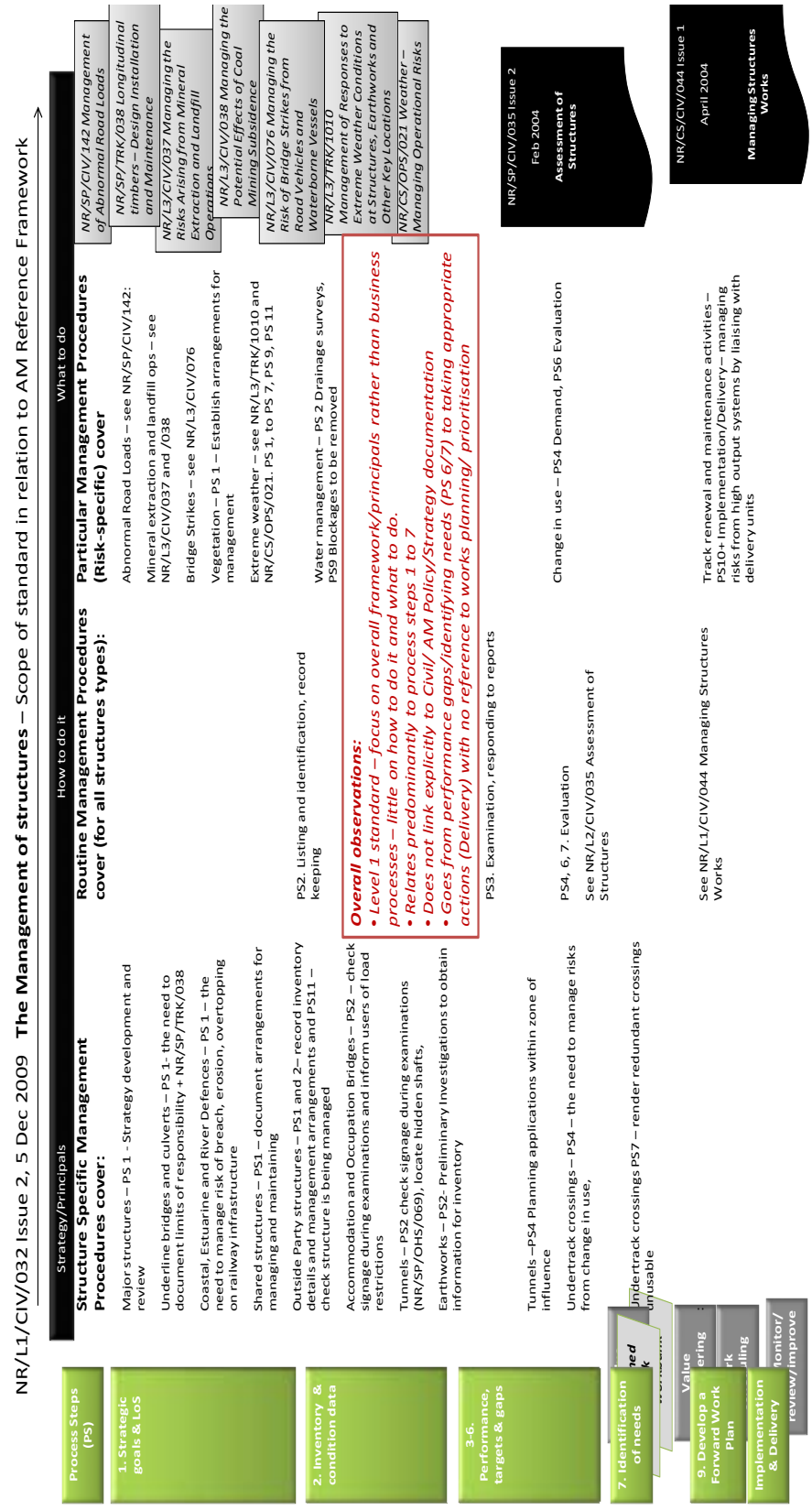


Figure 8.2: Mapping of Civil Structures Asset Management Standards and Guidance, also located in Appendix D.

8.3 Organisation

8.3.1 The NR Civils Asset Management team is organised around 5 Operational Routes (South East, Western, LNW, Scotland and LNE) with local Route asset management teams and a central asset management and engineering support function.

8.3.2 We have been provided with NR Organisation charts (Ref 045, 046) that show Building & Civils Asset Management as a single team. Discussion with the Route Asset Management teams gives us the impression of a two-tier organisation, the hands-on team at the Route level running day to day/ business as usual operations remote from a central management team who organise budgets and cascade various improvement initiatives down to the Routes. Whilst we have seen no evidence that this directly impacts on safety risk (as primary safety related decisions are made at Route level) there is a potential organisational and communication issue. It is recommended that NR considers measures to reduce this perceived two-tier organisation. ***[R8.3]***

Resource Levels

8.3.3 Discussion with the route asset management teams gives us the impression that the engineering resource level in the local route teams is very thinly stretched. In Western Route we understand that the Senior Structure Maintenance Engineers (SSMEs) each see about 20 structures per year out of a total stock of 6000 bridges. We understand that NR central asset managemnt team recommend that 1% of structures are visited each year.

8.3.4 LNE is now the only remaining route with a dedicated tunnel management resource. Other routes have moved to sharing this role with other responsibilities.

8.3.5 In the time available for this review we have been unable to benchmark the NR Route engineering resource levels with other similar organisations. However, as a simple comparator the HA has 7 regional based teams of Structures Delivery Team Advisers who undertake a role broadly compatible to that of the Route Civils Asset Team. The HA team comprises 1 Senior Adviser and 2 Advisers who are responsible for approximately 1200 Bridges. An equivalent NR Route Structures team in Western comprises 8 full time equivalents responsible for 6,000 bridges.

8.3.6 In addition there appears to be a financial constraint applied to the number of assessments that can be undertaken each year. Our discussions with Western route indicate that in the next four years (by 2014) they have 1100 arch assessments to be done in-house and 825 bridge assessments by CEFA. The current rate of CEFA assessments is 25-30 assessments per annum due, we were advised, to budget limitations.

8.3.7 Based on a NR bridge stock of 35,127 bridges and a suggested assessment interval of 18 years, this would imply 1,951 bridge assessments are required per annum. We have reviewed the Building and Civils team meeting ‘fat pack’ for Period 07 (Ref 385) and this indicates that 287 bridge assessments are planned to be undertaken nationally by the CEFA contractor during the FY 2010/11. It is recommended that this apparent disparity is reviewed and

that an explicit way forward is defined. It is our opinion that NR is not collecting sufficient asset measurement and condition data. ***[R8.4]***

8.3.8 It is recommended that the resource level and competency requirements (including professional qualifications) of route structures teams and the level of funding available for assessments is reviewed and benchmarked against other Infrastructure organisations. ***[R8.5]***

Competences, Training and Guidance

8.3.9 NR specification NR/SP/CMT/017 dated June 2006 sets out the minimum requirements for the training and assessment of people who undertake Civil Engineering work that may affect the Operational Safety of Network Rail controlled infrastructure, in order to ensure that personnel who undertake civil engineering work are competent to perform the work. The standard covers both earthworks and structures examiners.

8.3.10 This specification sets out a process by which candidates are required to demonstrate and maintain specific competencies for specific posts. There are comprehensive performance requirements for each post; these are generally assessed by the post holder's line manager. Simulated activities (e.g. use of photographs) can be used to generate valid evidence for specific aspects of the standards, for example to cover circumstances which occur infrequently.

8.3.11 There are no explicit technical or professional qualifications in this specification or levels of experience required for any of the posts, including Structures Managers and Examining Engineers. The current Tunnel Examination Code of Practice (NR/GN/CIV/026, Ref 230) requires Tunnel Examiners to be Chartered Civil Engineers, with experience in the examination and maintenance of tunnels.

8.3.12 We have been provided with documentation that indicates that NR has taken steps to assure competency of Route Earthworks Managers, but we have not seen similar documentation for Route Structures Engineers in general or specific bridge or tunnel skills.

8.3.13 We have not seen justification to support these apparent anomalies.

8.3.14 In our review we have not spent sufficient time with all routes to enable us to understand whether there are any clear differences in experience, qualifications and competence between Route Engineers and Managers from Structures, Earthworks and Tunnels in the various routes. It is recommended that this is investigated further. ***[R8.6]***

8.3.15 Our review of the NR standards and guidance has noted that the application of engineering judgement is enshrined in the documentation. For example:

- The assessment of Structures standard (NR/SP/CIV/035) requires an action plan to be in place to enable all structures not in the steady state to have a valid assessment. The action plan shall prioritise and define the programme for the assessments. There is no specific 'long-stop' date between assessments and therefore the timing is up to the judgement of the RSE.

- Engineering Verification standards (NR/L2/EBM/070, NR/L3/EBM/071) do not define the number, frequency or type of verification checks to be undertaken and civils-specific guidance is referred to the Professional Head to provide.

8.3.16 Whilst we accept that professional judgement is central to the management of structures, we have concerns that the current resource level, combined with the need for asset specific knowledge and the number of structures that each Route is responsible for, makes the Route Structures team vulnerable in terms of asset management resilience.

8.3.17 We also would note that care should be exercised by NR when moving from the current engineering judgement model to a process defined model to make sure that areas that require engineering judgement are maintained such that complex decisions are not over simplified. ***[R 8.7]***

8.3.18 In our opinion the roles of RSE and SSME require considerable hands-on experience in management of various types of structure to reach a level of competence appropriate to their roles. With the move to outsource detailed inspections to the CEFA Contractor, we are unclear how NR staff will be trained to develop into the role of RSE /SSME in the future. We would recommend that NR considers secondment of staff to the CEFA contractor or similar to ensure that such knowledge and experience is built up by future staff. ***[R8.8]***

8.3.19 We recommend that NR considers specific training courses for engineers maintaining different types of structure such as masonry arch structures and riveted and wrought iron bridges. ***[R8.9]***

8.3.20 Many of the inspectors we met are towards the end of their careers, with little evidence of any succession planning. We recommend that Network Rail consider training and recruitment of future inspectors with Amey and their other suppliers to ensure that the availability of suitability experience, knowledge and skills is reliably maintained for the future. ***[R8.10]***

8.4 Technology

Information Systems

8.4.1 We have read the NR Asset Information Strategy (Ref 394) and we understand that NR are currently reviewing and re-designing business processes for their Civil Engineering function and that once the business processes have been re-designed NR will be embarking on an IT systems and data project to develop and implement new system(s) to support the future processes and business objectives in advance of the beginning of the next regulatory cycle.

8.4.2 Specifically, we understand that these new IT system(s) will replace CARRS and the JBA database (Earthworks).

8.4.3 We have not had sight of this work, but based on our experience with other infrastructure organisations, there is a need for significant input from the route teams who will be using the systems to define both the ‘as-is’ processes and the ‘to-be’ processes. The detailed definition of such

processes is vital before an Asset Information System purchase is made. It is recommended that significant resource is allocated from the Route engineering teams to undertake such work with the IT business analysis function. ***[R8.11]***

8.4.4 It is recommended that NR consider the following specific aspects when scoping their requirements:

a) adopting a GIS based asset information system in the future to facilitate map based access to asset data;

b) including a facility for incorporating data from imaging and remote sensing techniques to provide improved qualitative and quantitative techniques;

c) including a facility for incorporating instrumentation / monitoring data; and

d) including use of handheld devices to record data in the field and transfer directly to the database. The handheld device would be able to upload historic asset information to support field inspections. ***[R8.12]***

8.5 Information and Data

Asset Data

8.5.1 The primary source of asset data comes from detailed examinations and assessments.

8.5.2 Following recent events, such as Stewarton and Enterkin Burn, NR is making renewed effort to understand the nature, current condition and behaviour of their Civil Structures. However the sheer number of Civil Structures (for example there are over 35,000 bridges) makes this a significant task. NR is making significant progress in developing RAMPs for their 300 strategic route sections. However, it is our opinion that there needs to be improved focus on collecting the critical data that will allow effective management of each asset.

Data Sources

8.5.3 In our visits to the routes we have found that the asset management team do not routinely have access to the component level data that is gathered in examination to calculate the SCMI score; the CARRS database only stores the overall condition score. The overall score is an aggregated score in which the effect of averaging means that poor individual scores for parts of the asset can be hidden by counterbalancing better scores for other parts.

8.5.4 Other information sources store the assessment results data and yet further sources store as built drawings or other works records (CCMS2 and DMFP). All of these data sources store an incomplete set of information, which means that the routes also create local data sources to fill the gaps in the main data sources. Routes take different approaches to this gap filling, resulting in numerous local databases or spreadsheets.

8.5.5 Additionally, in some routes the data connection to the central CARRS database is considered so unreliable that local copies of data normally held in CARRS are held on local servers and are used in preference to the CARRS database itself. Thus, the sources of data that are used exist in different states of currency, completeness format and coverage.

Data Quality

8.5.6 The non-uniformity of the data sources that the routes need to consult in order to obtain necessary information hampers their effectiveness in making important decisions.

8.5.7 Examinations are currently conducted annually for visual examinations, and typically 6 yearly for detailed examinations. Neither of these examinations record structure dimensions in a systematic way. Data for SCMI scoring is only recorded at the detailed examination. Detailed examinations would tend to report section thickness loss or loss of brickwork thickness, but this fact is of little value unless its context is also recorded, for example measurements taken at known locations. Recording the loss of thickness relative to the original thickness gives definite knowledge about the severity of corrosion, which coupled with certainty of location can assist in determining the loss in load carrying capacity. With masonry structures, recording loss of pointing, crack widths, lengths and direction are of equal importance.

8.5.8 Principal structure dimensions and section thicknesses are only recorded for assessments which can be as much as 18 years apart. This data can often be difficult to obtain, leading to reuse of data from older reports. This was a factor in the Stewarton collapse as errors in the interpretation of old data were perpetuated as a consequence (Ref 362). The RAIB report states that the causal factors were:

- *'the hidden corrosion trap affecting the inner surfaces of the main girders; the corrosion resulted in a loss of thickness of the web plates of these girders, and in places holes formed.*
- *the use of incorrectly assumed dimensions for the thicknesses of these web plates in the last two routine assessments of Bridge 88 (undertaken in 1982 and 1994), and no allowance for web plate corrosion loss; this meant that the calculated live load capacity of the east and centre main girders was higher than it should have been, and as a result, the reports of corrosion defects were not acted upon.'*

8.5.9 The RAIB Report on the Stewarton Bridge collapse does not give an overall SCMI score for the bridge. The RAIB re-scored the component level data based on the Atkins records from the examination. The score for the main girder was 50 and for the eastern outer girder was 10.

8.5.10 In response, NR carried out further checks on similar bridges: 1357 bridges were reviewed, 663 bridges inspected by engineers on site and 221 bridges have had physical works undertaken to expose hidden main girders of bridges similar to Stewarton. There was an issue with this work in defining for hidden critical elements 'what good looks like' and providing points of reference to the examiners. No bridge was identified to be in a similar condition to the bridge at Stewarton. Twenty bridges have however required

urgent repair (by November, nineteen complete and design of repairs progressing for works to repair last bridge) and nine bridges have required Temporary Speed Restrictions or other operating restrictions. (Ref 241)

8.5.11 The incident demonstrates that the existing records alone were insufficient to make judgements about the current capacity of the bridges; and that the inspection and reporting system failed to remedy a significant number of bridges with severe defects.

8.5.12 None of the data recorded for SCMI is updated when repairs or renewal are carried out so that it can be up to 6 years before the condition score is corrected to show the improvement.

Asset Families and Groups

8.5.13 There appears to be no means of grouping the CARRS asset data into families at present unless complex searches are constructed that interrogate the CARRS base data. This kind of query is beyond the capability of the Route staff. The lack of asset grouping makes it difficult to see whether there are common problems with assets of similar form. Without the ability to group, it is difficult to find common solutions and to make action plans for resolution.

8.5.14 Once asset groups are developed it will be possible to develop lifecycle plans for asset families which would lead to the development of specific asset management plans.

Potential for tracking degradation from assessment reports

8.5.15 We examined a number of reports for a sample structure (Underbridge ECM1/307 Chesterfield Canal):

- 1983 Assessment report (based on a 1977 assessment and supplemented with data from a 1963 assessment)
- 2005 Detailed Examination report
- 2008 Assessment report

8.5.16 There are a few direct comparisons that can be made on corroded sections. One cross girder seems to have changed from ½" (6mm) loss to 4mm loss.

8.5.17 Ballast was added in 1969 - previously it was direct fixed track. A comparison of section sizes used for the 1983 and 2008 analyses was attempted to see if this showed section loss over 25 years the data is however inconclusive. There are references to drawings that are not attached to the 2005 / 8 reports. The 2008 assessment report states that the shortfall in capacity can be attributed to a general weakness of the various elements rather than to any particular deterioration due to corrosion.

8.5.18 The 1983 assessment followed on traditional permissible stress calculation methods using BR standards, which were based on BS153; a permissible stress of 10 Tons/sq-inch (154N/mm2) was used. However, the 2008 assessment adopted load factor and limit state principles in accordance with

NR standards which are based on BS5400; a characteristic steel strength of 205N/mm²was used. Because of this fundamental change in approach, direct comparison of assumed material strengths is difficult, but we consider that the material strengths assumed in the two assessments are broadly comparable.

Conclusions

8.5.19 From our review of these documents, in our opinion it would be very difficult to use these documents to identify deterioration in the structure if numerous reports arrived per week. It really needs about ½ to 1 day per bridge to fully understand and compare the information, particularly where the assessments are carried out in both imperial and metric units to different standards. The time involved in making the information comparable is significant. With a better copy of the 1983 inspection record it would be possible to read the recorded section thickness / losses, and to possibly see a deterioration in the structure. However, it seems that different areas of the bridge are recorded as corroded on the two occasions. It is hard therefore to say that it shows a picture of deterioration.

8.5.20 The following recommendations are based on our reviews undertaken with NR in Swindon and York. It is recommended that:

a) NR more explicitly define the critical elements of different types of Civil Structures and identify suitable sub-groups such as different types of arch bridges, overconsolidated clay cuttings etc. based on their differences in engineering behaviour. The use of FMEA and similar techniques should be considered by NR for this activity. ***[R8.13]***

b) NR then collate existing asset information for these critical elements of Civil Structures and jointly review and agree with ORR the need for further inventory and condition data for the effective management of each asset sub-group. This work should be treated as a project with a specific full-time resource allocated, and should draw on the experience of other organisations. ***[R8.14]***

c) Based on the outcome from the collation exercise, a specific asset knowledge gap filling project should be initiated to provide missing critical asset data. ***[R8.15]***

d) NR should then consider obtaining more frequent measurements of condition to support deterioration modelling. Better integration of examination and assessment processes may assist in this respect. ***[R8.16]***

Examinations and Assessments

8.5.21 NR Standard NR/SP/CIV/035 states that action plans are required for all structures not in the ‘Steady-State’ (structures not having a structural assessment completed within the last 18 years).

8.5.22 In our review we have not seen any information or plans for assessment showing the time since last assessments. We have also not seen any action plans.

8.5.23 We have discussed assessments with the Routes in particular Western. We understand that an 18 year assessment programme commenced in 1996, and is due to run to 2014. Based on our discussions with Western we understand that the current position for the Route is:

- approximately 900 bridges have been assessed by Local Authorities (under the Bridgeguard programme).
- approximately 2000 remain to be assessed by 2014 comprising approximately:
  - 150 no concrete bridges (to be done by CEFA contractor)
  - 650 no metallic bridges (to be done by CEFA contractor)
  - 17 no timber bridges (to be done by CEFA contractor)
  - 1100 no arches to be done by the Route team themselves, but the current rate of progress is only 50 per year.

8.5.24 The CEFA contractor is undertaking about 25 to 30 assessments per year.

8.5.25 From the figures supplied by Western it appears that this assessment work will not complete by 2014 and that the rate of completion of assessments is significantly less than required. The main reason for this stated by NR is that they see little value in carrying out costly assessments which may find no or few capacity issues. There is an opportunity to develop a more focused, cost effective and more timely assessment regimes. ***[R8.17]***

8.5.26 We have identified organisations such as LUL and TfL who report condition scores for the critical elements in addition to the average for the structure. In our opinion this provides a better indication of the variability of condition. It is recommended that NR consider adopting a similar approach. ***[R8.18]***

8.5.27 Opportunities also exist to derive more useful measures of condition by taking measurements from defined points for example, mid span, quarter points and ends so that a reliable framework of data can be built on which to assess trends. Measuring condition at known points would also assist over a period of time in linking condition information to assessed capacity data. Other attributes would need to be taken into account in such an assessment (age, material, exposure etc). It is recommended that NR review their examination requirements to consider this opportunity. ***[R8.19]***

8.5.28 There is an opportunity to derive further useful data for selected structures by relating SCMI scores for both structures and elements to historic examination records. ***[R8.20]***

Risk Based Examination Intervals

8.5.29 In 2010 NR introduced a new suite of standards for Examination of Structures which included NR/L3/CIV/006. This standard introduced the principle of variable frequencies for detailed examinations in place of the previously adopted standard of 6 years. NR is the first major infrastructure owner in the UK to adopt this approach, although others are considering doing so.

8.5.30 A change to risk based examination intervals requires a thorough understanding of the condition, performance and risk level of each asset or asset sub group. We have not seen any evidence related to these issues. In principle the adoption of risk based examination intervals provides a method of targeting examination effort in a more effective way. However in our opinion the implementation of risk based examination intervals requires further review by NR, because of the short comings in asset knowledge discussed elsewhere in this report. ***[R8.21]***

8.5.31 Structural failure modes can be typified in two forms, quasi-brittle and quasi-ductile. Quasi-brittle failures, for example fatigue cracking, take place with little deformation prior to failure, which is often sudden.

8.5.32 In quasi-ductile failures, structures deform plastically and progressively. At ultimate failure the structure will have experienced a significant degree of deformation.

8.5.33 As a first approximation, assuming that performance can be correlated somehow with time, asset behaviour can be represented as shown in Figure 8.1, below.

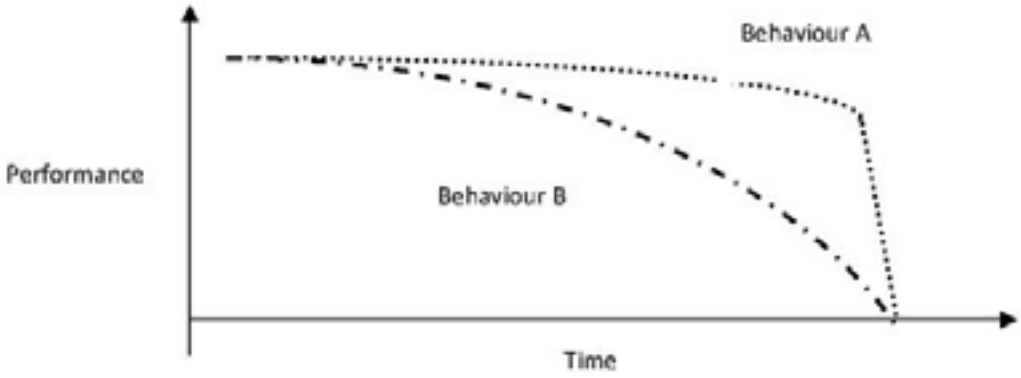


Figure 8.3: Illustration of ductile behaviour compared to brittle behaviour

8.5.34 Behaviour A is described conceptually as brittle failure. This is the mode of failure of, for example, a sheet of glass. The key feature of this mode of failure is that it provides little prior indication of a change in behaviour from 'gradual' reduction in performance to 'failure'.

8.5.35 Behaviour B is described conceptually as ductile failure. This is the mode of failure of, for example, soft iron. This mode of failure gives warning in the form of increasing deflections and may occur sufficiently slowly to enable the behaviour to be measured and extrapolated to provide a prediction of future performance. The other implicit feature of ductile behaviour is that there will be sufficient time to implement a plan of remedial action before 'failure' occurs.

8.5.36 Prediction of behaviour of Civil Structures requires a clear understanding of:

- the structural form so that load paths and global behaviour can be understood;

- the detailed structural system, in particular, the inter-relationship between 'components' such as beams and cross girders and 'elements' such as stiffeners (for example, this requires maintaining inventory data on the structure to be maintained at 'component' level;
- the long-term behaviour and deterioration of 'components' or 'elements' (for example behaviour A vs behaviour B in Figure 8.1);
- the current condition of 'components' or 'elements' (i.e. where on the long-term behaviour 'curve' each is at the current time); and
- what trigger events might cause a change in behaviour (e.g. change in loading pattern, climate, corrosion etc).

8.5.37 Useful guidance on the prediction of future behaviour of structural systems is given in the CIRIA Report R185[32] (Ref 414), the report states:

'…the Observational Method (OM) operates most effectively when conditions deteriorate only gradually to the design limit states. This enables monitoring records to be reviewed so that there is time after discovery for the modification plan to be implemented. The faster the deterioration rate the greater the requirement for continuous monitoring with immediate review …'

8.5.38 The CIRIA report notes that brittle behaviour of elements often leads to progressive failure. Stress is transferred to adjacent elements which in turn become overstressed, leading to progressive and rapid development of an extensive failure. This emphasises the point that the resilience of an overall structural system, that is its ability to re-distribute load via alternative load paths will be an important consideration when creating sub-groups of structures according to their behaviour.

8.5.39 Fundamentally, the adoption of risk based examination intervals requires the examiner to make a judgement on whether the asset condition is such that he can confidently assume that the asset will continue to be serviceable until the next detailed examination.

8.5.40 The proposal to reduce the period between examinations for some critical structures to less than 6 years is positive and is in line with the proposals by TfL and WAG. In principle, extending the interval for detailed examinations may be justified for some structures. However, we have yet to be convinced that extending examination intervals from the current industry accepted practice can be justified especially without some consideration of possible new and emerging failure modes. For example, there is growing evidence that masonry arch structures may be susceptible to cyclic fatigue which may induce a critical step change in behaviour. Although we understand that NR has taken action to address this particular topic, it highlights the need for caution when extending examination intervals. We have not reviewed any NR information on masonry fatigue.

8.5.41 It is our opinion that risk based examination intervals should be considered in relation to the specific behaviour of structures. It is recommended that

[32] CIRIA (1999) 'The Observational Method in ground engineering: principles and applications' Report 185 London 1999 (Ref 414).

risk based examination intervals are explicitly considered in the lifecycle planning for each sub-group of civil assets. ***[R8.22]***

8.5.42 It is noted that the RSSB report (Ref 105) recommended that, in order to assess the feasibility of the risk based approach, a three phase plan should be implemented, namely:

a) data collection and analysis to substantiate the risk-based approach;

b) consultation with the industry to confirm the approach and consider its implications; and

c) trial runs of the applications of variable examination intervals.

8.5.43 We have not been provided with information to indicate that the first of these recommended steps have been undertaken by NR.

8.5.44 Presently the application of risk based examination intervals relies on being able to make an assessment, based on current condition, of the time that will elapse before the asset reaches a state that is unacceptable (either from condition or risk) in sufficient time to be able to plan for repairs or replacement. From the extent of examination information that we have reviewed, we believe that knowledge of asset deterioration modes and factual condition data on which it must rely is presently inadequate to allow such a judgement to be made with any degree of certainty.

8.5.45 It is recommended that initially NR consider data collection and analysis to substantiate the risk-based approach as suggested by RSSB. ***[R 8.23]***

Recommendations

8.5.46 The recommendations in section 8 are as follows:

No.	Recommendation	Location in Text	Priority
Enablers			
R8.1	NR Standard NR/L1/ CIV/032 Issue 2 'The Management of Structures' (Ref 286) sets out the core procedures for structures management. In summary, there are a number of standards that set out various procedures associated with the management of structures, including, CIV/044 (Ref 285), CIV/035(Ref 308), CARRS Process Manual (Ref 060) etc. The relationships are shown schematically in Figures 8.1 and 8.2. In our review we did not find clear NR guidance on workbank prioritisation / value management. It is recommended that formal guidance is developed by NR	8.2.2	7
R8.2	There is an opportunity to develop an *'Asset Manual for Management of Civil Structures'* to clearly link and present a line of sight, based on a process led basis to promote consistency and provide a clear base-line for future improvements. This would include a clear description of the connection between the processes at route level and the relevant standards.	8.2.3	3

R8.3	We have been provided with NR Organisation charts (Ref 045, 046) that show Building & Civils Asset Management as a single team. Discussion with the Route Asset Management teams gives us the impression of a two-tier organisation, the hands-on team at the Route level running day to day/ business as usual operations remote from a central management team who organise budgets and cascade various improvement initiatives down to the Routes. Whilst we have seen no evidence that this directly impacts on safety risk (as primary safety related decisions are made at Route level) there is a potential organisational and communication issue. It is recommended that NR considers measures to reduce this perceived two-tier organisation	8.3.2	7
R8.4	Based on a NR bridge stock of 35,127 bridges and a suggested assessment interval of 18 years, this would imply 1,951 bridge assessments are required per annum. We have reviewed the Building and Civils team meeting 'fat pack' for Period 07 (Ref 385) and this indicates that 287 bridge assessments are planned to be undertaken nationally by the CEFA contractor during the FY 2010/11. It is recommended that this apparent disparity is reviewed and that an explicit way forward is defined. It is our opinion that NR is not collecting sufficient asset measurement and condition data.	8.3.7	1
R8.5	It is recommended that the resource level and competency requirements (including professional qualifications) of route structures teams and level of funding available for assessments is reviewed and benchmarked against other Infrastructure organisations	8.3.8	3
R8.6	In our review we have not spent sufficient time with all routes to enable us to understand whether there are any clear differences in experience, qualifications and competence between Route Engineers and Managers from Structures, Earthworks and Tunnels in the various routes. It is recommended that this is investigated further.	8.3.14	10
R8.7	We also would note that care should be exercised by NR when moving from the current engineering judgement model to a process defined model to make sure that areas that require engineering judgement are maintained such that complex decisions are not over simplified.	8.3.17	3
R8.8	In our opinion the roles of RSE and SSME require considerable hands-on experience in management of various types of structure to reach a level of competence appropriate to their roles. With the move to outsource detailed inspections to the CEFA Contractor, we are unclear how NR staff will be trained to develop into the role of RSE /SSME in the future. We would recommend that NR considers secondment of staff to the CEFA contractor or similar to ensure that such knowledge and experience is built up by future staff.	8.3.18	3

R8.9	We recommend that NR considers specific training courses for engineers maintaining different types of structure such as masonry arch structures and riveted and wrought iron bridges.	8.3.19	2
R8.10	Many of the inspectors we met are towards the end of their careers, with little evidence of any succession planning. We recommend that Network Rail consider training and recruitment of future inspectors with Amey and their other suppliers to ensure that the availability of suitability experience, knowledge and skills is reliably maintained for the future.	8.3.20	2
R8.11	We have not had sight of this work, but based on our experience with other infrastructure organisations, there is a need for significant input from the route teams who will be using the systems to define both the 'as-is' processes and the 'to-be' processes. The detailed definition of such processes is vital before an Asset Information System purchase is made. It is recommended that significant resource is allocated from the Route engineering teams to undertake such work with the IT business analysis function.	8.4.3	2
R8.12	It is recommended that NR consider the following specific aspects when scoping their requirements: a) adopting a GIS based asset information system in the future to facilitate map based access to asset data; b) including a facility for incorporating data from imaging and remote sensing techniques to provide improved qualitative and quantitative techniques; c) including a facility for incorporating instrumentation / monitoring data; and d) including use of handheld devices to record data in the field and transfer directly to the database. The handheld device would be able to upload historic asset information to support field inspections.	8.4.4	
R8.13	NR more explicitly define the critical elements of different types of Civil Structures and identify suitable sub-groups such as different types of arch bridges, overconsolidated clay cuttings etc. based on their differences in engineering behaviour. The use of FMEA and similar techniques should be considered by NR for this activity.	8.5.20 (a)	1
R8.14	NR then collate existing asset information for these critical elements of Civil Structures and jointly review and agree with ORR the need for further inventory and condition data for the effective management of each asset sub-group. This work should be treated as a project with a specific full-time resource allocated, and should draw on the experience of other organisations.	8.5.20 (b)	1
R8.15	Based on the outcome from the collation exercise, a specific asset knowledge gap filling project should be initiated to provide missing critical asset data.	8.5.20(c)	2

R8.16	NR should then consider obtaining more frequent measurements of condition to support deterioration modelling. Better integration of examination and assessment processes may assist in this respect.	8.5.20 (d)	2
R8.17	From the figures supplied by Western it appears that this assessment work will not complete by 2014 and that the rate of completion of assessments is significantly less than required. The main reason for this stated by NR is the coast of carrying out assessments which may find no or few capacity issues. There is an opportunity to develop a more focused, cost effective and more timely assessment regimes.	8.5.25	1
R8.18	We have identified organisations such as LUL and TfL who report condition scores for the critical elements in addition to the average for the structure. In our opinion this provides a better indication of the variability of condition. It is recommended that NR consider adopting a similar approach.	8.5.26	1
R8.19	Opportunities also exist to derive more useful measures of condition by taking measurements from defined points for example, mid span, quarter points and ends so that a reliable framework of data can be built on which to assess trends. Measuring condition at known points would also assist over a period of time in linking condition information to assessed capacity data. Other attributes would need to be taken into account in such an assessment (age, material, exposure etc). It is recommended that NR review their examination requirements to consider this opportunity.	8.5.27	1
R8.20	There is an opportunity to derive further useful data for selected structures by relating SCMI scores to historic examination records.	8.5.28	1
R8.21	A change to risk based examination intervals requires a thorough understanding of the condition, performance and risk level of each asset sub group. We have not seen any evidence related to these issues. In principle the adoption of risk based examination intervals provides a method of targeting examination effort in a more effective way. However in our opinion the implementation of risk based examination intervals requires further review by NR, because of the short comings in asset knowledge discussed elsewhere in this report.	8.5.30	1
R8.22	It is our opinion that risk based examination intervals should be considered in relation to the specific behaviour of structures. It is recommended that risk based examination intervals are explicitly considered in the lifecycle planning for each sub-group of civil assets.	8.5.41	3
R8.23	It is recommended that initially NR consider data collection and analysis to substantiate the risk-based approach as suggested by RSSB.	8.5.45	2

9 Continual Improvement

9.1 General

9.1.1 Continual improvement is defined by the Chartered Quality Institute[33] as: *'Continual improvement is a type of change that is focused on increasing the effectiveness and/or efficiency of an organisation to fulfil its policy and objectives. It is not limited to quality initiatives. Improvement in business strategy, business results, customer, employee and supplier relationships can be subject to continual improvement. Put simply, it means 'getting better all the time'.*

9.1.2 Continual improvement is a core process in ISO 9001[34] and PAS 55-1(Ref 384). Audit processes are usually directly linked to continual improvement processes, whereby non conformances identified in an audit are formally reviewed on a periodic basis as a source for improvement areas.

9.2 Audit and Assurance

9.2.1 We note that AMCL in their report '2010 Best Practice Review Update' (Ref 041) refer to a NR process for undertaking internal audits called NCAP (National Core Audit Programme) and a Network Rail Audit Manual. AMCL note that:

"Network Rail has a process of undertaking internal audits called NCAP (National Core Audit Programme) and the requirements for these audits are documented within Network Rail's Audit.Manual. The NCAP audit process still appears effective, with full independence of auditors achieved. A significant development is the creation of the 'Assurance Framework' which is aiming to improve Network Rail's compliance against standards and requirements. Although still embryonic, the Framework sets out to monitor a range of compliance KPIs and the new 'Compliance and Assurance' section supports the organisation in achieving compliance through specific initiatives (it does not audit)."

9.2.2 AMCL note that the newest part of the Assurance Framework is the concept of verification activities, whereby Level 1 (national) and Level 2 (geographical) engineers have specific on the ground assurance activities to undertake every year.

9.2.3 The framework is shown in Figure 9.1.

[33] http://www.thecqi.org/Knowledge-Hub/Resources/Factsheets/Continual-improvement/
[34] BS EN ISO 9001:2008 Quality management systems – Requirements

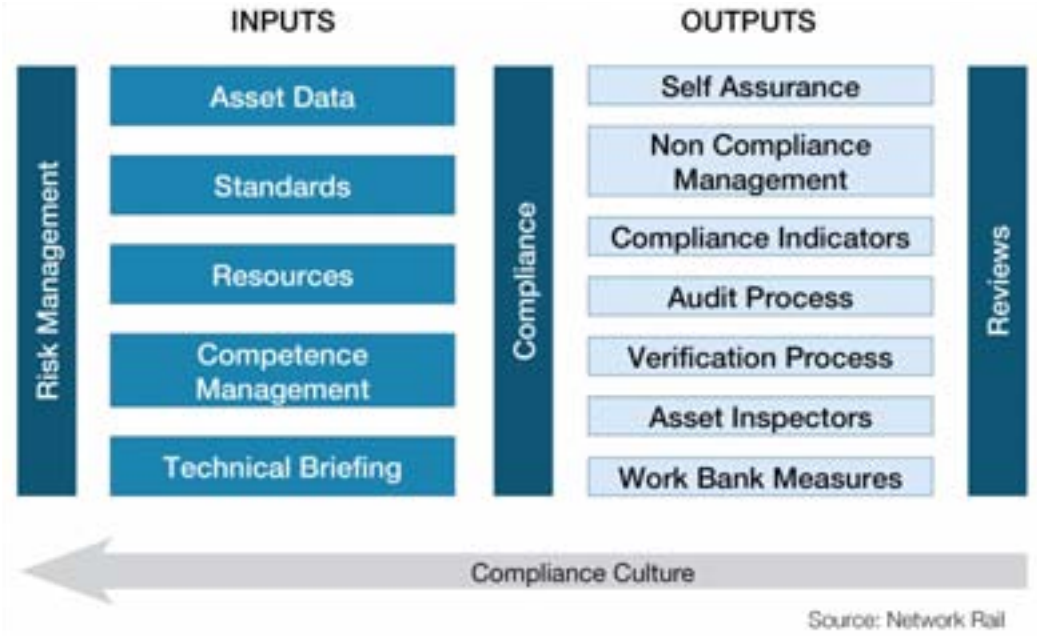


Figure 9.1 Assurance Framework (Ref 041)

9.2.4 We have met with the NR Senior Policy Development Specialist who is responsible for verification activities and we have read Standards NR/L2/EBM/070 Issue 1 and NR/L3/EBM/071 issue 1 both dated June 2009.

9.2.5 Standard NR/L2/EBM/070 states the purpose of verification as being:

9.2.6 *'The Engineering Verification process provides a means for Engineering to independently verify that Network Rail standards and specifications are correctly implemented and that assets are fit for purpose. This takes the form of:*

- *visual and tactile checks of the assets by small teams of engineers and technical specialists;*
- *checking the condition, activities and records of the infrastructure assets for compliance to engineering specifications, standards, processes and procedure, and confirming understanding of them; and highlighting:*
  - *actions that require intervention or immediate action;*
  - *skill gaps and training needs; and*
  - *areas requiring maintenance support for the consistent application of systems and processes.'*

9.2.7 It is noted that NR/L3/EBM/071 contains specific guidance for track, signalling and telecoms. Civils and E&P specific guidance is not included and the standard states that '*guidance should be sought from the relevant Professional Head(s)'*.

9.2.8 Appendix D of NR/L3/EBM/071 is entitled Civils Specific guidance, and whereas the other discipline specific appendices provide guidance for verification activities, Appendix D states only that guidance should be

sought from relevant Professional Heads. It is recommended that explicit civils specific guidance related to each asset group is included in the next issue of the standard. ***[R9.1]***

9.2.9 We have been provided with an verification check schedule for 2010/11 (Ref 395). This includes 154 planned verification checks.

9.2.10 A review of the NR (NR Asset Management – Engineering B&C '*Fat Pack*' 2010/11 Period 07 (Ref 385)) indicates that there in the year to the end of Period 07 there were 32 structures and 23 earthworks verifications undertaken and reported. The 'Fat Pack' indicates that 73 verifications carried out compared to the 82 planned. Extracts from the pack are included as Figures 9.2 and 9.3 below.

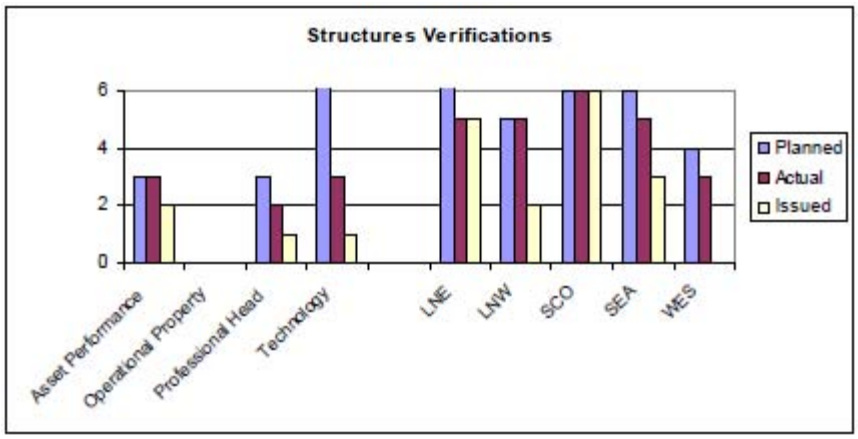


Figure 9.2: Structures Verifications (Ref 395)

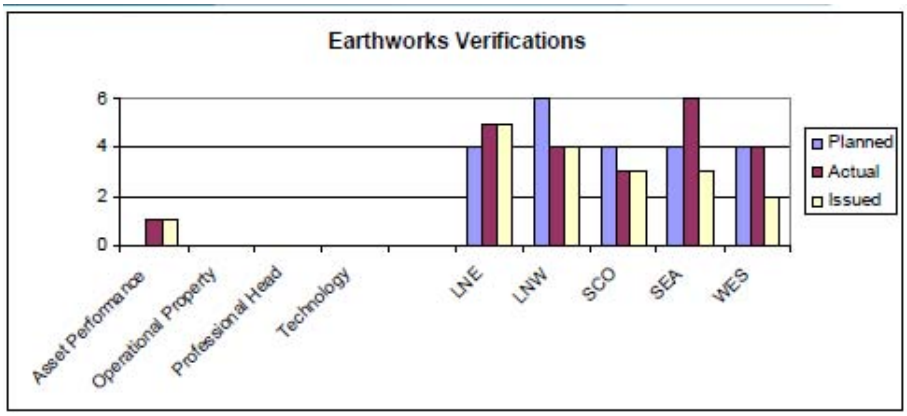


Figure 9.3: Earthworks Verifications (Ref 395)

9.2.11 Whilst the existence of the engineering verification process is reassuring it is unclear to us:

- how the verification checks are targeted;
- how the number of checks per annum is decided;
- the exact scope of each check; and
- how feedback is incorporated into a continual improvement process.

9.2.12 There is potentially an opportunity for NR to link the engineering verification process maps more explicitly into the overall asset management of Civil Structures and to develop and implement a specific regime of audits / verification related to critical aspects of Civil Structures asset management. ***[R9.2]***

9.3 Knowledge Management

9.3.1 Based on our review, the Route Asset Stewards meet regularly – however, the focus appears to be on day to day business and issues rather than on long term strategy or risks.

9.3.2 We found little evidence of systematic knowledge capture (except in Geotechnics teams) and in the deliverability review (see below).

9.3.3 During our review we have seen some evidence of the capture of 'best practice' – for example this was a specific item on the agenda for the deliverability review meeting in Western Operational Route. However we have not seen evidence as to how this knowledge is captured centrally and disseminated to other routes. The knowledge sharing does not appear to be part of a formal continual improvement process.

9.3.4 It is our view that there is an opportunity for more formal pooling of knowledge and experience between routes and which is not currently shared. This would be part of a formal continual improvement process. ***[R9.3]***

9.3.5 Our review indicates that the routes are primarily focused on day to day activities associated with managing a complex legacy asset of Civil Structures. It is recommended that NR/ORR to establish a broadly based group to consider the longer term strategy for risk management of Civil Structures. This would include foresighting and similar to explore possible future risks ***[R9.4].*** Such a 'Civil Structures Development Group' would consider future research needs and adopt foresighting or similar techniques to evaluate the potential effects of time related changes (e.g. environmental conditions, structural degradation, fatigue, etc).

9.4 Benchmarking

9.4.1 AMCL in their report '2010 Best Practice Review Update' (Ref 041) note that benchmarking is recognised as area of further development. We have not seen any explicit evidence of internal asset management performance benchmarking between operational routes. It is recommended that this is considered. ***[R9.5]***

9.4.2 As part of this review, we have facilitated a meeting between NR, ORR and HA and some water companies. We understand that NR are undertaking a significant benchmarking exercise in relation to their asset management information system – where NR are developing and implementing a replacement IT system(s) within NR for civils asset types.

9.4.3 We have not seen any evidence of business process benchmarking in relation to NR Civil Structures asset management. However, we understand that as part of the IT system definition, a business process mapping exercise is underway to identify the 'as is' and 'to be' processes before the IT project is

commenced. This involves identifying potential best practice reference sites from both a process and systems perspective that NR could visit. ***[R9.6]***

9.5 Research and Development

9.5.1 Our review of information provided[35] indicates that NR are involved with a number of collaborative research projects including topics such as:

- *management of abandoned shallow mine workings;*
- *construction over abandoned mine workings;*
- *alternative technologies for tunnel inspection (Phase 1);*
- *surface water mapping;*
- *flood resistance of critical infrastructure;*
- *culvert design and operation guide;*
- *flooding;*
- *fail safe alarm for earthworks failures;*
- *transport infrastructure drainage – condition appraisal and remedial treatment;*
- *coloured high skid resistant surfacing for level crossings;*
- *corrosion of metallic bridges; and*
- *revision of design guide for Fibre Reinforced Plastic (FRP) strengthening of concrete structures.*

9.5.2 The research which is in progress at present is focused primarily on current issues.

9.5.3 We have briefly reviewed planned research in the rail sector as set out in TSAG documents[36] [37] [38]. These documents set out technology opportunities identified by the Technical Strategy Advisory Group (TSAG) as an input to the CP5 process and beyond together with estimated costs and benefits through to 2038. We note that asset management is an identified topic area with specific topics such as:

- *technology to support integrated asset management; and*
- *remote condition monitoring and other requirements.*

[35] NR Structures Technology development portfolio.doc dated July 2010 (Ref 101)
[36] TSAG (2010a) 'TSAG input to POG – 31 March 2010 – Insertion of technology opportunities identified by TASG into the rail industry planning process for CP5 and beyond', Technical Strategy Advisory Group, 2010 (Ref 396)
[37] TSAG (2010b) 'TSAG input to POG – 31 March 2010 – Insertion of technology opportunities identified by TASG into the rail industry planning process for CP5 and beyond – Appendix B', Technical Strategy Advisory Group, 2010
[38] TSAG (2010c) 'TSAG input to POG – 31 March 2010 – Insertion of technology opportunities identified by TASG into the rail industry planning process for CP5 and beyond – Appendix C', Technical Strategy Advisory Group, 2010.

9.5.4 It is recommended that TSAG development opportunities are investigated by NR and that an active role is taken in developing and shaping such opportunities to support the asset management of Civil Structures. [***R9.7]***

9.5.5 It is recommended that a specific role of a Civil Structures Development Group would be to define future areas for research and development associated with Civil Structures and be a means of engagement with TSAG[39] and other research groups. ***[R9.8]***

9.6 Performance Indicators

9.6.1 We have looked at the NR current performance indicators for Civil Structures in some detail and reviewed them against industry best practice. With complex systems where failure is undesirable, it is often found that lagging indicators[40] that record the outcome after the event may not, on their own, provide enough information to guide actions to ensure success. It is generally recommended that leading performance indicators[41] (that measure the inputs to a process) are used to complement lagging indicators. Performance indicators should cover all items that pose significant threat and areas with the greatest improvement opportunity.

9.6.2 Our key findings are that:

a) There are no regulated outputs relating to the condition and reliability of the Civil Structures assets and NR are not required to deliver a specified level of asset renewal activity.

b) The overall Asset Stewardship Measure (KPI 237) is remote and highly insensitive to changes in Civil Structure condition – it is a weighted average of stewardship indicators for, track (40%), structures (10%), ops property (10%), signalling (25%), E&P (10%) and telecoms (5%) and it is based solely on –'*Civils' assets subject to additional examinations (number)'*.

c) For their own purposes NR measure a significant number of different performance indicators for the various Civil Structures assets.

d) A selection of these performance indicators are included in the Infrastructure Condition Report which is provided to ORR.

e) A number of useful leading indicators that used to be included in the Infrastructure Condition Report in P4 2008-09 (Ref 089) are now not included in the current Infrastructure Condition Report (Ref 090). It is unclear why these have been dropped as they potentially include useful measures such as:

i) Civils 2a Progress on Visual Civils Examinations;

ii) Civils 2b, Progress on Detailed Civils Examinations; and

iii) Civils 3, Bridge Examinations.

[39] Technical Strategy Advisory Group *http://www.futurerailway.org/Pages/home.aspx*
[40] 'A 'lagging performance indicator' is something that measures the final outcomes that result from activities.'
[41] 'A 'leading performance indicator' is something that provides information that helps the user respond to changing circumstances and take actions to achieve desired outcomes or avoid unwanted outcomes.'

9.6.3 These aspects are still reviewed by NR as illustrated by figure 9.4 taken from NR Asset Management – Engineering B&C 'Fat Pack' 2010/11 Period 07 (Ref 385). The 'Fat Pack' is now used by NR as the key B&C management report.

9.6.4 No explicit performance indicators are currently measured for coastal / estuarial defences and only limited performance indicators are produced for structures such as retaining walls. The current indicators are a mix of leading and lagging indicators, output and outcome measures and measures relating to the condition of the asset. No measures relating to the management of the asset are included such as the number of inspections versus required number.

9.6.5 There are not clear and explicit measures of both asset condition and performance (outcome) for each Civil Structure asset.

9.6.6 In particular, it is our opinion that the linkage between the Structures Condition Marking Index (SCMI) and deterioration / failure / risk is complex and unclear.

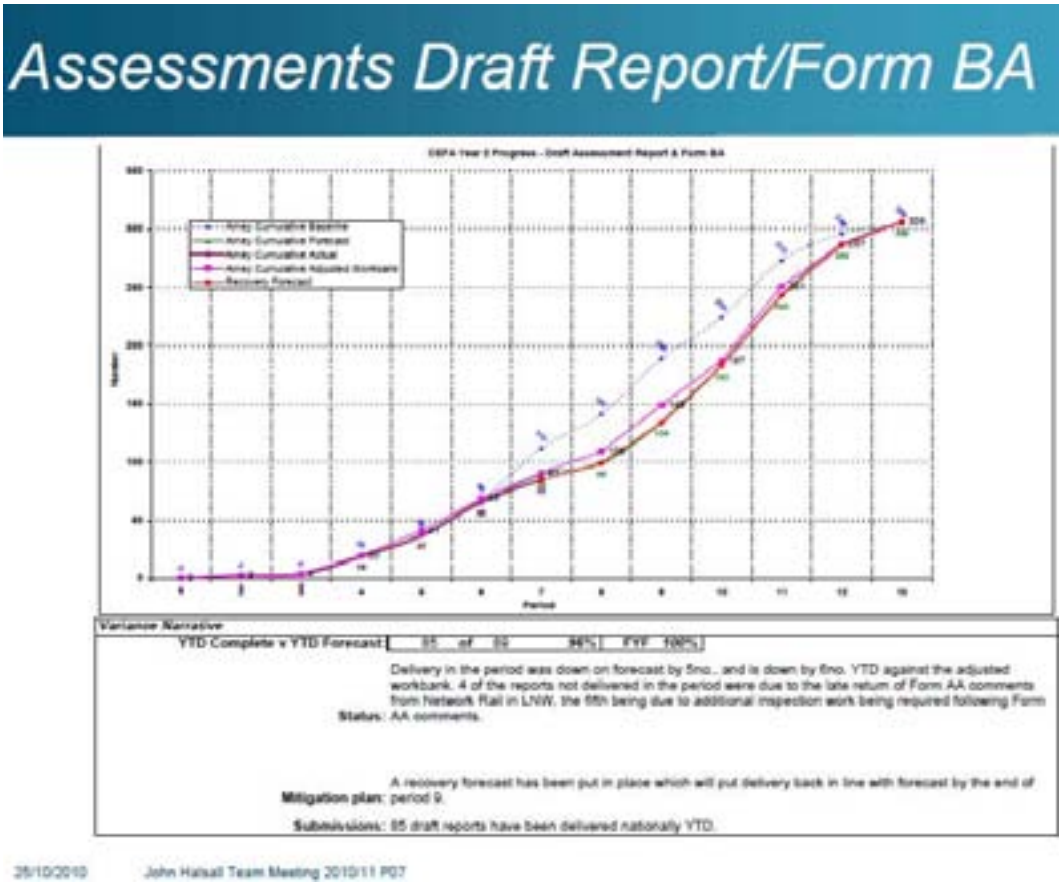


Figure 9.4: Progress Graph for CEFA Structure Assessments (Source NR Asset Management – Engineering B&C 'Fat Pack' 2010/11 Period 07)

9.6.7 There is an opportunity to develop more robust performance measures. The following specific recommendations are made:

9.6.8 There is an opportunity to improve the set of NR performance indicators for Civil Structures. At present threats and opportunities for improved performance cannot be clearly derived from the measures of the Asset Stewardship Index, Assets subject to special investigation or inspection and TSRs imposed as a result of condition (severity index). It is recommended that a more robust set of performance measures should be developed to support the effective management and stewardship of Civil Structures. ***[R9.9]***

9.6.9 The measures should be a mix of:

- leading and lagging indicators;
- output and outcome measures;
- measures relating to the condition of the asset; and
- measures relating to the management of the asset.

9.6.10 The measures should cover all items from the management system that pose significant threat as well as areas with the greatest for improvement opportunity.

9.6.11 Specific focus should be placed on measures that can be directly related to asset condition, asset performance and the management of asset risk.

9.6.12 In particular it should include an improved leading measure for reporting on the condition of bridge structures.

9.6.13 In developing the more robust set of performance measures it is recommended that risk management techniques such as FMEA, event and probability trees are used to identify precursor events / early warning indicators that might be suitable leading indicators.

9.6.14 Condition, asset performance and risk data should be made available to ORR, together with measures relating to the management of the asset such as progress with examinations and assessments compared to the number of assets. ***[R9.10]***

9.6.15 Notwithstanding the recommendation to adopt improved performance indicators for Civil Structures, it is recommended that existing measures are maintained and run in parallel until confidence in the data quality of the new measures has been established. ***[R9.11]***

9.6.16 There is also the opportunity to produce an overall annual State of Network Report for Civil Structures Assets which would complement the NR Annual Return and present the performance indicators. ***[R9.12]***

9.7 Improvement Plan

9.7.1 We have found it challenging to understand how recommended improvements and current planned changes (Asset Management Strategy, Building and Civils Improvement Plan, Transformation Plan etc.) all relate to each other and to the overall asset management strategy. It is recommended these linkages are mapped so that it can be understood which aspects specifically impact on the management of Civil Structures. ***[R9.13]***

9.7.2 In Section 8, we have recommended that a there is an opportunity to develop an Asset Manual for Management of Civil Structures and that this would potentially include process maps. It is recommended that NR subsequently develop a Civil Structures Asset Management Improvement Plan to build on the base-line defined in the Asset Manual for Management of Civil Structures and to set out the planned future developments on a time and cost constrained basis. ***[R9.14]***

Summary

9.7.3 In summary :

9.7.4 Audit and Assurance

a) We have reviewed documentation relating to NR internal audit standards and procedures. AMCL in their 'Best Practice Review Update' indicate that audits are happening and appear effective.

b) In addition to audit, NR are undertaking a defined programme of verification checks. We have not seen examples of these checks, but we have seen evidence that NR undertook 32 structures and 23 earthworks verification checks in this financial year to end of Period 07.

c) It is unclear to us how these verification c hecks are targeted, the scope of each check and how feedback is incorporated into a continual improvement process.

9.7.5 Knowledge Management and Benchmarking

a) There is some evidence of knowledge sharing in Civil Structures asset management but it is not formal and does not appear to be part of a continual improvement process.

b) We have not seen any evidence of internal cost and asset management performance benchmarking between operational routes.

9.7.6 Research and Development

a) NR is currently involved in a number of collaborative research projects focussed primarily on current issues.

9.7.7 Performance Indicators

a) There are no regulated outputs for the condition and reliability of Civil Structures.

b) The Asset Stewardship Indicator is remote and highly insensitive to changes in Civil Structure condition.

c) There are not clear and explicit measures of asset condition and performance for each Civil Structure asset group.

d) The linkage between SCMI and deterioration / failure / risk is complex and unclear.

Recommendations

No.	Recommendation	Location in Text	Priority
Continual Improvement			
R9.1	Appendix D of NR/L3/EBM/071 is entitled Civils Specific guidance, and whereas the other discipline specific appendices provide guidance for verification activities, Appendix D states only that guidance should be sought from relevant Professional Heads. It is recommended that explicit civils specific guidance related to each asset group is included in the next issue of the standard.	9.2.8	8
R9.2	There is potentially an opportunity for NR to link the engineering verification process maps more explicitly into the overall asset management of Civil Structures and to develop and implement a specific regime of audits / verification related to critical aspects of Civil Structures asset management.	9.2.12	8
R9.3	It is our view that there is an opportunity for more formal pooling of knowledge and experience between routes and which is not currently shared. This would be part of a formal continual improvement process.	9.3.4	6
R9.4	Our review indicates that the routes are primarily focused on day to day activities associated with managing a complex legacy asset of Civil Structures. It is recommended that NR/ORR to establish a broadly based group to consider the longer term strategy for risk management of Civil Structures. This would include foresighting and similar to explore possible future risks. Such a 'Civil Structures Development Group' would consider future research needs and adopt foresighting or similar techniques to evaluate the potential effects of time related changes (e.g. environmental conditions, structural degradation, fatigue, etc).	9.3.5	6
R9.5	AMCL in their report '2010 Best Practice Review Update' (Ref 041) note that benchmarking is recognised as area of further development. We have not seen any explicit evidence of internal asset management performance benchmarking between operational routes. It is recommended that this is considered.	9.4.1	7
R9.6	We have not seen any evidence of business process benchmarking in relation to NR Civil Structures asset management. However, we understand that as part of the IT system definition, a business process	9.4.3	3

No.	Recommendation	Location in Text	Priority
	mapping exercise is underway to identify the 'as is' and 'to be' processes before the IT project is commenced. This involves identifying potential best practice reference sites from both a process and systems perspective that NR could visit.		
R9.7	It is recommended that TSAG development opportunities are investigated by NR and that an active role is taken in developing and shaping such opportunities to support the asset management of Civil Structures.	9.5.4	3
R9.8	It is recommended that a specific role of a Civil Structures Development Group would be to define future areas for research and development associated with Civil Structures and be a means of engagement with TSAG and other research groups.	9.5.5	6
R9.9	There is an opportunity to improve the set of NR performance indicators for Civil Structures. At present threats and opportunities for improved performance cannot be clearly derived from the measures of the Asset Stewardship Index, Assets subject to special investigation or inspection and TSRs imposed as a result of condition (severity index). It is recommended that a more robust set of performance measures should be developed to support the effective management and stewardship of Civil Structures.	9.6.8	3
R9.10	Condition, asset performance and risk datashould be made available to ORR, together with measures relating to the management of the asset such as progress with examinations and assessments compared to the number of assets.	9.6.14	
R9.11	Notwithstanding the recommendation to adopt improved performance indicators for Civil Structures, it is recommended that existing measures are maintained and run in parallel until confidence in the data quality of the new measures has been established.	9.6.15	3
R9.12	There is also the opportunity to produce an overall annual State of Network Report for Civil Structures Assets which would complement the NR Annual Return and present the performance indicators.	9.6.12	3
R9.13	We have found it challenging to understand how recommended improvements and current planned changes (Asset management Strategy, Building and Civils Improvement Plan, Transformation Plan etc.) all relate to each	9.7.1	2

No.	Recommendation	Location in Text	Priority
	other and to the overall asset management strategy. It is recommended these linkages are mapped so that it can be understood which aspects specifically impact on the management of Civil Structures.		
R9.14	In Section 8 we have recommended that a there is an opportunity to develop an Asset Manual for Management of Civil Structures and that this would potentially include process maps. It is recommended that NR subsequently develop a Civil Structures Asset Management Improvement Plan to build on the base-line defined in the Asset Manual for Management of Civil Structures and to set out the planned future developments on a time and cost constrained basis.	9.7.2	2

10 Recommendations

10.1 Opportunities

10.1.1 This section presents our recommendations based on our findings and observations set out in the previous sections.

10.1.2 We have broadly grouped our identified opportunities according to the simplified asset management framework model (see Figure 10.1) which broadly aligns with the model currently adopted by NR [Ref 041].

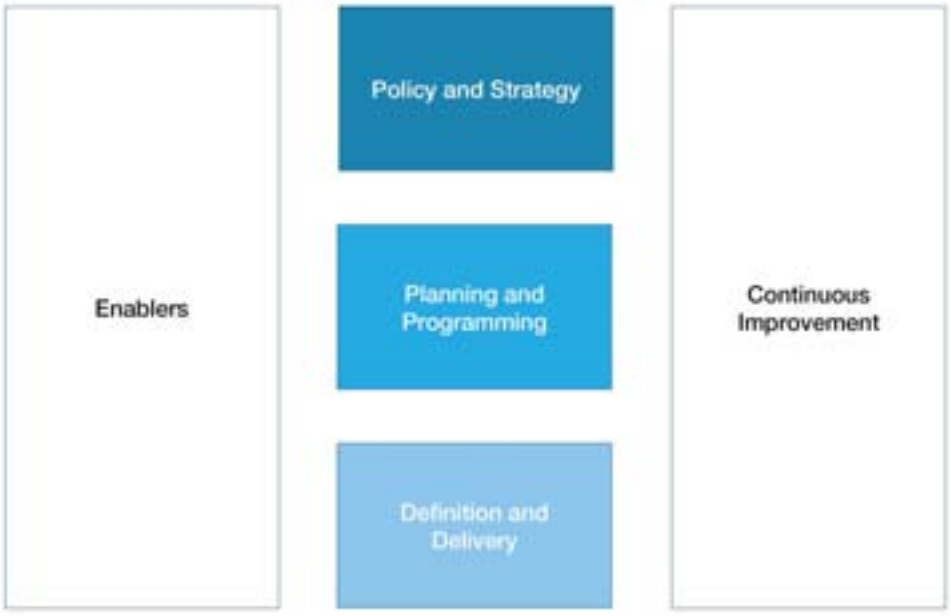


Figure 10.1: Simplified Asset Management Framework

10.1.3 We have assigned an indicative priority to each opportunity based on our view of its importance to asset management of Civil Structures.

10.1.4 These recommendations will be developed with ORR and NR into an action plan to provide a platform for a costed delivery / change plan to be produced by NR.

10.1.5 Table 10.1: Recommendations and Opportunities

No.	Recommendation	Location in Text	Priority
Policy and Strategy			
R5.1	With targets there is always an element of *'what gets measured gets done …'* and we believe that the ORR should consider including more explicit asset stewardship performance measures (in terms of operation, safety etc.) for Civil Structures in the CP5 Regulatory Targets to confer suitable importance to asset stewardship of Civil Structures. These measures would be supported by a balanced set of performance indicators to assist NR in their management of the assets. The performance indicators would be derived from effective business information systems that would allow the easy derivation of current performance. This is discussed further in Section 9.6.	5.4.24	2
R5.2	We recommend that ORR with NR should develop a more explicit definition of tolerable risk levels for the management of Civil Structures. Such a definition would assist NR in their development and prioritisation of a workbank for Civil Structures on a risk basis. Ideally the tolerable risk levels would link directly back to a DfT HLOS safety target. There is also an opportunity to link safety risk into the revised Civil Asset Intervention Policies currently being developed by NR.	5.5.8	2
R5.3	We have not seen these high-level statements translated into specific levels of service / performance targets similar to those adopted by SCC and others. Accordingly our view is that there is an opportunity to more clearly define the success criteria for the asset stewardship and management of Civil Structures (e.g. level of service objectives, relative weightings between criteria) between ORR and NR. These level of service criteria should be derived from and be consistent with the Strategic Goals and Objectives set for CP5.	5.5.16	3
R5.4	The NR Asset Management Strategy does not explicitly explain the relationship of the Strategy to the NR Strategic Goals / Objectives and key performance indicators, and similar. This makes it difficult to understand how the overall strategy aligns with delivery of these and should be taken into account in the management of Civil Structures. It is recommended that the connection between the NR high-level AM Policy and AM Strategy and tactical management of the Civil Structures asset is defined more fully in future revisions of the documents	5.6.6	3

No.	Recommendation	Location in Text	Priority
Planning and Programming			
R6.1	It is recommended that asset groups for lifecycle planning are made more specific. This will allow lifecycle plans to be developed at a sub-group level and the more effective management of assets.	6.4.4	3
R6.2	It is recommended that NR asset intervention policies are developed to reflect a wider range of intervention options. These policies would then be used as a basis for lifecycle option development.	6.5.13	1
R6.3	It is also recommended that Asset Intervention Policies such as the following are adopted: • *Do Minimum* • *Managed Deterioration* • *Lowest Initial Cost* • *Lowest Whole Life Cost* • *Enhancement* • *Heritage Structures* with lifecycle plans being developed at as sub-group level to reflect the individual needs of particular Sub-Groups of Civil Structures assets.	6.5.14	1
R6.4	We note that LNW have approximately 12,000 bridges, and 5,000 retaining walls. From our discussions with the Route Structures Engineer, we understand that there are typically about 100 major interventions (Investment Projects) and about 1000 Minor Works instructions per annum. NR has confirmed these numbers are typical of other Routes of the network. We estimate that, on average, structures are currently subject to a major intervention about once every 170 years, with minor works being carried out at a rate of once every 17 years. Some minor works are likely to be unrelated to the condition or integrity of a structure. The frequency of intervention seems surprisingly low. It is recommended that intervention rates for similar infrastructure operators are obtained and compared with these figures.	6.6.7	2
R6.5	In our review we have found little evidence that programmed maintenance activity such as preventive maintenance is considered for Civil Structures. Accordingly, there appears to be an opportunity to consider the potential benefits from increased routine maintenance (planned, regular programmed interventions e.g. pointing, painting, de-vegetation etc.) as part of the lifecycle options. A secondary benefit of such activities is that they also	6.6.8	1

No.	Recommendation	Location in Text	Priority
	provide an opportunity to view structure condition and identify unexpected defects. It is recommended that preventive maintenance is explicitly considered as part of the lifecycle planning options for Civil Structures at a group / sub-group level.		
R6.6	It is recommended that lifecycle plans are developed at a sub-group level to reflect the individual needs of particular Sub-Groups of Civil Structures assets and that a series of technical options considering both maintenance and renewal are produced for most or all of the defined Asset Intervention Policies.	6.6.9	3
R6.7	NR has advised that they are unable to demonstrate the cost effectiveness of maintenance painting. We understand that this conclusion was reached by comparing the net present value of bridge deck replacement with the current cost of maintenance painting, and therefore it is not done under normal circumstances. We have not reviewed the evidence which supports this conclusion. Given the large number of metal bridges under NR stewardship, there is an opportunity to work with the supply chain to develop improved specifications, materials and techniques which will enable this work to be carried out efficiently and cost effectively. It is recognised that this is a complex technical issue because there are many legacy paint systems in use.	6.7.13	4
R6.8	It is recommended that NR develops a formal explicit structures workbank of all currently outstanding work on a route. This should include any existing defects which are not currently been recorded. This unconstrained workbank should be independent of funding constraints / overall priorities. It should be made available and reviewed when funding levels are being set.	6.7.14	2
R6.9	Most infrastructure owners find estimation of future medium / long-term renewal requirements for Civil Structures to be a challenge. As part of our review work, initial discussions with some of the key utility and infrastructure organisations has been initiated. It is recommended that specific discussions about decision support tools and modelling should continue to be undertaken to benchmark and share experience in this area.	6.7.17	4
R6.10	Based on the above meetings, we consider that ORR/NR should jointly develop a set of explicit business rules to be used by NR in their asset planning and future development of a medium / long-term asset investment	6.7.19	4

No.	Recommendation	Location in Text	Priority
	planning tool. These should be aligned to lifecycle planning principles as outlined above.		
R6.11	It is recommended that the development of these business rules and their implementation in to a medium / long-term asset investment planning tool should be independently reviewed in parallel with the development to ensure clarity of assumptions made in the planning.	6.7.20	3
R6.12	As part of the development process, consideration should be given to identifying Civil Structures asset data sets likely to be required for the medium / long-term modelling so that any additional data sets can start to be collected as part of the inspection and examination process.	6.7.21	3
R6.13	Decision support tools can be particularly useful for developing medium / long-term workbanks and optimising different conflicting factors such as direct costs, penalty costs, costs from lost performance and amortised costs. The inclusion of an optimisation function may be a specific area to consider in the future tool.	6.7.22	8
R6.14	The effective medium / long term modelling of structures performance requires an understanding of the relationship between the three asset management variables: cost of service, level of service and reliability of service (or risk of service interruption). The application of risk based decision support tools is a developing area and it is recommended that this is a specific area for future research and development.	6.7.23	9
R6.15	It is noted that over a number of years NR have actively participated and supported in Construction Research and Information Association's (CIRIA) continuing research on infrastructure asset management. It is recommended that collaborative research would be a very appropriate way to develop the application of risk based decision support tools.	6.7.24	9
R6.16	We have not seen a commentary or similar document explaining how the recommendations made in the RAIB Report in December 2008 have been progressed. It is recommended that this is reviewed.	6.8.17	1
R6.17	NR have 17,000 retaining walls. Based on limited discussions and our review of NR Standards, we understand that retaining walls do not have an SCMI score from inspections and that their capacity is not routinely assessed. It is recommended that a condition	6.8.18	3

No.	Recommendation	Location in Text	Priority
	scoring system for retaining walls is initiated together with a formal capacity assessment. Further work to understand the level of asset knowledge (inventory and condition etc.) and risks posed by of NR retaining walls is recommended.		
R6.18	In the light of the R6.17, it is recommended that the prioritisation process is reviewed in some detail to understand how the relative merits of different asset renewal projects are evaluated.	6.8.19	2
R6.19	Our remit did not include consideration of drainage issues. We note that the CP4 settlement included a sum of £200m to be spent on drainage matters. However, it is recommended that consideration is given to the prioritisation of slope drainage schemes as part of the wider review of relative priorities for maintenance works.	6.8.20	6
R6.20	We have not been provided with the justification for the reduction in annual earthworks expenditure over the control period, or information as to how this expenditure relates to condition, performance and risk associated with the earthworks asset. It is recommended that this is clarified with NR.	6.8.25	1
R6.21	It is recommended that NR consider producing a National Level Asset Management Plan to support requests for funding and to summarise how allocated funding will be used to deliver an agreed level of service within an acceptable risk profile. This National Level Asset Management Plan should also include an explicit planned volume of work.	6.10.10	3
R6.22	A key purpose of an AMP is to quantify any gap between current performance and the desired target performance. The current RAMP does not define a target performance for Civil Structures or current performance of Civil Structures on the route. This means that the RAMP is more of an inventory listing than a tool to direct future expenditure to achieve targets / outcomes. This is a key area for future development.	6.10.17	4
R6.23	We have not had sight of the planned development trajectory for RAMPs, and recommend that (if not done so already) a clear vision / blueprint for the ‘to be’ RAMP and how it will be used by the business is developed.	6.10.18	4
R6.24	In particular it would be useful for the RAMP in the future to include more about the planning and programming stage rather than	6.10.19	4

No.	Recommendation	Location in Text	Priority
	simply being a summary of planned renewals delivery.		
R6.25	This would recognise that the development will be incremental but provide a clear overall direction for the asset management planning process. Specifically it would be useful for the 'to be' process defining how the RAMPs will support the Interim Strategic Business Plan (ISBP) for CP5 to be articulated and shared with the ORR. This would link across to the business process mapping required for overall asset management and for Asset Management Information System development.	6.10.20	4
R6.26	A key aim of a network section level AMP, such as a RAMP, is to promote ownership and to be a practical aim to decision making. We have concerns that the sheer number of RAMPs (305) is too many to allow this to happen. In other organisations such as the HA, they have between 7 and 14 network section level AMP. We would recommend that NR consider producing AMPs at an operational route level. These could be based on the RAMPs but collated into operational route level documents.	6.10.21	4
R6.27	We find it surprising that only 13 out of the 300 major structures are planned to require maintenance expenditure in the 5 year CP4 period. It is recommended that this is investigated further.	6.10.28	3
R6.28	It is recommended that NR consider producing structure group / sub-group level AMP to help improve the sharing of best practice for Civil Structures management, promote uniformity of practice, and provide clarity as to the technical needs for on a structure group / sub-group level. Lifecycle planning would be a significant element in such structure group / sub-group level AMPs.	6.10.36	3
R6.29	In addition, it was suggested that a more holistic view should be taken at an individual bridge structure level. Initially, this potentially would require significant resource to develop individual plans but is something that NR should consider.	6.10.38	3
R6.30	NR should also consider combining the various individual separate processes and procedures as part of their 'to be' asset management process definition activity.	6.10.39	3
R6.31	It is recommended that NR explicitly consider future demand in their asset management planning process.	6.10.42	4
R6.32	The process of prioritisation is revised to show a clear decision making process which is	6.10.45 (a)	4

No.	Recommendation	Location in Text	Priority
	based on coherent systems, supported by knowledge (e.g. RAMP Chesterfield Canal).		
R6.33	Conditions score for bridges are enhanced to include both the overall SCMI score and a set of SCMI crit scores for critical elements.	6.10.45 (b)	1
R6.34	A more effective means of updating SCMI is developed.	6.10.45 (c)	1
R6.35	A system of grouping / sub-grouping of assets by type and behaviour is developed.	6.10.45 (d)	2
R6.36	The prioritisation process is made more explicit and transparent to include level of service considerations.	6.10.45 (e)	4

No.	Recommendation	Location in Text	Priority
Enablers			
R8.1	NR Standard NR/L1/ CIV/032 Issue 2 'The Management of Structures' (Ref 286) sets out the core procedures for structures management. In summary, there are a number of standards that set out various procedures associated with the management of structures, including, CIV/044 (Ref 285), CIV/035(Ref 308), CARRS Process Manual (Ref 060) etc. The relationships are shown schematically in Figures 8.1 and 8.2. In our review we did not find clear NR guidance on workbank prioritisation / value management. It is recommended that formal guidance is developed by NR	8.2.2	7
R8.2	There is an opportunity to develop an *'Asset Manual for Management of Civil Structures'* to clearly link and present a line of sight, based on a process led basis to promote consistency and provide a clear base-line for future improvements. This would include a clear description of the connection between the processes at route level and the relevant standards.	8.2.3	3
R8.3	We have been provided with NR Organisation charts (Ref 045, 046) that show Building & Civils Asset Management as a single team. Discussion with the Route Asset Management teams gives us the impression of a two-tier organisation, the hands-on team at the Route level running day to day/ business as usual operations remote from a central management team who organise budgets and cascade various improvement initiatives down to the Routes. Whilst we have seen no evidence that this directly impacts on safety risk (as primary safety related decisions are made at Route	8.3.2	7

	level) there is a potential organisational and communication issue. It is recommended that NR considers measures to reduce this perceived two-tier organisation		
R8.4	Based on a NR bridge stock of 35,127 bridges and a suggested assessment interval of 18 years, this would imply 1,951 bridge assessments are required per annum. We have reviewed the Building and Civils team meeting 'fat pack' for Period 07 (Ref 385) and this indicates that 287 bridge assessments are planned to be undertaken nationally by the CEFA contractor during the FY 2010/11. It is recommended that this apparent disparity is reviewed and that an explicit way forward is defined. It is our opinion that NR is not collecting sufficient asset measurement and condition data.	8.3.7	1
R8.5	It is recommended that the resource level and competency requirements (including professional qualifications) of route structures teams and level of funding available for assessments is reviewed and benchmarked against other Infrastructure organisations	8.3.8	3
R8.6	In our review we have not spent sufficient time with all routes to enable us to understand whether there are any clear differences in experience, qualifications and competence between Route Engineers and Managers from Structures, Earthworks and Tunnels in the various routes. It is recommended that this is investigated further.	8.3.14	10
R8.7	We also would note that care should be exercised by NR when moving from the current engineering judgement model to a process defined model to make sure that areas that require engineering judgement are maintained such that complex decisions are not over simplified.	8.3.17	3
R8.8	In our opinion the roles of RSE and SSME require considerable hands-on experience in management of various types of structure to reach a level of competence appropriate to their roles. With the move to outsource detailed inspections to the CEFA Contractor, we are unclear how NR staff will be trained to develop into the role of RSE /SSME in the future. We would recommend that NR considers secondment of staff to the CEFA contractor or similar to ensure that such knowledge and experience is built up by future staff.	8.3.18	3
R8.9	We recommend that NR considers specific training courses for engineers maintaining different types of structure such as masonry arch structures and riveted and wrought iron bridges.	8.3.19	2
R8.10	Many of the inspectors we met are towards the	8.3.20	2

	end of their careers, with little evidence of any succession planning. We recommend that Network Rail consider training and recruitment of future inspectors with Amey and their other suppliers to ensure that the availability of suitability experience, knowledge and skills is reliably maintained for the future.		
R8.11	We have not had sight of this work, but based on our experience with other infrastructure organisations, there is a need for significant input from the route teams who will be using the systems to define both the 'as-is' processes and the 'to-be' processes. The detailed definition of such processes is vital before an Asset Information System purchase is made. It is recommended that significant resource is allocated from the Route engineering teams to undertake such work with the IT business analysis function.	8.4.3	2
R8.12	It is recommended that NR consider the following specific aspects when scoping their requirements: a) adopting a GIS based asset information system in the future to facilitate map based access to asset data; b) including a facility for incorporating data from imaging and remote sensing techniques to provide improved qualitative and quantitative techniques; c) including a facility for incorporating instrumentation / monitoring data; and d) including use of handheld devices to record data in the field and transfer directly to the database. The handheld device would be able to upload historic asset information to support field inspections.	8.4.4	
R8.13	NR more explicitly define the critical elements of different types of Civil Structures and identify suitable sub-groups such as different types of arch bridges, overconsolidated clay cuttings etc. based on their differences in engineering behaviour. The use of FMEA and similar techniques should be considered by NR for this activity.	8.5.20 (a)	1
R8.14	NR then collate existing asset information for these critical elements of Civil Structures and jointly review and agree with ORR the need for further inventory and condition data for the effective management of each asset sub-group. This work should be treated as a project with a specific full-time resource allocated, and should draw on the experience of other organisations.	8.5.20 (b)	1

R8.15	Based on the outcome from the collation exercise, a specific asset knowledge gap filling project should be initiated to provide missing critical asset data.	8.5.20(c)	2
R8.16	NR should then consider obtaining more frequent measurements of condition to support deterioration modelling. Better integration of examination and assessment processes may assist in this respect.	8.5.20 (d)	2
R8.17	From the figures supplied by Western it appears that this assessment work will not complete by 2014 and that the rate of completion of assessments is significantly less than required. The main reason for this stated by NR is the coast of carrying out assessments which may find no or few capacity issues. There is an opportunity to develop a more focused, cost effective and more timely assessment regimes.	8.5.25	1
R8.18	We have identified organisations such as LUL and TfL who report condition scores for the critical elements in addition to the average for the structure. In our opinion this provides a better indication of the variability of condition. It is recommended that NR consider adopting a similar approach.	8.5.26	1
R8.19	Opportunities also exist to derive more useful measures of condition by taking measurements from defined points for example, mid span, quarter points and ends so that a reliable framework of data can be built on which to assess trends. Measuring condition at known points would also assist over a period of time in linking condition information to assessed capacity data. Other attributes would need to be taken into account in such an assessment (age, material, exposure etc). It is recommended that NR review their examination requirements to consider this opportunity.	8.5.27	1
R8.20	There is an opportunity to derive further useful data for selected structures by relating SCMI scores to historic examination records.	8.5.28	1
R8.21	A change to risk based examination intervals requires a thorough understanding of the condition, performance and risk level of each asset sub group. We have not seen any evidence related to these issues. In principle the adoption of risk based examination intervals provides a method of targeting examination effort in a more effective way. However in our opinion the implementation of risk based examination intervals requires further review by NR, because of the short comings in asset knowledge discussed elsewhere in this report.	8.5.30	1
R8.22	It is our opinion that risk based examination intervals should be considered in relation to	8.5.41	3

	the specific behaviour of structures. It is recommended that risk based examination intervals are explicitly considered in the lifecycle planning for each sub-group of civil assets.		
R8.23	It is recommended that initially NR consider data collection and analysis to substantiate the risk-based approach as suggested by RSSB.	8.5.45	2

No.	Recommendation	Location in Text	Priority
Continual Improvement			
R9.1	Appendix D of NR/L3/EBM/071 is entitled Civils Specific guidance, and whereas the other discipline specific appendices provide guidance for verification activities, Appendix D states only that guidance should be sought from relevant Professional Heads. It is recommended that explicit civils specific guidance related to each asset group is included in the next issue of the standard.	9.2.8	8
R9.2	There is potentially an opportunity for NR to link the engineering verification process maps more explicitly into the overall asset management of Civil Structures and to develop and implement a specific regime of audits / verification related to critical aspects of Civil Structures asset management.	9.2.12	8
R9.3	It is our view that there is an opportunity for more formal pooling of knowledge and experience between routes and which is not currently shared. This would be part of a formal continual improvement process.	9.3.4	6
R9.4	Our review indicates that the routes are primarily focused on day to day activities associated with managing a complex legacy asset of Civil Structures. It is recommended that NR/ORR to establish a broadly based group to consider the longer term strategy for risk management of Civil Structures. This would include foresighting and similar to explore possible future risks. Such a 'Civil Structures Development Group' would consider future research needs and adopt foresighting or similar techniques to evaluate the potential effects of time related changes (e.g. environmental conditions, structural degradation, fatigue, etc).	9.3.5	6
R9.5	AMCL in their report '2010 Best Practice Review Update' (Ref 041) note that benchmarking is recognised as area of further development. We have not seen any explicit evidence of internal asset management performance benchmarking between operational routes. It is recommended that this is considered.	9.4.1	7
R9.6	We have not seen any evidence of business	9.4.3	3

No.	Recommendation	Location in Text	Priority
	process benchmarking in relation to NR Civil Structures asset management. However, we understand that as part of the IT system definition, a business process mapping exercise is underway to identify the 'as is' and 'to be' processes before the IT project is commenced. This involves identifying potential best practice reference sites from both a process and systems perspective that NR could visit.		
R9.7	It is recommended that TSAG development opportunities are investigated by NR and that an active role is taken in developing and shaping such opportunities to support the asset management of Civil Structures.	9.5.4	3
R9.8	It is recommended that a specific role of a Civil Structures Development Group would be to define future areas for research and development associated with Civil Structures and be a means of engagement with TSAG and other research groups.	9.5.5	6
R9.9	There is an opportunity to improve the set of NR performance indicators for Civil Structures. At present threats and opportunities for improved performance cannot be clearly derived from the measures of the Asset Stewardship Index, Assets subject to special investigation or inspection and TSRs imposed as a result of condition (severity index). It is recommended that a more robust set of performance measures should be developed to support the effective management and stewardship of Civil Structures.	9.6.8	3
R9.10	Condition, asset performance and risk data should be made available to ORR, together with measures relating to the management of the asset such as progress with examinations and assessments compared to the number of assets.	9.6.14	
R9.11	Notwithstanding the recommendation to adopt improved performance indicators for Civil Structures, it is recommended that existing measures are maintained and run in parallel until confidence in the data quality of the new measures has been established.	9.6.15	3
R9.12	There is also the opportunity to produce an overall annual State of Network Report for Civil Structures Assets which would complement the NR Annual Return and present the performance indicators.	9.6.12	3
R9.13	We have found it challenging to understand how recommended improvements and current planned changes (Asset management Strategy, Building and Civils Improvement Plan, Transformation Plan etc.) all relate to each other and to the overall asset management	9.7.1	2

No.	Recommendation	Location in Text	Priority
	strategy. It is recommended these linkages are mapped so that it can be understood which aspects specifically impact on the management of Civil Structures.		
R9.14	In Section 8 we have recommended that a there is an opportunity to develop an Asset Manual for Management of Civil Structures and that this would potentially include process maps. It is recommended that NR subsequently develop a Civil Structures Asset Management Improvement Plan to build on the base-line defined in the Asset Manual for Management of Civil Structures and to set out the planned future developments on a time and cost constrained basis.	9.7.2	2

Areas for Further Review

10.1.6 This section sets out suggested areas for further review as part of future collaborative working between ORR and NR.

Table 10.2: Areas for Further Review

No.	Area for Further Review	Location in Text	Priority
Context			
F4.1	We are aware of further more detailed information held by the HA that would be pertinent to this study and help provide a benchmark for NR to compare asset condition. We have formally approached the HA Asset Management Office but at the time of writing (December 2010), permission to refer to this data is awaited.	4.1.3	3
Prioritisation/ Value Management			
F6.1	It is understood that the SRM is primarily populated using relevant historical accident data but that where little data exists particularly for the low frequency but potentially high consequence accidents, the model makes use of predictive fault and event-tree modelling, structured expert judgement from technical specialists, and statistical methods. It is recommended that the applicability of such data to low frequency, high consequence events associated with Civil Structures (such as bridge deck failure or cutting failures) is reviewed.	6.9.4	3
Definition and Delivery			

F7.1	We have not reviewed the Definition and Delivery stage (GRIP processes etc.) as these processes are common to all NR project delivery. However, it is recommended that the application of GRIP to the renewal of Civil Structures could be an area for further review by ORR in conjunction with NR. In particular the application of Asset Intervention Policies and the application of value engineering to the options selection and evaluation process should be reviewed.	7.2.10	4

Appendix A

Mandate

Mandate for Independent Report - Asset Management (Pages A1-A6)

Audit Title:	Review Asset Policy, Stewardship and Management of Structures
Mandate Ref:	AO/007
Document version:	Draft D
Date:	11th May 2010
Draft prepared by:	Mervyn Carter / John Halsall / Dan Boyde
Remit prepared by:	
Network Rail reviewer:	

Authorisation to proceed

ORR		
Network Rail		

Background

1.1 Context

As a single organisation Network Rail has the UK's largest stock of bridges exceeding 35,000, as well as an extensive asset base of embankments (circa 8000 km), cuttings (circa 6500km), 24,000 culverts, 300km sea defences and 17,000 retaining walls.

Considering the size, value and investment requirements of this asset base and both customer and other functions reliance upon civils assets it is essential that Network Rail's asset management processes are visibly fit for purpose. In certain areas and where there is demonstrable value to Network Rail and key stakeholders a leading position would be expected. This is particularly important when the heterogeneity and safety critical nature of the assets is taken into consideration.

The complex nature of the civils asset base and their variety of age, form and operating risk by necessity requires a complex matrix of management processes, standards and procedures. Numerous audits and investigations have been undertaken over the past decade but such investigations have typically been isolated reactions to known incidents or known, potential deficiencies. Whilst all parties are satisfied that adequate action has been taken to address specific issues emerging from these studies there has never been an overarching review of Network Rail's approach to managing structures, and it has therefore proven difficult to establish a shared view of the end to end process.

In PR08, ORR concluded that Network Rail had failed to demonstrate the appropriate level of investment required for sustainable delivery of outputs for structures assets. Looking forward and beyond CP4, both ORR and Network Rail are now actively working on various aspects of PR13.

1.2 Purpose

NR and ORR wish to work in collaboration to develop an agreed and benchmarked view of Network Rail's current position with respect to Civil Structures asset management processes together with proposed opportunities for improvement.

The two primary purposes are:

I. Understand Network Rail's current management of Civil Structures
II. Develop a plan for achieving best practice management of Civil Structures

Carrying out the project will enable the following:

Provide assurance to stakeholders in Network Rail's end to end asset management process

- Ensure that attention and effort is focussed in critical areas to add maximum value
- Clearly define the base line position against which to measure improvement
- Allow efficient deployment of resources within NR to ensure appropriate stewardship
- Identify and enable any best practice shortfalls to be addressed
- To generate a Network Rail improvement plan
- To improve the efficiency and effectiveness with which Network Rail manages its civils assets and in doing so, identify opportunities for sustainable cost reductions and to have the flexibility to respond to different funding scenarios in a sustainable way
- Support and inform Network Rail in the run up to the ISBP and SBP
- Develop a shared understanding of the requirements for the PR13 process

Once an agreed baseline position has been determined (and any immediate issues identified) it will be possible to identify an action plan to resolve immediate issues and plan the steps necessary to deliver medium term improvements and move to a target position for the management of civil assets across CP4 and CP5.

Scope

2.1 Overall Scope

To understand the totality of Network Rail's policies for the management of structures from top to bottom, compare with relevant [asset management] good practice and comment on their effectiveness and fitness for purpose

NR and ORR consider that a collaborative review should be undertaken to:

- Establish a coherent understanding of Network Rail Civils end to end asset management process
- Benchmark the current position against relevant good practice and comment on its fitness for purpose. Highlight any immediate opportunities for improvement
- Define a quantitatively defined target future position for the management of civil assets during CP4, and CP5 and beyond, and define a route map, action plan, costs and benefits to move from the current to future positions
- Provide supporting analysis which will support both ORR and Network Rail to be well informed with respect to PR13 including ORR drafting of the reporting requirements
- Identify lowest whole life cost options to deliver performance and safety

2.2 Establish a coherent understanding of NR Civils end to end Asset Management process

From discussion with Network Rail and the review of the documents in the 'documentation section' of this brief, compile a single comprehensive document (or suite of documents) that defines clearly how the current Network Rail Asset Management Policy for Civil Engineering (Structures) operates and directs investment in CP4.

Review the Network Rail Standards and working practices for inspection, examination, assessment, which in turn lead to maintenance and renewal of structures.

Consider the effectiveness of these processes and review the appropriateness of the methods of examination and assessment being aware of the recent bridge failures at Stewarton, Enterkin Burn and River Crane. Include in this review comment on whether Network Rail adequately allow for common modes of failure including but not limited to for example for bridges, fatigue, scour, changed loading conditions, material degradation

Provide comment on any existing inadequacies in the present Network Rail Specifications, etc and working practices and competencies taking account of relevant RAIB to ensure re-occurrence in the future of similar failures is reduced 'So Far As Is Reasonably Practicable'

Review the appropriateness of the current asset information and metrics. Including proposals for future Lead indicators for performance, safety and sustainability

Assess the suitability and appropriateness of the systems that support the management of Civil Structures, the interaction of these systems and the reporting capabilities

Review the boundary between Civil Structures and Operational Property assets and recommend accordingly

2.3 Benchmarking

Benchmark the current position against relevant good practice (both UK and abroad) and comment on its fitness for purpose, including recognition and adoption as appropriate of new technology.

2.4 Produce an Action Plan

Develop an action plan that complements and builds upon the asset management "road map" to progress civils asset management from today's position through CP4 at a detailed level and provides a platform for further development.

The Action Plan should contain sufficient information to enable Network Rail to develop a business case and costed delivery / change plan (outwith the scope of this mandate)

2.5 Provide supporting analysis to inform PR13

Allow Network Rail to define reasonable expectations of asset data feeding into models for the generation of ISBP and SBP.

Contribute to the definition of reporting requirements

2.6 For the purpose of this brief structures consist of:

- Bridges (including footbridges)
- Tunnels
- Retaining walls
- Culverts
- River and estuarial defences
- Earthworks

OLE masts signal posts and other subsidiary structures are excluded.

Methodology

Considerable numbers of audit, investigations and workshops have taken place in recent years reviewing the sufficiency of NR's asset management systems.

This review shall call upon, but not repeat the work carried out in previous independent Reporter reviews.

Consideration should be given to:

- Desktop study
- Interviews
- Field surveys (if necessary for verification)

The ORR shall be kept informed of all meetings and site visits by the Independent Reporter and the ORR may attend the meetings and site visits as required.

The audit report shall be set out in three main sections:

- Current Situation
- Recommendations for improvement
- Plans for improvement

Deliverables

Produce a report of Network Rail's management of Civil Structures. The report shall be formatted such that all paragraphs are numbered.

A version of the report shall be prepared for loading onto the ORR website.

Timescales

Draft timescales are detailed below. However, a final programme will be submitted by the project team 2 weeks after award for sign off by the Project Governance Board.

Investigation to commence 1 June 2010.

Draft report by 30 September 2010

Final report by 1 November 2010

Documentation

The Independent reporter shall be provided with copies of relevant documentation, including as a minimum:

- Network Rail's Asset Management Policy for Civil Engineering (Structures), March 2010
- Network Rail Asset Management Policy Justification for Civil Engineering (Structures) Policy, March 2010
- CARRS audit, April 2010 (AMCL)

Other supporting documents that convert the Network Rail's Asset Management Policy for Civil Engineering (Structures) into Working Practices (including but not limited to Railway Group Standards, Railway Group Guidance Notes, Network Rail Company Standards, Codes of Practice and Guidance Notes) will be provided as required.

Independent Reporter remit proposal

The Independent Reporter shall prepare a remit for review and approval by the ORR and Network Rail on the basis of this mandate. The approved remit will form part of the mandate and shall be attached to this document.

The remit will detail methodology, tasks, programme, deliverables, resources and costs.

Governance process for issuing report

Revision	By	Purpose	Outcome
Draft A	ORR / NR	Review for factual correctness and comments	Within 10 working days, both the ORR and Network Rail should provide written responses detailing their comments on the report. Where requested, the Independent Reporter will provide expansion of sections of the report where NR or ORR require further detail.
Draft B	ORR / NR	Review	Draft B will take into account the redlined comments from the ORR and Network Rail (showing originator initials). Where this is not possible due to multiple comments on the same text, then the original text and the two different comments will be shown. The Independent Reporter will issue Draft B report to both ORR and Network Rail. All three parties will meet to discuss the report and agree its contents and recommendations as far as possible. It is anticipated that the review of Draft B would take no longer than 2 working

			weeks.
Revision 1	Independent Reporter	Issue	The Independent Reporter will issue its final report. If agreement over its contents has not been reached the report will contain the Independent Reporter's independent assessment and also include opinions from ORR and Network Rail to document their positions. ORR will publish the report on their website. It is anticipated that the issue of version 1 would take no longer than 1 working week after receiving full comments on Draft B.

Project Review Board

As a minimum the progress of this audit will be reviewed on a monthly basis at the Asset Management Tripartite meeting.

A Project Board will be established with representatives from the ORR, Network Rail and the Independent Reporter. The Reporter will record the minutes and action points of the Project Board meetings.

However, ad hoc meetings may be held as required.

The ORR shall be provided with copies of all minutes and working papers which contribute to the preparation of reports, whether interim or final.

Appendix B

Definitions and Terms

B1 Definitions and Terms

(Pages B1-B11)

Term	Definition	Location
Additional Examination	A targeted inspection aimed at reporting the condition of specific elements of an asset. These examinations are instructed specifically, for example the inspection of the bolts of the Llantarnam type bridges, which have a fatigue sensitive detail that has to be frequently checked or Cast Iron beams which are checked annually for cracking	
AMCL	Asset Management Consulting Ltd	
AMEM	AMCL Asset Management Excellence Model™	
AMP	Asset Management Plan	
AMP-CEP	Asset Management Plan – Civil Engineering Policy	
Assessment	Determination of the load carrying capacity of a bridge	
Asset Stewardship Index (ASI) Measure	The ASI is a composite measure comprising track geometry, broken rails, Level 2 exceedences, points/track circuit failures, signalling failures, electrification failures and structures/earthworks related TSRs. The index is based on a ceiling level of 1.1 to be reached at 2008/9. It is calculated such that the lower the current index is, the better.	ORR website, accessed 07 December 2010
Asset Stewardship Indicator (ASI)	NR KPI 237 – Asset Stewardship Indicator is the weighted average of Stewardship Indicators (SI) for i. Track Stewardship (40%) ii. Structures SI (10%) iii. Ops Property (10%) iv. Signalling (25%) v. E&P (10%) vi. Telecoms (5%)	see NR Corporate KPI Manual (Ref 102) and NR Infrastructure Condition Report (Ref 090)
BCMI	Bridge Condition Marking Index (previously SCMI: Structure Condition Marking Index).	NR/L3/CIV/006/01A
Blind Shaft	A Shaft that has been sealed, capped or filled in such a way as to render the position of the Shaft discernible from the ground surface or from within the Bore.	NR/L3/CIV/006/01A
Bridge	A Structure of one or more Spans greater than or equal to 1800mm, whose prime purpose is	NR/GN/CIV/045

Term	Definition	Location
	usually to carry traffic or services over an obstruction or gap, but excludes Culverts.	
Bridge Management Strategy	A document that defines the specific management processes, competencies and timings that are required for the management of a particular Unique Bridge.	NR/GN/CIV/045
Bridge Strike	An incident in which a road vehicle or its load, or a waterborne vessel or its load, impacts with the fabric of a Bridge.	NR/GN/CIV/045
Brittle failure	Description of the mode of failure of, for example, a beam that is overstrength in bending but weak in shear. In this situation the beam will fail by the development of a shear crack, which propagates almost explosively through the material. This kind of failure occurs typically without significant warning and leads to almost instantaneous collapse of the element concerned. Other examples of brittle failure include metal fatigue induced fractures which, initially develop progressively as fatigue occurs, but at a critical point the element concerned reached a limit at which the material can no longer sustain the loads applied and brittle fracture takes over, leading to sudden failure.	
Capacity	A measure of the maximum / optimum ability of an asset	
CARRS	Civil Asset Register and electronic Reporting System.	NR/L3/CIV/006/01A
CECASE	Civil Engineering Cost And Strategy Evaluation	
CIRIA	Construction Research and Information Association	
Coastal, Estuarine and River Defence (CERD)	A structure that protects railway infrastructure by preventing erosion or flooding of railway infrastructure by tidal or non tidal waters, including: **Coastal Defence** – A particular section of works defined by ordnance Survey (O.S) grid reference and rail track mileage. The terms include both Sea Defences and Coastal Protection Works. **Coastal Protection Works** – Works that protect railway infrastructure by preventing erosion of land and encroachment by the sea and perform no flood defence role. Coastal Protection Works exist seaward of the limits	NR/GN/CIV/045

Term	Definition	Location
	specified by the Forth Schedule of the Coast protection Act 1949. The term includes estuarial protection works. **River Protection Works** – A particular section of works, crossing or adjacent to flowing water, which protect railway infrastructure by preventing erosion or flooding of land by a non-tidal length of a Watercourse. **Sea Defence** – A particular section of works defined by O.S grid reference and railway track mileage, which protects railway infrastructure from flooding or attack by the sea.	
Constrained Workbank (Technical) CWBT	All work items that satisfy the definition of Structures renewal Item and have been accepted by the RSE as in-keeping with the Territory's overall priorities. {This does NOT necessarily mean that it's in the Business Plan – ie it is only "technically" constrained, not financially constrained}	CARRS Renewal Process Manual
CP4,5	Control Period 4, 5 etc. Each Control Period is 5 years long. CP4 is 2009 to 2014 CP5 is 2015 to 2019 Etc	
Culvert	A Structure with a span or diameter greater than 450mm and less than 1800mm, whose prime purpose is usually but not exclusively, to permit water or services to pass under a railway, road or other network rail infrastructure. The term excludes Outside Party Pipelines.	NR/GN/CIV/045
Cutting	An open excavation to permit a Railway or road to maintain its level and Gradient through high ground.	NR/GN/CIV/045
Cyclic Maintenance	Cyclic maintenance includes tree pruning, grass cutting, weed clearance from footways, and gulley cleaning	Eastbourne BC
Depreciated Replacement Cost / Net Asset Value	The calculated current monetary value of an asset or group of assets, normally calculated as the Gross Replacement Cost minus accumulated depreciation and impairment. This is synonymous with Net Book Value.	[Roads Liaison Group 'Management of Highway Structures – A Code of Practice' September 2005]
Detailed Examination	A close examination of all accessible parts of a structure, generally within touching distance, of sufficient quality to produce a	NR/GN/CIV/045

Term	Definition	Location
	record that includes condition of all parts of the structure, the uses to which the structure is being put, recommendations for remedial action, and other relevant facts.	
Deterioration	The performance if funding is insufficient to maintain Steady State (Financial) (if this is planned it should be referred to as Managed Deterioration).	Roads Liaison Group 'Management of Highway Structures – A Code of Practice' September 2005
Ductile failure	Description of the mode of failure of, for example, a beam, where progressive yielding of the material of the beam allows the failure to occur slowly and progressively. This mode of failure may occur sufficiently slowly to permit load to be removed or emergency propping to be placed such that final collapse is avoided	
DfT	Department for Transport	
DST	Decision Support Tool	
Earthwork	An Embankment, Cutting (soil or rock) or Natural Slope (soil or rock). Any local support, bolting or netting of Rock Cuttings shall be classified as part of the Rock Cutting for Examination purposes. Any reinforced soil wall less steep than seventy degrees shall be examined as an Earthwork. Generally a single Earthwork shall comprise either Up or Down side of the railway, the two sides being separated by an imaginary line along the centre of the track or tracks.	NR/GN/CIV/045
Earthworks Condition	The categorisation of an Earthwork as 'Poor', 'Marginal' or 'Serviceable' as a result of an Examination.	NR/GN/CIV/045
Earthworks Engineer	The person with responsibility for the safe management of Embankments, Cuttings and Natural Slopes within a defined geographical are or specific location.	NR/GN/CIV/045
Embankment	An Earthwork that allows railway lines to pass over low lying ground, or ground liable to flood, at an acceptable level and gradient.	NR/GN/CIV/045
Enhancement	The work and funding needed to enhance performance to a specified target.	
ESTEEM	'Engineering Strategy for Economic and Efficient Management tool' – LUL asset planning tool	
Failure	An unplanned situation that arises when a system or process, item of equipment, asset	NR/L3/CIV/006/01A

Term	Definition	Location
	(or an element of one) is no longer capable of performing one or more of its intended functions.	
FMEA	Failure Mode Effects Analysis	
FOC	Freight Operating Company	
Footbridge	A Structure used to give pedestrians access by crossing over tracks, a concourse or a road, and includes any associated steps, stairs or ramps. Footbridges include high level walkways between Buildings.	NR/L3/CIV/006/01A
FP7	Framework Programme (FP7_ European Union's Seventh Framework Programme for Research and Technological Development. This is the EU's main instrument for funding research in Europe and it will run from 2007-2013.	
GIS / Geographic Information System	Computer information system where geographically dispersed assets can be displayed on mapping, allowing the asset database information to be presented in a visually meaningful way	
Gross Replacement Cost / Gross Asset Value	The total cost of replacing a highway asset as part of the existing highway network.	[Roads Liaison Group 'Management of Highway Structures – A Code of Practice' September 2005]
HAMP	Highways Asset Management Plan	
HLOS	High Level Output Specification	
ISBP	Interim Strategic Business Plan	
IP	Investment Projects	
Lagging Indicator	A measure based on past performance	
Leading Indicator	A measure offering prediction of future performance or condition	
Listed (Structure)	A building which has been placed on the Statutory List of Buildings of Special Architectural or Historic Interest.	
LNE	London North East (Route)	
LNW	London North West (Route)	
LoS	Level of Service	
LUL	London Underground Limited	
Lifecycle plans (LCPs)	LCPs document how each of the asset groups that make up the infrastructure is managed. Each lifecycle plan provides a definition of the standards that are applied to the management of the asset group in question	Based on Highland Council RAMP

Term	Definition	Location
	and details the processes that are used to ensure that these standards are delivered.	
Maintenance (HA)	Maintenance is a collective term used to cover all the activities and operations undertaken to manage and maintain a highway structure, e.g. inspection, assessment, renewal, upgrade etc. a) Regular maintenance – covers inspections, structural assessments, routine maintenance and management of substandard structures. b) Programmed maintenance – preventative maintenance, component renewal, upgrading, improvements and component replacements. c) Reactive maintenance – emergency work and essential maintenance.	Roads Liaison Group 'Management of Highway Structures – A Code of Practice' September 2005
Maintenance Work (NR)	Any planned work requiring the reinstatement of the components of a Structure without resulting in a permanent change to the general form of the Structure, or any permanent reduction of the existing structure gauge or standards of safety. The term includes: • Like-for-like repairs and replacement of components; • Repairs and replacement of components in similar or modern equivalent materials provided that such substitution does not affect the integrity or performance of the Structure; and • "good housekeeping" activities such as cleaning, painting, removal of harmful vegetation from Structures, cleaning mud and silt from watercourses and the like.	NR/SP/CIV/003
Major Structure	A Structure that requires its own bespoke Management Strategy, which defines the specific process and requirements for managing the structure.	NR/L1/CIV/032
Natural Slope	Sloping ground that has been formed by natural processes.	NR/GN/CIV/045
NCAP	National Core Audit Programme	
NR	Network Rail	
OPAS	Operational Property Asset System	NR/L3/CIV/006/01A
Operational Property Structure	A Structure located within Operational Property	NR/L3/CIV/006/01A

Term	Definition	Location
	The Term includes but is not limited to: • Platform Canopies and supporting elements; • Footbridges; • Multi-storey and sub-surface Car Parks; • Platforms; • Retaining Walls; and • Train Sheds and structural elements of adjacent Buildings which provide support.	
ORR	Office of Rail Regulation.	
Overline Bridge (Overbridge)	The bridge which passes over the railway and includes public highway, Accommodation, Occupation and bridleway Bridges.	RT/CE/C/045
PAS55	BSI PAS 55-1:2008 Asset Management see Ref 1 and 2. (Publicly Available Specification)	
Prioritisation Score	The score generated by applying Network Rail's prioritisation model to the asset.	CARRS Renewal Process Manual
Proposed Year of Implementation	The year that works will be implemented on site. Where this straddles a financial year, the year in which the majority of work is undertaken (by capital value) shall be used.	CARRS Business Process Renewal DRAFT
PTE	Passenger Transport Executive	
RAIB	Rail Accident Investigation Branch	
RAMP	Route Asset Management Plan	
Renewal	The work and funding needed to provide like for like replacement of an asset	
Retaining Wall	Any structure built to support ground at a higher level on one side than the other, including any associated strutting or anchors. The term excludes the following: water retaining structures; wing walls, abutments and piers forming parts of Bridges or Culverts; Platform walls, Coastal Defences and River Protection Works.	RT/CE/C/045
RGE	Route Geotechnical Engineer	
Rock and Soil Cutting	An excavation that allows railway lines to pass at an acceptable level and gradient through the surrounding ground: for a rock cutting the term includes local support, such as dentition, bolting, and netting.	NR/L3//CIV/065
Rock Slope Hazard Index (RSHI)	Network Rail standardised system used to assess the condition of Rock Cuttings and Natural Rock Slopes, based on observed features of the Earthworks.	NR/GN/CIV/045
ROGS	Railways and Other Guided Transport	

Term	Definition	Location
	Systems	
Route Availability (RA) Classification	An alpha-numeric code which indicates the capacity of a line to carry a given axle weight and spacing	NR/GN/CIV/045
Routes –(Operational)	There are five NR operational Routes – London North East, London North West, Scotland, South East, Western, each headed by a Route Director	
Routes – (Strategic)	Network Rail has 17 Strategic Routes which are the foundation of the rail industry planning process. These are: Route A - Kent Route B - Sussex Route C - Wessex Route D - East Anglia Route E - North London Line Route F - Thameside Route G - East Coast and North East Route H - Cross-Pennine, Yorks and Humber and North West Route I - London and East Midlands Route J - London and West Route K - West of England Route L - Wales Route M - West Midlands and Chilterns Route N - West Coast Route O - Merseyside Route P - Scotland East	NR Website accessed 7 Dec 2010
Route Utilisation Strategies (RUS)	Network Rail's 17 Strategic Routes are underpinned by a programme of Route Utilisation Strategies (RUSs). RUSs establish the strategic direction from a systematic analysis of future requirements of the network. The programme of 19 individual RUSs covers the entire network. It also includes a Network RUS which is developing strategies for stations, depots, rolling stock and electrification, and a Freight RUS which has established a strategy to meet anticipated freight demand.	NR Website accessed 07 Dec 2010
RSE	Route Structures Engineer	
Scour	The removal of material from under or adjacent to structural supports, foundation or Earthworks by the action of flowing water.	NR/GN/CIV/045
Sensitive Structure	A structure which requires Detailed	NR/GN/CIV/045

Term	Definition	Location
	Examinations to be carried out at intervals less than the normal interval defined in Specification Volume EX (….) 2 – "Examination of …." (RT/CE/S/…), because the rate of deterioration is unpredictable or exceptionally rapid, or because of the loads carried, or because of the particular structure or site conditions.	
Shaft	An opening between the Tunnel and ground level usually provided to ventilate or give access during construction or afterwards. The term excludes shallow openings in covered ways which can be examined as part of the Tunnel.	NR/GN/CIV/045
Soil Slope Hazard Index (SSHI)	The Network Rail standardised system used to assess the condition of the soil Embankments, soil Cuttings and Natural soil Slopes, based on observed features of the Earthwork.	NR/GN/CIV/045
SSAE	Senior Structures Assessment Engineer	
SRM	Safety Risk Model	
SSME	Senior Structures Maintenance Engineer	
STAMP	Structures Asset Management Protocol A software tool that is used to investigate optimum scenarios for Asset Maintenance operations and planning of future works. Used for planning works on a 1 to 2 year horizon.	
Steady State (Assessment)	The situation in which a Structure has a valid Assessment not more than 18 years old or the Structure is less than 18 years old.	NR/SP/CIV/035
Steady State (Financial)	The level of work and funding needed to sustain the current level of performance. This information is required for asset valuation purposes.	Roads Liaison Group 'Management of Highway Structures – A Code of Practice' September 2005
Structure	Something designed to support a load. The term includes Bridges; viaducts; Tunnels; Culverts; Retaining Walls; Coastal and estuarial defences; gantries, posts and stanchions carrying overhead line equipment, lighting or signals; Train Sheds; Platform canopies; Platforms; Buildings; water retaining structures; Embankments; Cuttings; Temporary Works or Temporary Works attached to a structure. The term includes any permanent access facilities provided.	NR/GN/CIV/045

Term	Definition	Location
Structure Category	The category (A, B, C, D, E, F or G) to which a structure is assigned, in accordance with RT/CE/P/032 – "Managing Existing Structures" that defines which management process to be used to manage the structure.	NR/GN/CIV/045
Structures Construction Marking Index (SCMI)	The system used to quantify the condition of structures, bases on the codification of defects on elements of the structure.	NR/GN/CIV/045
Structures (Highways Agency)	The definition of 'Structure' in the Highways Agency includes, Bridges and Large Culverts, Small Span Structures, Retaining Walls, Sign / Signal Gantries, Masts, Mast Schemes, Tunnels, Service Crossings and Other Structures.	Ref HA Standard BD 62/07
Structures Renewal Item	An item of physical work associated with one asset with capital value of >£50k.	CARRS Business Process Renewal – Ref 1.22
Structures Works	Physical intervention to a structure including strengthening, replacement (part or whole), structural temporary works, Maintenance Works and preventative maintenance, e.g. painting, re-pointing and waterproofing. It excludes routine maintenance work such as vegetation clearance, drain clearance and debris removal.	RT/CE/P/044 Issue 1 April 2004
TCMI	Tunnel Condition Marking Index The system used to quantify the condition of lined Tunnels based on the codification of defects on elements of the Structure.	NR/L3/CIV/006/01A
TOC	Train Operating Company	
TRL	Transport Research Laboratory	
TSAG	Technical Strategy Advisory Group	
TSR	(Track) Temporary Speed Restriction. A speed restriction imposed on a section of line in response to an external constraint such as a track defect, a weak bridge, a failing embankment etc.	
Tunnel	A structure provided to allow the railway or services to pass under higher land, Buildings and/or water, which has been excavated without removing the surface of the land. The term includes the bore, any associated Shafts, adits, portals, inverts and drainage system within, or attached to the structure of the Tunnel. The term also applies to any other type of construction that needs to be examined as a Tunnel.	NR/GN/CIV/045
Unconstrained	All work items that satisfy the definition of	CARRS Business

Term	Definition	Location
workbank	'Structures Renewal Item' and have been accepted by the SSME and satisfying the company's asset management policy in terms of scope, priority and planned year.	Process Renewal – REF 1.22
Underline Bridge	A Bridge carrying one or more operational railway tracks. An Underline Bridge usually carries the railway over a road or water.	NR/GN/CIV/045
Viaduct	A multi spanned Bridge consisting of 3 or more spans that may carry track or road at a level above normal ground level or to facilitate a change in level.	NR/L3/CIV/006/01A
Visual Examination	An examination to identify changes in the condition of a structure carried out from a safe observation location, without using special access equipment but using permanent access ladders and walkways, binoculars and hand held lighting where necessary.	NR/GN/CIV/045
WCC	Warwickshire County Council	
Workbank	All outstanding maintenance work on [highway] structures on a network where Maintenance is a collective term used to cover all the activities and operations undertaken to manage and maintain a [highway] structure, e.g. inspection, assessment, renewal, upgrade etc.	Roads Liaison Group 'Management of Highway Structures – A Code of Practice' September 2005

Appendix C

References

C1 Document Register

Appendix C1 is the Document Register (pages C1 to C11)

Arup No.	Date Received	Originator	Title	Issue Date
001	27 May 2010	ORR	Civil Structures Review Version 1.5 NR	11 May 2010
002	11 Jun 2010	AMCL	Asset Management Improvement Roadmap	4 May 2010
004	12 Jun 2010	ORR	Independent reporters	-
005	12 Jun 2010	ORR	Notice 4200303 served on Network Rail Infrastructure Ltd on 18 March 2010	18 Mar 2010
006	12 Jun 2010	ORR	Asset policies	1 Jun 2010
007	12 Jun 2010	ORR	Periodic review 2008: Draft determinations June 2008	Jun 2008
008	12 Jun 2010	ORR	ORR Review | Issue 2 | June 2010	Jun 2010
009	12 Jun 2010	ORR	ORR Best Practice Study	Mar 2008
010	12 Jun 2010	Secretary of State for Transport	Network Licence granted to Network Rail Infrastructure Limited	1 Apr 2009
011	12 Jun 2010	ORR	Network Rail Monitor and annual assessment 2009-10	2010
012	12 Jun 2010	ORR	Promoting safety and value in Britain's railways | Our strategy for 2009-14	Dec 2008
013	12 Jun 2010	ORR	Internal Guidance on Cost Benefit Analysis (CBA) in Support of Safety-Related Investment Decisions: Conclusions	29 Feb 2008
014	12 Jun 2010	AMCL	Response to Recommendations Relating to Signalling Assets in Ellipse	19 Apr 2010
015	12 Jun 2010	Halcrow	Independent Reporter A | Annual Return Audit 2009 | Final Report	8 Jan 2010
016	12 Jun 2010	Mouchel Consulting	Independent Reporter B | Annual Return 2003 | Final Report	21 Aug 2003
017	12 Jun 2010	Mouchel Consulting	Annual Return 2004 | Final Report	31 Aug 2004
018	13 Jun 2010	Winder Phillips Associates	Review of Network Rail's Performance Improvement Plans for Control Period 3 with Strategic Business Plan	May 2008
019	13 Jun 2010	University of	International benchmarking of	Oct 2008

		Leeds	Network Rail's maintenance and renewal costs: An Econometric Study based on the LICB Dataset (1996-2006)	
020	13 Jun 2010	University of Leeds	International benchmarking of Network Rail's maintenance and renewal costs	Jun 2008
021	13 Jun 2010	AMCL	Independent Reporter - Part C | Interim Review of Network Rail's 2007 Asset Policies	09 Jan 2008
022	13 Jun 2010	AMCL	Independent Reporter Part C Services | Best Practice Review - Final Report	06 Feb 2007
023	22 Jun 2010	Network Rail	Network Rail Asset Management Policy | Civil Engineering Policy	Mar 2010
024	22 Jun 2010	Railway Strategies	Predict & prevent	01 Jul 2008
025	25 Jun 2010	Network Rail	Network Rail Asset Management Policy Justification for Civil Engineering Policy	26 Mar 2010
026	28 Jun 2010	ORR	ORR's assessment highlights Network Rail's mixed performance in the first year of a five-year plan to transform the railway	02 Jun 2010
027	28 Jun 2010	Network Rail	Network Rail | Strategic Business Plan Update | Control Period 4	Apr 2008
028	28 Jun 2010	Network Rail	Network Rail | Initial Strategic Business Plan | Control Period 4	Jun 2006
029	28 Jun 2010	Network Rail	Control Period 4 Delivery Plan 2009	-
030	1 Jul 2010	ORR	Network licence condition 24: asset register - ORR Board position on compliance	14 May 2008
032	1 Jul 2010	ORR	The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) | A guide to ROGS	July 2009
033	1 Jul 2010	ORR	Annual assessment of Network Rail 2007-08	Sep 2008
034	1 Jul 2010	AMCL	IR CP4: Remit 3 | Response to CP3 Recommendations	28 Apr 2010
035	1 Jul 2010	AMCL	Independent Reporter AIS Audit | ADM and Data Assurance Processes	19 Apr 2010
037	1 Jul 2010	Network Rail	Progress Report on the Development of the Asset Information Strategy and Asset	Oct 2008

			Register	
038	1 Jul 2010	Network Rail	Annual Return 2009	-
040	15 Jul 2010	Network Rail	Network Rail | Strategic Business Plan | Control Period 4	-
042	20 Jul 2010	Network Rail	Network Rail Annual Return 2010 | Contents	-
043	20 Jul 2010	Network Rail	Network Rail Annual Return 2010 | Executive Summary	-
044	20 Jul 2010	Network Rail	Network Rail Annual Return 2010 | Introduction	-
045	22 Jul 2010	Network Rail	NR Organisation Chart - Duncan Sooman	22/07/2010
046	22 Jul 2010	Network Rail	NR Organisation Chart - John Halsall	22/07/2010
047	23 Jul 2010	ORR	Asset Policies 2010 Civil Engineering - Structures Review Questions	07/07/10
048	26 Jul 2010	ORR	Structural Assessment of Railway Bridges - Standards and Practices	31/03/1998
049	26 Jul 2010	DWR consult	A review of British railway bridge flood failures	2004
060	4 Aug 2010	Network Rail	CARRS Renewals Process	-
061	4 Aug 2010	Network Rail	-	-
062	4 Aug 2010	Network Rail	High Level Summary of the Business Planning Process	-
063	4 Aug 2010	Network Rail	-	-
064	4 Aug 2010	Network Rail	-	-
065	4 Aug 2010	Network Rail	Policies in CP4 - Living with Defects	-
066	10 Aug 2010	Network Rail	Transformation Programme – Visible & Agile Workbank Planning (VAWP) Strategy & Targets	4 Jun 2009
067	10 Aug 2010	Network Rail	CECASE Phase One and Two: Functional specification for modelling process	19 Oct 2007
068	18 Aug 2010	Network Rail	Civil Engineering Asset Register and Reporting System: CSFS01 Overview Functional Specification	01 Jun 2009
069	10 Aug 2010	Network Rail	Bridge condition (M8)	-
070	10 Aug 2010	Network Rail	Stewarton	-
071	11 Aug 2010	Railtrack	Strengthening of Railtrack Owned Highway Bridges	Mar 1999
072	18 Aug 2010	RAIU	Malahide Viaduct Collapse on the Dublin to Belfast Line on the 21st August 2009	17 Aug 2010
074	31 Aug 2010	Network Rail	Asset Management Strategy	15 Jun 2010

075	31 Aug 2010	Network Rail	Health & Safety Management System	30 Nov 2009
077	31 Aug 2010	Network Rail	Process Definition & RACI, Version 1	11 Feb 2008
078	8 Sep 2010	Network Rail	Civil Engineering Strategic Cost Model Annex 1: Functional Specification	14 Jul 2010
079	8 Sep 2010	-	South Fraser Perimeter Road Project: Appendix B Asset Preservation Specification	26 Jan 2009
080	8 Sep 2010	Ontario	Performance Measurement: A Reference Guide	Mar-05
081	8 Sep 2010	OAMWG	Infrastructure Asset Management Business Framework MTO Performance Measures	-
083	8 Sep 2010	The World Bank	Procurement of Works and Services	Oct-08
084	8 Sep 2010	RTA	Bridge Inspection Procedure Manual	Jun-07
085	8 Sep 2010	Austroads	Guidelines For Bridge Management	26/06/1905
086	8 Sep 2010	Highways Agency	Performance Measures for Highway Structures	10 Jan 2005
087	8 Sep 2010	Network Rail	Network Rail's Railway Safety Case: Appendix Two Risk Assessment	5 Jan 2005
088	8 Sep 2010	ORR	CP4 Monitoring Handbook	14 Apr 2010
089	8 Sep 2010	Network Rail	Engineering Infrastructure Condition Report Period 04, 2008 - 2009	Jul 2009
090	8 Sep 2010	Network Rail	Infrastructure Condition Report Period 04, 2008 - 2009	Jul 2010
091	8 Sep 2010	Network Rail	Network Condition Report, Period 4, 2010-2011	2010
093	15 Sep 2010	ORR	Company KPI Definitions	Nov 2009
094	22 Sep 2010	Network Rail	Director, Buildings & Civils Asset Management	8 Sep 2010
095	-	Network Rail	CP4 Route AMP, Stategic Route Section, G.05 Peterborough to Doncaster	12 Jun 2010
097	16 Sep 2010	ORR	Notes of meeting with Network Rail on risk based asset management for structures	23 Feb 2009
098	23 Sep 2010	Network Rail	Asset Management (B&C) Business Planning Process & Guidelines	30 Oct 2009
099	23 Sep 2010	Network Rail	LNE Structures & Earthworks Deliverability Review	21 Jul 2010
100	23 Sep 2010	Network Rail	High Risk summary report -	-

			Underbridge 130	
101	23 Sep 2010	Network Rail	Structures Technology - Development portfolio (July 2010)	Jul-10
102	23 Sep 2010	Network Rail	Network Rail Corporate KPI Manual	-
103	23 Sep 2010	TRL	The inherent risk of unseen deterioration in bridges	9 Aug 1997
105	23 Sep 2010	RSSB	Development of risk based examination intervals for Network Rail bridges	2006
106	23 Sep 2010	ORR	Schedule of detailed examination reports provided by Network Rail for site visits to SE 30 March and LNE 31 March	Mar-10
107	23 Sep 2010	Network Rail	Network Rail Coastal and Estuarine Defence Management Strategies - Good Practice Guidance	9 Oct 2008
108	23 Sep 2010	ORR	Civils SBP Submission - Major Structures Executive Summary	22 Feb 2008
109	23 Sep 2010	Network Rail	Management Plan TJG2/5 Goole Swing Bridge	-
110	23 Sep 2010	ORR	PR2008 – Civil Engineering Structures - Major Structures Examples	01/02/2009
111	23 Sep 2010	Network Rail	Major Structures Maintenance Strategy	May-10
112	-	First Class Partnerships for ORR	Network Rail Ops Property & Structures LNE Site Inspections, 31 March 2010	06/04/2010
114	29 Sep 2010	Mouchel Parkman for ORR	Establishing a regulatory target for bridge condition	18 Nov 2005
115	Received 20/09/10 Filed 29/09/2010	Network Rail	Network Rail Coastal and Estuarine Defence Management Strategies - Good Practice Guidance	9 Oct 2008
116	Received 17/09/10 Filed 29/09/10	Network Rail	Slope Hazard - RSHI Algorithm	-
117	Received 17/09/10 Filed 29/09/11	Network Rail	Slope Hazard - SSHI Algorithm New Soil Weightings	-
118	Received 17/09/10 Filed 29/09/12	Babtie	Development of the Soil Slope Hazard Index and associated Algorithm	22 Sep 2003

119	Received 17/09/10 Filed 29/09/13	Network Rail	Asset Accountability Matrix	-
120	Received 17/09/10 Filed 29/09/14	Network Rail	Earthworks Prioritisation Model	-
121	Received 27/09/10	Network Rail	Appendix A to M (Folders)	-
122	Received 27/09/10	Network Rail	High Risk summary report - St Michael's Tunnel	23 Jun 2009
123	27/09/10	Network Rail	ORR Railway Safety Directorate Network Rail Inspection Plan 209/10 Earthworks / Structures and Risk Based Exams, National Common Findings Report - Network Rail comments on factual accuracy	-
124	27/09/10	ORR	Network Rail Inspection Plan 2009/10 Inspection Report Assignment 8 Earthworks & Structures & Risk-based Examinations (Workstream 3- Network Rail HQ)	40293
125	Received 29.09.10	Network Rail	High Risk summary report - Bibbington Summit	7 Jul 2009
126	Received 29.09.10	Network Rail	High Risk summary report - GJC Bridge 101 Wackersall Road	2 Apr 2009
127	Received 29.09.10	Network Rail	Civils Business Plan	-
128	Received 24.09.10	Network Rail	Policy development	-
129	Received 15.10.10 Files 20.10.10	ORR	Civil Engineering Liaison Meeting - Notes of Meeting	28 Sep 2010
130	Received 14.10.10 Files 20.10.10	Atkins	Report from Mervyn Carter, ORR	-
131	Received 14.10.10 Files 20.10.10	Network Rail	Policy development	-
132	Received 22.09.10 Files 20.10.10	ORR	Network Rail Structures and Operational Property Asset Policy Review SE London Site Inspections	11 Jun 2010

133	-	First Class Partnerships for ORR	Network Rail Ops Property & Structures LNE Site Inspections, 31 March 2010	06/04/2010
134	Received 21.09.10 Files 20.10.10	Mouchel Consulting	Structures Annual Cost Profile (SACP) Presentation to the ORR	9 Sep 2003
135	01.11.10	Highways Agency	Structures Asset Management within the HA	29 Oct 2010
136	-	RAIB	Rail Accident Report - Derailment nr Gillingham tunnel, Dorset	Oct-10
137	-	Arup	Review of the use of the MAC Contract in the UK	23 Oct 2009
138	17/08/10	-	Generic AMP	-
140	-	AUSTROADS	AGBT07/09 | Guide to Bridge Technology Part 7: Maintenance and Management of Existing Bridges	-
150	-	-	Strategic Asset Management Modelling of Infrastructure Assets	Jun 2010
153	-	CIRIA	Iron and Steel Bridges: Condition appraisal and remedial treatment	-
162	-	-	Independent Reporter: Review of Statistical Sampling Used in CECASE	22 May 2008
177	-	-	Whole Life Infrastructure Asset Management: Good Practice Guide for Civil Infrastructure	-
214	-	-	Risk Based Bridge Asset Management	-
216	-	Transport for London	Risk Based Inspection Intervals	25 Mar 2010
217	-	Atkins	Risk-based Principal Inspection: Guidance Note	15 Feb 2010
218	03/Nov/2010	Network Rail	Network Rail – Buildings and Civils Safety Actions | Progress Report to ORR Safety Directorate	Oct 2010
219	03/Nov/2010	Network Rail	Guidance for Maintenance Patrollers and Lineside Staff	05/08/2010
220	03/Nov/2010	Network Rail	Progress Report No 05 - Structures Identified for Monitoring	-
221	03/Nov/2010	Network Rail	Letter of Instruction: NR/BS/LI/167 [Issue 2]	05-Sep-10
222	03/Nov/2010	Network Rail	Letter of Instruction: NR/BS/LI/192 [Issue 2]	30-Sep-10
223	03/Nov/2010	Network Rail	Letter of Instruction:	30-Sep-10

			NR/BS/LI/193	
224	03/Nov/2010	WS Atkins Rail Limited	Detailed Examination Report (Arches)	23-Nov-99
225	03/Nov/2010	Atkins	Structure Examination Summary Sheet	31-Mar-09
226	03/Nov/2010	-	Orr response	-
227	10/Nov/2010	Network Rail	Strategic Route Sections – Briefing Note	-
228	12/Nov/2010	Network Rail	End Product Checks of Structures Examination Reports	15-May-03
238	10/Aug/2010	-	The Civil Engineering Cost and Strategy Evaluation (CECASE) Phase One and Two | Functional specification for modelling process	19-Oct-07
241	10/Aug/2010	-	Stewarton	-
242	10/Aug/2010	Network Rail	Transformation Programme – Visible & Agile Workbank Planning (VAWP) Strategy & Targets	04-Jun-09
243	11/Aug/2010	LoBEG	Strengthening of Railtrack Owned Highway Bridges	Mar 1999
244	12/Aug/2010	Network Rail	Asset Management (B&C) Business Planning Process & Guidelines	30-Oct-09
245	12/Aug/2010	Network Rail	Buildings & Civils | Synergy Programme	04-Aug-10
246	12/Aug/2010	Network Rail	Investment Paper Template	-
248	-	Network Rail	Letter of Instruction: NR/BS/LI/167 [Issue 2]	05-Sep-10
249	-	Network Rail	Building and Civils Improvement Programme (incl Transformation)	09-Sep-10
250	-	Network Rail	Network Rail October 2007 Strategic Business Plan | Supporting Document | Asset management	-
251	-	Network Rail	Network Rail Asset Management Policy | Civil Engineering Policy	Mar 2010
253	-	Network Rail	The management of structures	05-Sep-09
254	-	Network Rail	[Extract from] Network Rail Annual Return 2009	-
255	-	AMCL	Independent Report AIS Audit | ADM and Data Assurance Processes	19-Apr-10
257	-	Network Rail	Strategic Cost Modelling	-
258	-	Network Rail	Civils Business Plan	-
259	-	Network Rail	Buildings and Civils Asset Management	09-Nov-09

260	-	Network Rail	Engineering	06-Nov-09
261	12/Nov/2010	Network Rail	LNE Civils	-
262	12/Nov/2010	Network Rail	LNET - Detailed Exams - Non RBE	-
263	12/Nov/2010	Corus Rail Consultancy	Assessment - Bridge ACM1/307	12-Nov-10
264	12/Nov/2010	Network Rail	Generic Liability Questions | Guide No. 18	12/11/2008
265	12/Nov/2010	Network Rail	Prioritisation tool	Jun 2009
266	12/Nov/2010	Network Rail	Scenario Comparison	-
267	12/Nov/2010	Network Rail	SRE Job Log | ECM1/307	Feb 2008
268	15/Sep/2010	Network Rail	Health and Safety File Requirements	01/04/2010
269	15/Sep/2010	Network Rail	End Product Checks of Structures Examination Reports	15/05/2003
270	15/Sep/2010	Network Rail	Risk Based Examination | Management of Data Associated with Decision Criteria for Exam Frequency	-
271	-	Network Rail	Safety-Related CBA Tool Guidance	-
274	-	Network Rail	Corporate Risk Scoring Matrix	-
282	-	DfT	Managing the accidental obstruction of the railway by road vehicles	Feb 2003
283	-	TfL	Transport for London | Highway Asset Management Plan	Sep 2007
284	-	-		-
349	03/Sep/2010	Network Rail	Asset data management	01/06/2008
351	25/Nov/2010	Network Rail	Risk Review Scour	25/11/2010
352	25/Nov/2010	Network Rail	Risk Review Earthworks	25/11/2010
353	25/Nov/2010	Network Rail	Risk Review Flooding_Drainage	25/11/2010
356	12/Nov/2010	Network Rail	Earthworks: as-is process mapping	05/11/2010
357	12/Nov/2010	Network Rail	Earthworks: draft 'as-is' process map	-
358	-	Network Rail	Asset management	Oct 2007
360	-	Network Rail	Network Rail Annual Return 2010	-
361	-	Network Rail	Renewals - Prioritised Workbank Rev C	-
362	-	RAIB	Rail Accident Report - Derailment of a freight train near Stewarton, Ayrshire, 27 January 2009	Feb 2010
363	-	Network Rail	Report of a Formal Investigation into Collapse of Bridge 45 SMJ2/45: 10m 0198yds	15/09/2009
364	-	RAIB	Rail Accident Report - Network	Dec 2008

			Rail's Management of Existing Earthworks	
365	-	Network Rail	Route Plans 2010 - Route Plan G, East Coast & North East	Mar 2010
366	-	Halcrow	Network Rail Western Territory, Tunnels Management Strategy, Llangyfelach Tunnel	Feb 2008
367	-	Donaldson Associates Limited	Network Rail North Western Territory, Tunnels Management Strategy, Desk Study, Stalybridge Tunnel, MVL3/3	Oct 2004
368	-	Network Rail	Network Rail, Asset management policy	29/09/2010
369	19/Nov/2010	Network Rail	Authority Request FHR6/27 Holme Tunnel	22/11/2010
370	-	Network Rail	Verification meeting list from Ken Brady	30/11/2010
371	06/Dec/2010	Network Rail	Network Rail Bridge Detailed Examination Report	12/10/2004
372	06/Dec/2010	Network Rail	Infrastructure Capability Programme, Progress report to ORR, Verification of Route Availability – Phase 2	Sep 2007
373	06/Dec/2010	Network Rail	British Rail Eastern Region – Under Bridge Assessment	Jul 1983
374	06/Dec/2010	Network Rail	Network Rail London North Eastern Territory – Assessment Report	Jul 2008
375	30/Nov/2010	Network Rail	Network Rail's asset management improvement roadmap (to March 2014)	-
376	05/Nov/2010	Network Rail	Work Items 5x5 Risk Matrix	Apr 2004
377	21/Sep/2010	Network Rail	Network Rail, Bridge Detailed Examination Report	07/01/2008
378	21/Sep/2010	Atkins	Detailed Examination Report	27/08/2000
381	-	Network Rail	Route Plans 2010: Route Plan G East Coast & North East	Mar 2010
382	-	Network Rail	Asset management policy	29-Sep-10
383	-	Network Rail	Asset Management Strategy	15-Jun-10
385	-	Network Rail	Asset Management-Engineering B&C 2010/11 Period 07	25/10/2010
394	-	Network Rail	Progress Report on the development of the Asset Information Strategy and Asset Register	Apr 2008
395	30/Nov/2010	Network Rail	Verification list	-
397	-	-	Appendix B	31/03/2010
398	-	-	Appendix C	31/03/2010
399	18/Jan/2011	Network Rail	Draft Slides Used At Forum With ORR Safety Directorate	-

400	-	ORR	Management of Structures | Comments of Arup Draft Final Report Version 1	-
401	-	Arup	Kent Route Sustainable Vegetation Management Strategy for Structures	-
405	25/Jan/2011	-	CECASE - Spec and Business Rules	-
406	25/Jan/2011	Network Rail	Medium to Long Term Renewal Modelling - CECOST	-
408	20/Jan/2011	Network Rail	Buildings & Civils Asset Management | Executive Review Meeting Period 7 - 2011/11	5th Nov 2010
409	20/Jan/2011	Network Rail	List of Major Structures	-
410	20/Jan/2011	Network Rail	Risk Based Approach to the Examination of Civil Engineering Infrastructure	20/01/2011
413	-	ORR	Periodic Review 2008 – Determination of Network Rail's outputs and funding for 2009-14	October 2008

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C3 Standards

The following list contains the standards which have been referred to in this report (Pages C19-C21.

Arup Ref No	Doc Ref No	Title	Date of Issue
073	NR/ARM/M30DF	Asset Reporting Manual	
076	NR/L2/HAM/02201	Management of Risk arising from Deferred Renewals (formerly NR/L2/AMG/02201)	26/08/2008
229	NR/SP/CIV/035	Assessment of Structures (formerly RT/CE/S/035)	Feb 2004
230	NR/GN/CIV/026	Examination of Tunnels (formerly RT/CE/C/026)	Jan 1996
236	NR/SP/CIV/084	Management of existing Tunnels (formerly RT/CE/S/084)	Apr 2004
237	NR/L1/CIV/032	The management of structures	05/09/2009
285	NR/CS/CIV/044	Managing Structures Works (formerly RT/CE/P/044)	Apr 2004
288	NR/GN/CIV/015	The Assessment of Underbridge Capacity (formerly RT/CE/C/015)	Nov 1995
289	NR/GN/CIV/025	The Structural Assessment of Underbridges	Jun 2006
291	NR/L2/CIV/086	Management of existing Earthworks	06/06/2009
292	NR/L3/CIV/006	Handbook for the examination of Structures	05/06/2010
293	NR/L2/AIF/001	Asset data management	04/09/2010
297	NR/L2/EBM/088	Arrangements for maintenance of new and changed assets	06/06/2009
298	NR/L2/INV/002	Accident and Incident Reporting and Investigation	05/09/2009
299	NR/L2/OCS/250	Network Rail National Emergency Plan	06/03/2010
300	NR/L2/SIG/30021	Alterations to Authorised Line Speeds	26/08/2008
306	NR/L3/CIV/065	Examination of Earthworks	01/12/2008
307	NR/SP/CIV/003	Technical Approval of Design-Construction and maintenance of Civil Engineering Infrastructure (formerly RT/CE/S/003)	Apr 2004
309	NR/SP/CIV/082	Management of Existing retaining walls (formerly RT/CE/S/082)	Apr 2004
311	NR/SP/CIV/089	Management of Existing Coastal Estuarine and River Defences (formerly RT/CE/S/089)	Apr 2004
312	NR/SP/CIV/091	Management of Existing Ancillary Structures (formerly RT/CE/S/091)	Apr 2004
313	NR/SP/CIV/092	Specification Volume EX(G) 2 Examination of Ancillary Structures	Apr 2004

315	NR/GN/CIV/041	Code of Practice Structures Condition Marking Index Handbook for Bridges	Aug 2004
316	NR/GN/CIV/203	Evaluation and Assessment of Earthworks	Oct 2007
317	NR/L2/AMG/02201	Management Of Risk Arising From Deferred Renewals	01/06/2008
320	NR/L3/CIV/037	Managing the risk arising from mineral extraction and landfill operations	01/12/2008
321	NR/L3/CIV/038	Managing the potential effects of coal mining subsidence	01/12/2008
326	NR/L3/ELP/27237	Overhead Line Work Instructions	Jun 2008
327	NR/L3/INV/0108	Reporting of environmental events	05/09/2009
328	NR/L3/INV/0113	Statutory reporting of accidents, incidents and occupational ill health	05/09/2009
329	NR/L3/INV/0201	Deciding the lead organisation and level of investigation	05/09/2009
330	NR/L3/INV/0301	Tracking of investigations, recommendations and local actions	05/09/2009
331	NR/L3/OCS/041	Operations Manual - Contents & Responsibilities Matrix	05/06/2010
332	NR/L3/OCS/043/2/02	National Control Instructions and Approved Code of Practice Section 2.2 Emergency Arrangements	01/03/2008
333	NR/L3/OCS/043/2/03	National Control Instructions and Approved Code of Practice Section 2.3 Incidents	05/06/2010
334	NR/L3/OCS/043/7/01	National Control Instructions and Approved Code of Practice Section 7.1 Weather Management	05/06/2010
335	NR/L3/TRK/1010	Management of responses to extreme weather conditions at structures, earthworks and other key locations	26/08/2008
337	NR/SMS/APPENDIX	NR-SMS Appendixes	01/12/2009
338	NR/SMS/PART/B	Specified Tests Index	01/12/2009
339	NR/SMS/PART/C	NR-SMS Tasks Index	05/06/2010
340	NR/SMS/PART/R	Maintenance Record Cards	05/06/2010
341	NR/L3/CIV/028	The management of reports of Safety-Related Events on Civil Engineering infrastructure	05/06/2010
342	NR/L3/CIV/071	Geotechnical Design	06/03/2010
343	NR/L3/CIV/176	Management of reports on Bridge Strikes	01/06/2008
344	NR/PRC/MPI/CI0058	Controlling the Risk of Earthwork Instability during MP&I "Civils" Excavation Works	Feb 2007
345	NR/GN/CIV/202	Management of the risk of Bridge Strikes	01/06/2008

347	NR/SP/CTM/011	Competence & Training in Track Engineering	Dec 2006
350	NR/L3/EBM/089	Asset management plan	
355	NR/L2/OPS/021	Weather - Managing the operational risks	06/03/2010
407	NR/SP/CTM/017	Competence & Training in Civil Engineering	01/06/2006
415	NR/GN/CIV/045	Code of Practice for Terms and Definitions for Use in Civil Engineering Standards	August 2004
416	NR/L3/EBM/070	Engineering Verification	June 2009
417	NR/L3/EBM/071	Undertaking Engineering Verification	June 2009

Appendix D

Enlarged Graphics

Appendix D consists of four figures which are located below (Pages D1 - D7)

Network Rail				Highways Agency	Warwickshire	TfL
A Bridges & Culverts	Bridges	Underbridges	23981 No.		1059 No.	1800 No.
		Overbridges	11146 No.			
			No.			
	Culverts		23973			
	Bridges and Large Culvert			} 8250 No.		
	Small Span Structure					
	Sign/Signal Gantry					
	Mast			17000 No.		
	Service Crossing and Other					
B Retaining Walls			17000 No.		700 No.	
C Tunnels	Lined		327km	11 No.		
	Unlined					
	Open Shaft					
D Earthworks	Embankments	7861 Km		Km		
	Cutting Rocks	850 Km	} 14186 Km			
	Soil	5475 Km		12130 Km		
	At Grade			Km		
	Bunds			Km		
E Building and Station Structures						
F Coastal Estuarine and River Defence			300 Km			

Figure 4.1: Comparison of Civil Structures asset numbers between Infrastructure Owners

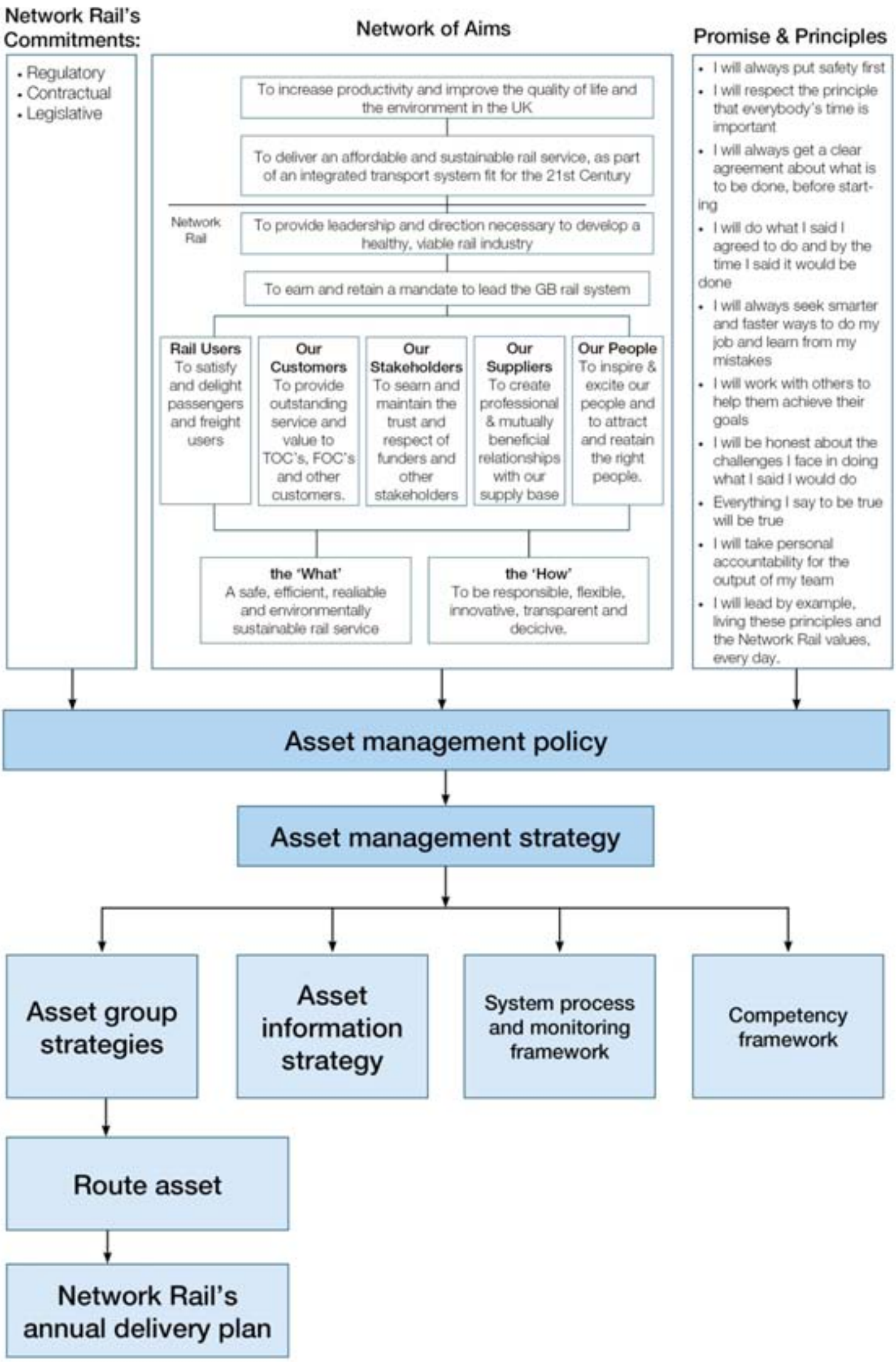

Figure 5.13 NR Asset Management Document Hierarchy (Ref 358)

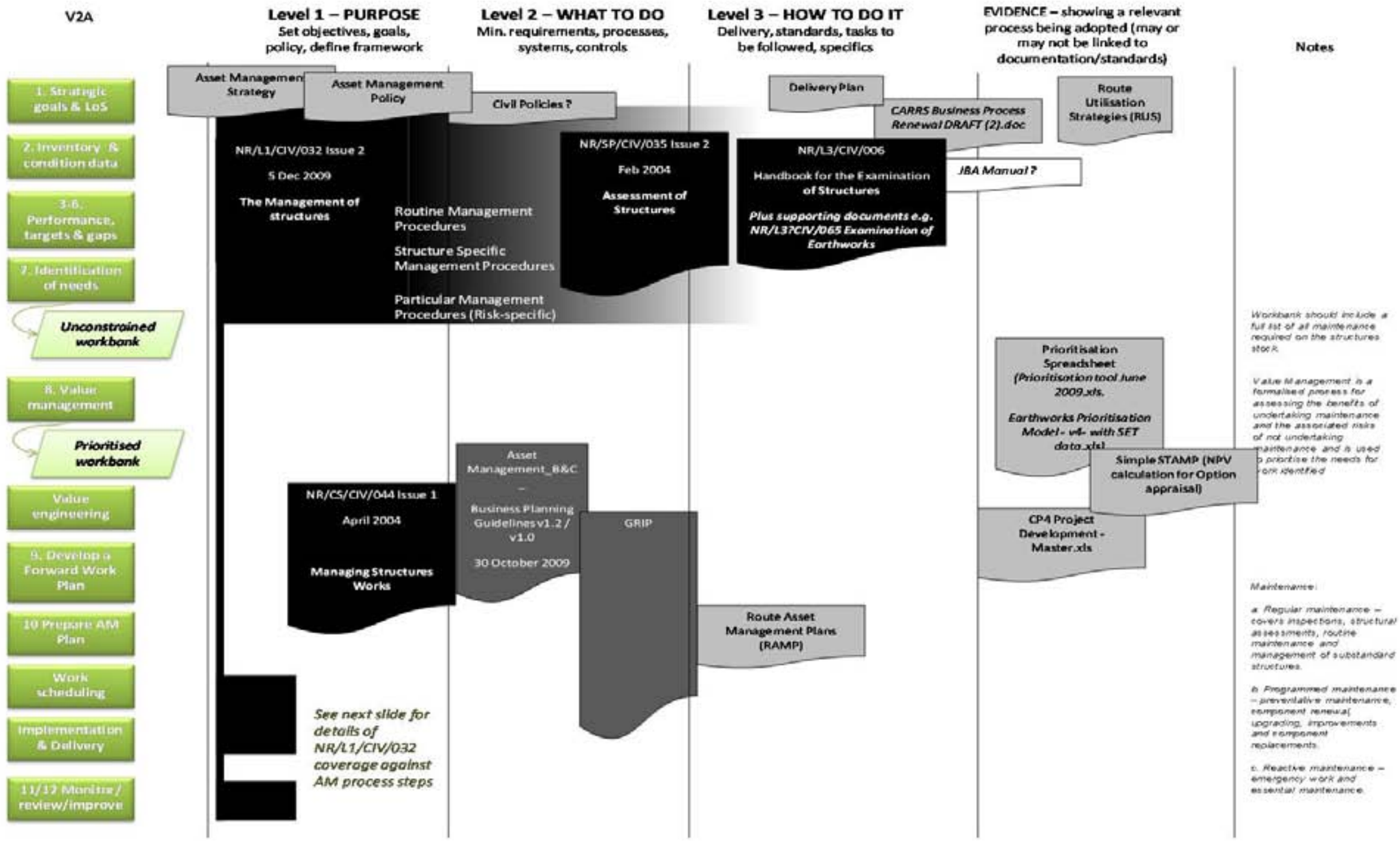

Figure 8.1 Mapping of Civil Structures Asset Management Standards and Guidance

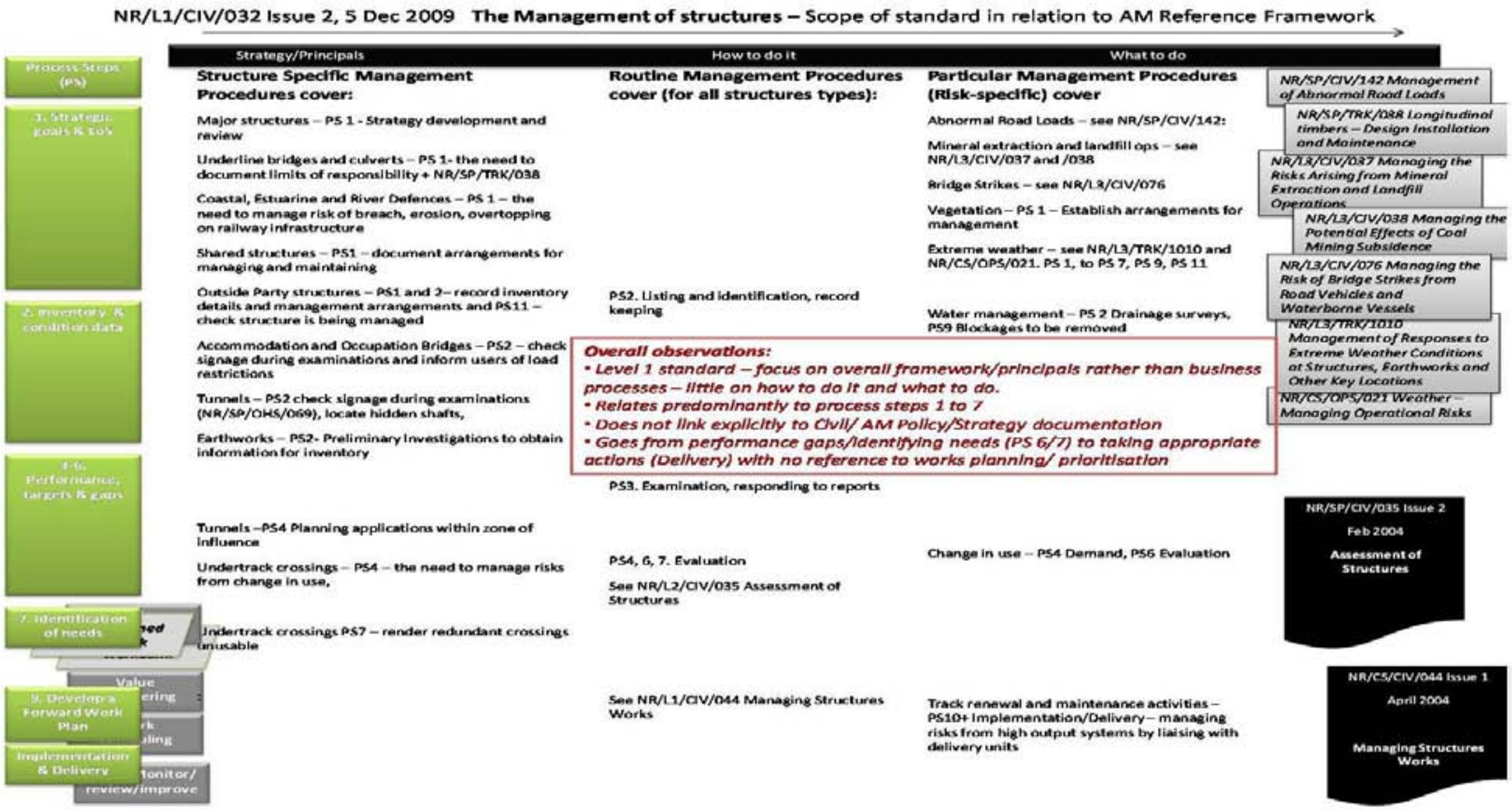

Figure 8.2 Mapping of Civil Structures Asset Management Standards and Guidance