Road Maintenance Review
International Comparison

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Background

The World Road Association's National Committee in the United Kingdom – known as WRA UK - sought to use its network of contacts to help support the Highways Maintenance Efficiency Programmes (HMEP) in England and the Roads Review in Scotland.

In October 2011, the Secretariat (comprising John Smart and Justin Ward) wrote on behalf of Jim Barton (First Delegate of WRA UK) and Joe Burns (Chairman of WRA UK) to the First Delegates of the following countries: Australia, Austria, Belgium, Canada, Quebec, China, Finland, France, Germany, Japan, Netherlands, New Zealand, Norway, Singapore, South Korea, Spain, Sweden, Switzerland and the United States of America.

Responses were received from the majority of these countries. The First Delegates provided contact details for appropriate staff to complete a short online survey. The responses are included in Appendix A (minor corrections to English have been made to a couple of responses).

At the start of 2012, detailed follow up interviews were conducted via individual web conference calls with the United States of America, Norway, Sweden and Quebec. A conference call was not possible with Singapore, but they did answer additional questions which were emailed to the WRA UK Secretariat. These interviews were structured around the initial findings from the HMEP Potholes Review: Progress Report (2011). This framework was taken forward for the development of this report, with text from that report used to place the international lessons in context of the issues faced in the UK.

The report draws on an International Technology Scanning programme[1] conducted by the United States Federal Highways Administration (FHWA) called 'Managing pavements, monitoring performance'. This was undertaken over the 6-26 June 2011 and engaged the following countries: New Zealand, Australia, Sweden, the Netherlands, and the United Kingdom.

The report also reviewed a number of policy/strategy documents provided by countries and includes a case study provided by the Netherlands that was written for the World Road Association (PIARC).

Thanks to: John Stratton, New South Wales, David Darwin and Richard Quinn, New Zealand Transport Agency; Laurent Donato, Department of Strategic Roads

[1] The scan tour looked at how other transport agencies in Europe, Australia and New Zealand had addressed challenges and forged policies and programs to effectively deal with rising costs, declining revenues, and increasing demands for mobility and growth. In order to learn how others have successfully addressed these challenges, and how those practices could be adapted and implanted in the United States, the American Association of State Highway Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA) undertook an international scan tour. The delegates travelled to New Zealand, Australia, Sweden, Netherlands, and England http://www.fhwa.dot.gov/international/scan/2011/

Luxembourg; Vesa Mannisto, Finnish Transport Agency; Ángel García Garay, Spain Roads Administration; Arjen Stoelinga, Rijkswaterstaat, the Netherlands; and Pablo Juliá, Federal Roads Office, Maintenance, Switzerland

With particular thanks to: Butch Wlaschin, US DOT Federal Highway; Torgeir Leland and Even Sund from the Norwegian Public Roads Administration, Directorate of Roads; Michel Brown, Minstère des Transports du Québec; and Yoong Chin Chong, Land Transport Authority, Singapore and Stefan Jonsson, Swedish Transport Administration. Thanks also to the First Delegates of the World Road Association for helping to get this project started.

Executive Summary

The aim of the study was to support the highways efficiencies programmes underway in England and Scotland by looking at what other countries were doing; in simple terms there were two key aims: firstly to establish how the UK was performing compared to other countries and, secondly, to learn about any particular international policy or practices that the UK could implement.

On the first question, the UK's activities were featured positively within the scan tour by the United States Federal Highway Administration (FHWA), conducted in 2011. The tour considered that all the countries visited (listed in the background on the previous page) were advanced with asset management and that they were addressing customer service needs on the highway network. This ability to see one's country through another's eyes was encouraging: the UK appears to be performing well and adopting approaches that are in line with leading countries in the field of highway (maintenance) operations.

Certainly, in talking to Bruce Wlaschin (Director, Office of Asset Management, Pavements and Construction, Office of Infrastructure) at the Federal Highway Administration who was involved with the scan tour he considered the UK to be leading the field in a number of areas (how to use asset data to inform decisions and adopting asset management approaches).

Colleagues in Norway were also fairly candid about the risks of a failure to invest in the highway network. Torgeir Leland and Even Sund said that serious under-investment in the network attracted significant negative media coverage which, in turn, increased the political pressure to address the funding shortfall within highways. However, as highlighted by Sweden, a systematic and robust approach can lead to maintaining the network at a constant level, even with reduced budgets; further research on how Sweden manages their network is therefore recommended.

In regards to the second question, there was no magic bullet from the study. Some interesting models and approaches however, for example to move towards getting it right first time the Swedish transport authority effectively 'rents' the road space to the private contractor. Singapore appears to work very constructively with utility companies and it is likely that there are lessons for the UK here. Long-term funding was also important and research on how Australia has implemented the mandatory use of 10-year financial plans (for three out of six Australian states) is recommended.

The resilience of the network, through preventing water getting into the road surface is a key strategic focus for New Zealand. Again, lessons for the UK could be learnt on what approaches they are taking towards resealing.

A case study on the Netherlands approach to asset management has also been included. Their approach was recognised by the US scan tour and by the WRA UK team leading this review. See appendix B for the details of this.

Resilience of Road Network to Severe Weather

The local road network includes some roads that are designed and constructed to established standards. However, the vast majority of the network comprises roads which have progressively evolved. The formation of potholes is well understood, as is the effect of winter weather and other factors such as inadequate drainage.

Local roads, especially when evolved rather than constructed, are fragile and therefore less resilient to climate change, including severe and unpredictable weather events. Over the past three years there has been an increase of potholes as a result of severe winter weather, primarily through the physical process of freeze-thaw and the ingress of water.

Customer satisfaction surveys carried out by stakeholder groups over the same period consistently report increased dissatisfaction with the quality of the local road network. Research suggests that the majority of motorists regard maintenance of local roads as the top spending priority.

At present, there is only limited guidance available to local highway authorities on how to deal with the issue of adapting to these weather events and improving resilience of the network. There are also few examples of best practice.

Issue to consider: Improving the resilience of the local road network must be a priority in order to provide efficient and effective service to all road users that meets their requirements. Provision of guidance on the maintenance of local roads that will enable greater resilience should be considered.

Gap: Guidance in Well-maintained Highways for maintaining the local road network to improve its resilience. Such guidance is not currently under development.

International comparison

Switzerland, Finland, the Netherlands, Norway and Singapore all reported that severe weather and climatic events was the cause of damage on the road network.

*A systematic process appears to underpin increased resilience of the road network. As highlighted by the United States FHWA scan tour (2011): '**The Swedish Transport Administration reports that having a systematic approach for managing the road network has allowed them to keep pavement conditions at constant levels, even with less money and increasing traffic levels'.***

For many countries, there will be a balance of focusing on urgent needs (worst first) and longer term strategic needs. The scan tour highlighted how New Zealand addresses this issue:

'The New Zealand Transport Agency has recognized that staff tend to focus on urgent needs at the cost of the long-term strategic needs identified by the agency. Therefore, the agency is focusing on developing two separate asset management

positions, with one position focusing on the important strategic initiatives of the organization and the other position focusing on urgent needs. Because of the importance the agency places on road safety, pavement skid and texture information is collected for the entire road network and investigatory levels and intervention levels are set to trigger safety improvements'.

The concept of intervention levels to trigger safety improvements would fit well with the risk based approach used within the UK.

The scan tour also highlighted the importance of keeping moisture out of the pavement:

At VicRoads, safety issues are currently the highest priority, followed by strategies for keeping the moisture out of the pavement. Other priorities, such as reducing roughness and minimizing user costs, are deferred until more funds become available. As a result of these priorities, the agency has sacrificed funding for the highest category of roads to fund resealing of the local roads in an effort to keep moisture out of the system and to reduce the risk associated with the deterioration of the local road network. VicRoads also reports that due to the priority it places on keeping moisture out of the road surface, contractors must reseal the roads before any area has more than 100 ft2 of deterioration. The emphasis is on keeping pavements from deteriorating to the point that rehabilitation is required.

Spain also they consider it very important to seal surface cracks to prevent entry of water into the road and the subsequent rapid deterioration of the pavement.

In some countries, the severity of the winter period means that maintenance activities are not carried out during this period. In Quebec the winter season lasts for five months of the year and as a result the highways authority separates out winter and summer highways maintenance with any treatments on the network carried out over the summer months. For this to work there must be a financial planning process in place so that funds and programme are available to optimise the summer months work window.

Different maintenance approaches are used in Finland - mastic asphalt and special fixing mixtures are used to repair damage, especially if repairs are required during winter time. Asphalt Concrete is only over the summer period. Cracks are sealed with bitumen or special mixtures on main roads during summer time.

Finally, if the network is not maintained then the wider dissatisfaction will become a national political issue. A combination of factors increased the media's attention on the resilience of the road network in Norway. Over several decades of underfunding meant that some parts of the network deteriorated severely. Currently, the Government in Norway is considering increasing funding of roads by 45%. The poor condition of the network attached a significant amount of negative media attention, compounded over the winter months by a number of lorries getting stuck (particularly from trade with former eastern bloc countries).

Sweden's main focus is to think in terms of connections rather than separate roads and to develop guidance dependent on the road class (page 9) about the response times.

Purpose and Use of the Network

The local highway network is essential for both a successful economy and other needs of society. It must be accessible to all. The use of local roads is diverse and varies from commercial use and private vehicles to cyclists and pedestrians. Providing good customer service to all these groups is a key function of local highway authorities who often manage the maintenance priorities of their networks based on road classification.

The current road classification system, however, does not necessarily represent the use and function of the network, especially for non-principal roads, and consequently will not be accurately reflected in the maintenance hierarchies adopted by some local highway authorities. The frequency of inspection and maintenance is linked to maintenance hierarchy and can lead to inappropriate decisions and a greater risk of an inadequate maintenance regime and higher occurrence of potholes.

Issue to consider: Consideration should be given to how local highway authorities develop maintenance hierarchies for all road users based on the function and use of the route. Guidance should be further developed to support such an approach, which would be beneficial in ensuring that maintenance focuses on the needs of all road users.

Gap: Well-maintained Highways introduces the concept of hierarchy for carriageway, footways and cycleways but the guidance does not necessarily reflect the current use of the local road network and is not inclusive of all road users. Guidance to update this approach is needed and is currently being proposed as part of a revision of Well-maintained Highways.

International comparison

The United States, New Zealand, Quebec, and the Netherlands all specifically cited asset management as an approach they sought to adopt (or had adopted) for their road network. It is likely that a number of the other countries use asset management approaches for managing their highway network.

The differentiation of the maintenance hierarchies certainly is on the agenda internationally. The United States Federal Highway Administration (FHWA) is currently developing different levels of service based on the use of the road. The FHWA aims to incentivise investment approaches by asking system owners (State Governments) to outlined investment plans and how they plan to spend money to preserve/maintain the network, resurface and fully reconstruct. The FHWA expects to have different defined levels of service within the next 18 months. The US Forestry Service (which manages a lot of unpaved roads) do have five different levels which each have clearly defined levels of service i.e. for level one the road might be inspected/maintained once a year whereas for levels four and five it might be every couple of weeks.

In Norway the public road network is classified in three levels: National roads (state owned), County roads and Municipal roads. Norway reported that level of traffic was the

key parameter for maintenance hierarchies. Norway has developed a maintenance standard that specifies intervention levels and response times.

Singapore carries out regular inspections with higher frequency for roads subject to higher traffic loading. They also carry out preventive maintenance so as to prevent the need to carry out structural maintenance. Singapore use different asphalt mixes that are considered more appropriate and durable under different traffic conditions. In general dense-graded asphalt mixes are used for major arterial, collector and local roads. At traffic junctions with high traffic loading and stresses, rigid or semi- rigid pavements are used. For motorways, they use opened graded mix or drainage mix due to its ability to reduce splash/spray and aquaplaning and traffic noise.

New Zealand's approach is similar - through carrying out more frequent inspection cycles, shorter response times, and reduced tolerance of surface defects on the higher classification roads they prioritise the hierarchy of their network. All roads are inspected routinely at one to six week cycles, commonly with a video record being kept and analysed in a regional office to identify defects for treatment by routine road maintenance crews.

New Zealand's annual road condition surveys are made across the entire network (predominantly thin surface unbound granular pavement construction) using a mix of high speed data for rutting, texture, skid resistance etc., and site specific investigation for surface cracking or pavement strength. The results are used to filter and inform detailed field inspections leading to nationally prioritised annual programmes of surface or pavement repairs, surface dressing, pavement recycling/rehabilitation, pavement reconstruction. The mix and timing of repairs to pavement reconstruction is selected to minimise the long term costs of providing reliable access along the State highway network, and to reduce safety and comfort service level risk appropriate for each classification of road arising from the occurrence of surface defects.

Sweden's contractors have different inspection intervals depending on what road it is: this falls between two to 14 days.

Sweden also have defined their road types into five classes: major cities, other national main roads and connection roads with average annual daily traffic higher than 8000 vehicles, designated commuter and service roads, other important roads for business, and finally, rural roads and single track roads. For the different classes, levels of service are specified for the following six quality elements: accessibility/ punctuality, robustness, traffic and passenger information, comfort, safety and usability.

Roads and Maritime services in New South Wales specifies inspection frequency and routine maintenance standards which vary by road categorisation. Standards specify intervention levels and response times.

Economic Benefits of Highway Maintenance

The highway network is the most valuable asset owned by local authorities and a well-maintained local road network is essential for economic prosperity. Although some work has been done to assess the costs and benefits of highways maintenance expenditure, the economic benefits of good road maintenance have not been systematically determined at either national or local levels. This would help local highway authorities to demonstrate value for money and efficiency of investment in highway maintenance. In addition, the cost of potholes to the economy, through disruption, increased user costs and vehicle wear and tear, is not known with any certainty and should be included in such an approach.

Issue to consider: Consideration should be given to developing a consistent approach for determining economic costs and benefits of highway maintenance. This will allow local highway authorities to robustly define the need for investment in road maintenance and prioritise against other expenditure.

Gap: There is no central guidance for determining economic benefits of highway maintenance. The Department for Transport and the sector could consider building on some initial work that has been carried out in this area.

International comparison

The economic benefits are easier to determine for new roads than for existing roads (i.e. for highway maintenance). The United States currently do not have the granularity of information to determine the economic benefits of different surfacing treatments. They are currently trying to determine how 'x' level of investment equates to 'y' amount of asset life. Certain States such as North Carolina and Florida have this well documented.

Analysis by Norway of the road network has led to stricter standards for rutting on high volume roads (for 2014 onwards) based on a socio-economic analysis of the intervention levels for pavements and winter operation. Like the US, they still have some way to go to develop a fully embedded life cycle approach for maintenance.

Singapore is as a city state with a small road network (compared with other countries). However, the road network as a percentage of the total land area is 12% and this is difficult to increase further. Therefore managing traffic congestion is very important and demand management measures have been put in place to control the increase in vehicles (Certificate of Entitlement) and road usage at critical thoroughfares (Electronic Road Pricing); these introduce a high economic and social costs to the motorist and in return road users expect a safe and effective network.

The Swedish government wanted to quantify the socio-economic benefits of road maintenance and for certain elements, such as snow removal from pavements and a focus on bridges and tunnels, this has been possible but so far they have been unable to quantify the economic value of maintenance activities for the whole network.

National Policy

Local highway authorities understandably focus maintenance investment on the part of the network that carries higher volumes of traffic, namely the principal road network. In the past, the former National Indicators (NI) 168 and 169 were used to report on the condition of all classified roads with NI 168 focussing specifically on principal roads. The indicators were frequently used by central government to monitor the performance of individual local authorities via Comprehensive Area Assessment. The assessment regime and the National Indicators were abolished by the Coalition Government in October 2010, in line with the policy of freeing up local authorities from central government control.

The use of National Indicators as a measure of a local authority's performance may have encouraged local highway authorities to adopt a "worst first" strategy, only treating roads when they reach poor condition, with obvious signs of failure. This has contributed to an increase in potholes.

Use of NI 168 may also have encouraged local highway authorities to focus their resources on the principal road network as NI 168 was very often used in Comprehensive Area Assessment. Consequently, for a combination of understandable factors, the condition of principal roads is significantly better than non-principal roads.

Road condition is measured annually through a traffic speed survey carried out by all local highway authorities using vehicles fitted with "Scanner" equipment. The data is collected by all local highway authorities on the same basis as the former NI 168 and 169 under an arrangement called the Single Data List. It is then released by the Department for Transport. The Highways Agency collects data using a similar technique for the motorway and trunk road network but processes and releases it in a different format. Despite routine surveys of all classified roads, there is no national quantitative survey undertaken that specifically measures the number of potholes on the local road network, although the road condition data referred to above may reflect the existence of potholes but not in an explicit way.

In Scotland condition of the local public road network is measured for all local authorities through the annual Scottish Road Maintenance Condition Survey (SRMCS), also using the Scanner equipment. The results of the survey are used to classify the road network into one of three measures: Green – acceptable; Amber – some deterioration and should be investigated to determine optimum time for maintenance; Red – poor condition and likely to require maintenance within one year. The annual survey also includes a 10% random sample of unclassified network in each region. The results are reported by the Society of Chief Officers of Transportation in Scotland (SCOTS) and passed to each individual council. Transport Scotland uses Deflectograph and Sideway-force Coefficient Routine Investigation Machines (SCRIM) machine based surveys in addition to Scanner for the motorway and trunk road network but processes it in a

different way. Results are released through the Scottish Government's annual Transport Statistics publication.

Issue to consider: Consideration needs to be given to a more appropriate measure to report road condition that will encourage a more effective and efficient approach to road maintenance. Such a measure could take into consideration the road users' perception of road condition. A more effective and efficient approach to road maintenance will be achieved by adopting a whole life approach measuring performance over the long term. This should also enable funding priorities between the non-principal and principal roads to be determined at a local level.

Gap: The abolition of all National Indicators was announced in October 2010 as an unnecessary burden on local highway authorities. There is still a requirement on local highway authorities to collect road condition data and this is published annually. However, a single indicator of condition does not encourage the adoption of an asset management approach.

International comparison

The United States reported that the FHWA are working on developing a composite performance measure (that is likely be weighted) that would take account of roughness, rutting, cracking and vaulting. They would seek to implement this in late 2012 and the indicator would be used in conjunction with a measure on International Roughness Index (IRI). They did note that a number of individual states are already using a composite performance measure.

The FHWA scan tour (2011) reported on performance management approaches internationally, of particularly note was the approach in the Netherlands:

'The Road Traffic and Transport Authority in the Netherlands develop Service Level Agreements (SLAs) between the Asset Owner and the Asset Manager. In the past, these SLAs have been based primarily on pavement condition indicators, but they are developing new metrics for highway availability and reliability, which better dovetail with higher level policy issues. The SLAs are made for four years and include the related financial plan based on a long-term financial forecast. The agency also bases its Key Performance Indicators (KPIs) on a model that focuses on both technical and non-technical factors. It is referred to as the RAMS-SHEEP model, with RAMS representing technical considerations such as Reliability, Availability, Maintainability, and Safety, and SHEEP representing the soft side of the decision process, which includes Security, Health, Environment, Economics, and Politics. The KPIs help the organization address its highest priorities when resources are constrained'.

The scan tour highlighted the progress made by the Netherlands and, as such, the focus for the UK should seek to further benchmark their approach against the Netherlands. A World Road Association (PIARC) case study has been included in Appendix B on this area.

The Swedish Transport Administration alternate between a winter and summer customer questionnaire and the findings from this are connected to the quality deliveries (see page 9) and this informs the long term planning of the network.

Local Decision Making and Preventative Maintenance

As previously stated, over recent years National Indicators have contributed to local highway authorities adopting a “worst first” approach to maintenance, allowing the roads to deteriorate to a poor condition, rather than focusing on a preventative approach to maintenance. At the same time, there has been an increased use of thin surface course systems which, although offering some safety and environmental advantages, have resulted in road surfaces that may be more prone to pothole formation, if not used and laid in appropriate circumstances. Concerns have also been raised on the durability of such materials.

The risk of potholes occurring may be mitigated by local highway authorities investing in the right preventative treatments at the right time and best practice may be demonstrated in this area, hence adopting an invest to save approach.

How maintenance funding is used is a local decision and therefore there is no consistent approach to allocation of maintenance funding at a local level. At present, some local highway authorities have adopted the principles of asset management leading to an approach that minimises cost of investment over the whole life of the road and supports a preventative approach to maintenance.

Issue to consider: Local highway authorities will benefit from moving towards a whole life approach to funding of highway maintenance. This will ensure that maintenance treatments are prioritised using the principles of asset management.
• The adoption of a preventative approach to maintenance over the whole life of the road will provide a more efficient approach to preventing the formation of potholes.
• Best practice should be established for the use of thin surface course systems and other materials to mitigate the risk of pothole formation in the future. Industry’s role in providing such guidance should be considered.

Gap: Current guidance on asset management does not reflect the latest developments in the field. Comprehensive guidance and examples of current best practice are being developed under the Highways Maintenance Efficiency Programme

International comparison

Singapore highlighted certain limitations with moving towards a whole life approach. They reported:

It may be difficult to adopt whole life approach in funding highway maintenance in view that our roads do not only serve as corridors for traffic but also as corridor for the rail network and utility services. The rail network is built immediately below/above the road network wherever possible and in some cases the drainage canal network is also built below the road alignment. These utilities and tunnels form part of the road structure. Highway maintenance activities will have to take into consideration and coordinate with the utility maintenance and development

requirements as well as rail network development and construction. Hence, whole life approach for funding of highway maintenance may be complex in view of the above. The funding approach we adopt is to ensure the network is maintained to achieving the road users' safety and to the set performance standards.

Developing a focus on asset management is a key objective for the FHWA in the United States. The design/construction of a road typically equates to 17-20% of the whole life cost, so now the key question is: what is the plan for the remaining 80% of the cost. The shift in focus is notable: historically the United States has focused on building roads. Now the question is what to do after the ribbon has been cut as the overall focus shifts away from building towards maintaining the road network.

Sweden has explored different asset management methodologies and has settled on the application on PAS-55 [Asset Management Standard] as they believe this can be effectively applied to the highways administration and have decided to implement this for recently (March 2012). The Swedish Transport Administration has an excellent asset management approach to bridge and tunnel maintenance management systems with both good data and the use of the data to inform both annual and long term planning (10 years ahead). The system is called BaTMan. Sweden is also moving towards a more robust pavement management system.

The Netherlands, as mentioned in the last section, are well focused on Asset Management. The team of directors of Rijkswaterstaat (DT-RWS) decided in September 2008 to use Asset Management as the leading principle for the management of the infrastructure.

Road surface damage is uncommon in the Netherlands - typically one or less incidents per kilometre travelled – and caused by the poor condition of the road generally and severe climate events and natural hazards. In the Netherlands there are regular, yearly inspections of the road surface. The results from these inspections are input for a damage prediction model; usually Rijkswaterstaat replaces the surface just before damage is expected ('preventive maintenance'). The motivation for this is as follows:

- *no unexpected interruption of service or damage of vehicles;*
- *long term this strategy is cheaper than repairing (heavier measures are needed when repairing and tender-prices are higher when sudden measures are needed and the tendering and realization is under pressure).*

The Netherlands have a set of national standards and were the only country in our study to state that they had a process for departing from the standards. Standards in the future will be based on service-levels (reliability, availability and safety) that are agreed with the Ministry. Since budgets are challenged Rijkswaterstaat uses their RAMS SHEEP-bases prioritisation system (see page 12).

Finally, and of key importance is the financial planning that underpins the development of an asset management approach. As the scan tour from the US highlighted - the Institute of Public Works Engineering Australia (IPWEA) reports that the long-term

financial plan is key to advancing the philosophy of asset management and to providing a sustainable and viable approach for maintaining road assets. The scan tour notes:

In Australia, three of the six Australian states have mandated that local governments use 10-year financial plans. The financial plans consider the whole-of-life costs associated with the maintenance and renewal of a road (e.g., initial cost, operating costs, maintenance and renewal costs, disposal costs), which has enabled local governments to move from annual budgeting to long-term financial planning that links service levels with funding requirements.

National Standard – Defining Potholes

Well-maintained Highways, the Code of Practice for Highway Maintenance, provides guidance to local highway authorities on maintenance, including the inspection of defects such as potholes. Local highway authorities should adopt locally approved policies based on the guidance and recommendations of the Code with local variations, as appropriate.

As local highway authorities make their own decisions regarding maintenance, there is no national standard definition of a pothole, only guidance based on best practice including risk assessment and defect thresholds. Typically, potholes are defined as having a depth of 40mm as highlighted by ADEPT. The Highways Agency has recently adopted the same definition of potholes for the motorway and trunk road network.

Issue to consider: Consideration should be given to developing a national definition for potholes. However, this should be part of a risk based assessment of defects as recommended by Well-maintained Highways. Examples of good practice, including testing by the Courts, should be explored. There is a diverse range of views regarding this matter.

Gap: Well-maintained Highways provides limited guidance on potholes and best practice in their identification, assessment and reporting. This Review will address this issue.

International comparison

Norway has a standard definition for defect reporting. Anything wider than 10cm should be repaired within a week (the definition is 3cm for a bike lane and equally within a week). The management of this is handled through the procurement/contracting process. In practice a risk based system is used where the degree of traffic hazard the pothole represents determines the reaction time for the intervention.

The United States have no national definition. Singapore also does not have a national definition of a pothole. However, the normal practice is that a localised round depression formed by the loss of aggregates will be termed as pothole.

*Switzerland have a set of standards (*www.vss.ch*) but no process for departing from them, however they are currently developing a risk assessment process at the moment.*

Sweden has an objective to have roads without holes larger the following dimensions: a width of 10 cm and depth of 2cm for major cities, other national main roads and connection roads, designated commuter and service roads. For other important roads for businesses and rural roads the depth is the same but the width increases to 15cm.

Effectiveness of Pothole Operations

Local highway authorities adopt a variety of approaches to managing pothole operations, including identification, recording and repairs.

The use of technology by local highway authorities or their service providers for recording potholes, as part of safety inspections, is variable. Where technology has been adopted, it has been demonstrated beneficial to both customers and local highway authorities. These benefits include improved communication, time savings, audit trail and better management of liabilities.

All staff involved in managing pothole operations, including operatives undertaking pothole repairs, need to be trained and competent in identifying defects, including potholes, and the variety of materials, equipment and technology available. However, there is no consistent approach to providing appropriate training and qualifications.

Issue to consider: Consideration should be given to establishing best practice on the benefits of both investing in and using technology for safety inspections. A review should be undertaken of current training and qualifications available. Work with training organisations to provide training on more efficient and effective pothole repair.

Gap: There is no current guidance on efficient and effective pothole operations. Identifying best practice and developing appropriate guidance should be included in the next phase of this Review. This should include items such as training, qualifications and use of technology.

International comparison

The use of technology has been briefly covered in earlier sections, e.g. New Zealand's where it was noted that roads are inspected routinely at one to six week cycles, commonly with a video record being kept and analysed in a regional office to identify defects for treatment by routine road maintenance crews.

Exploring the issue of training was interesting, taking Norway as an example there was recognised lack of skills/knowledge on winter maintenance operations (it was found that some people did not how to mount snowploughs). This led to a programme commenced in autumn 2011 whereby everyone involved with operating a winter service vehicle (spreaders) had to go on a 36 hour course to understand both the theory and practice of winter operations. Course delegates then had to complete an exam and only on successful completion were they allowed to conduct winter operational tasks, including snowploughing, and spreading sand and salt. In terms of the highway maintenance operation, Norway is seeking to develop a similar increased focus on the workmanship issues when laying asphalt.

The United States do not teach Asset Management as a subject area in Engineering Schools/Universities. They have been looking to benchmark against other countries and looked at the application of the International Infrastructure Management Manual

(IIMM) – used by New Zealand and Australia – which is an accreditation system for their asset managers/pavement managers, maintenance managers.

Currently the most far reaching programme the US has is in California for the renewal of engineering licences. Credit can be gained through taking pavement management/preservation classes (through taking a seminar or class) and the credits gained apply towards the licence renewal.

The FHWA are looking to apply this as a model more widely across the US. Currently the US is working to accredit the maintenance workers as there is currently no accreditation programme for this group. The FHWA deliver a lot of training and part of the focus of this is on training a whole new group of younger professionals to carry out highways inspections.

The Federal Highways Scan tour (2011) focused on training issues:

'The Road Traffic and Transport Authority in the Netherlands...place an emphasis on moving things forward early, rather than waiting until something is perfect. As a result, change occurs fairly rapidly and employees are encouraged to take controlled risks. To foster this culture, the Road Traffic and Transport Authority has implemented vertical learning courses on asset management. These courses involve one day of training on asset management for people at all levels of the organization. The 30 to 40 participants role play in specific areas commonly involved in asset management, such as facilitation, cooperation with other groups, and mentoring. The training philosophy is that the participants will learn more by doing something rather than studying it. Training is a high priority for the agency because a "loss of technical knowledge can lead to diminished organisational capabilities and less technical quality with time."'

The Swedish Transport Authority is currently going through a transition from a focus on completing courses to a more competence based approach. Previously the courses were run by the Authority. Going forward the approach will be more market orientated with different providers running the training and as long as individuals demonstrate achieving defined competency levels then the Swedish Transport Authority will be content with the skills and abilities of people working on the network. Safety inspections in Sweden are more often visually conducted by staff rather than automated with technology.

Right First Time

Local highway authorities have adopted a variety of response times to repair potholes, many having recently extended response times to enable first time permanent repairs. Initial evidence would suggest that this approach has reduced the need for temporary repairs, which although make the road immediately safe do not provide value for money, as they need to be revisited to be made permanent. This also leads to customer dissatisfaction, as they see work repeated on the network. In defining response times, local highway authorities often need to find a balance between a right first time solution that provides value for money with the need for immediate pothole repairs to ensure the safety of all road users.

At present, there is neither detailed national guidance nor specification for the repair of potholes. The ADEPT Report "*Pothole repair techniques for local highways*" provides a process for right first time pothole repairs but does not include a specification. Furthermore, it does not cover the use of alternative materials and techniques.

Issue to consider: Local highway authorities would benefit from more detailed guidance, including specifications, on the repair of potholes in order to ensure efficient and effective repairs. The objective will be to ensure a balance between safety and a right first time approach, ensuring a more efficient and effective approach to the repair of potholes.

Gap: ADEPT has published a report titled "Pothole repair techniques for local highways" which is a starting point on guidance. Industry, including both local highway authorities and service providers, has a role in developing this best practice for the repair and specification of potholes. This should be included in the next phase of this Review.

International comparison

United States Department of Transportation, Federal Highway Administration scan tour (2011) highlighted an interesting model for encouraging a 'right first time approach':

'The Swedish Transport Administration is contracting out 20-year Design-Build-Operate-Maintain contracts with safety, surface, and durability performance measures. The contractor has to "rent" access to enter the road for maintenance activities, so there is an incentive to do the right treatment the first time and to minimize the amount of time spent on the site'.

Utilities

Utilities have the right to access local highways and will continue to do so. The local road network may be susceptible to weakening of the road structure following intervention by utilities.

Issue to consider: Local highway authorities must undertake appropriate quality control and compliance checking measures through trained personnel. Utilities must undertake reinstatements of the highway to the required standard. Both parties should work together through joint working bodies to continually review specifications and innovative ways to minimise disruption and ensure resilience of the network.

Gap: Industry, including local highways authorities, utilities, suppliers and industry regulators must be encouraged to develop guidance as to how reinstatements can be made more resilient to weather damage. This should be included in the next phase of this Review.

International comparison

Singapore, Belgium, New Zealand, Norway and the United States all cited poor quality reinstatements after part of the road has been excavated causes as a cause of damage on the road network.

In Singapore, the Land Transport Authority (LTA) is the only highway authority and takes charge of the maintenance of all roads. The LTA, reported a positive outcome of utilities in terms of a reduced need for resurfacing:

In Singapore, utilities are laid under the roads to maximise land use. This means that the roads have to be frequently opened up to either repair/maintain or upgrade the existing utility services or lay new ones. In 2011, the number of street work applications exceeded 10,000. In the process, the affected lanes of significant length are resurfaced during the reinstatement. This reduces the need for the LTA to carry out resurfacing at large areas of the road network as they are resurfaced due to the utility works.

Singapore manages and control road diggings for utilities installations with power given under the Street Works Act. They also manage and control road usages such as obstruction on footway and carriageways with the power given under the Street Works Act.

Under the Street Work Act (SWA), the LTA is able to control any engineering work on the roads and all parties working on the roads will have to comply with our requirements/conditions as specified under the permit issued/Code of Practice. As part of the requirements, the contractor is required to have a qualified supervisor overseeing the road reinstatement works. Where utility agencies do not comply with the specified requirements/conditions, the LTA are able to fine them and/or suspend them from working on the roads for a period of time. The LTA chairs a monthly co-ordination

committee comprised of members from all utility agencies. In the committee meeting, there is a sharing of both good and bad practices relating to road diggings and reinstatement works. These have been effective in ensuring that the utility agencies carry out the works in compliance with the requirements placed upon them.

The United States aims to introduce legislation to address the problem of poor quality reinstatements by utilities through various policy mechanisms: principally by encouraging collaboration and through the introduction of a charging scheme. They did report some local jurisdiction exists within individual states was already in place and that collaboration was encouraged in combination with focusing on getting the utility company in and out as quickly as possible.

Norway said that the issue of reinstatements was certainly a problem for urban (mainly municipal) roads, and that this has been addressed by some of the larger cities (e.g. Oslo and Bergen). Like the United States, they too look to introduce new legislation. The issue has been heavily debated and there is currently a new law under consideration to better govern the behaviour of utility companies towards carrying out works on the highway.

Sweden reported problems with third parties causing damage to the road network and seek to minimise this by improving communications in the coordination of works.

Stakeholders, Communications and User Perceptions

Providing good customer service is a key function of a local highway authority. Local needs of all road users have to be taken into consideration when developing policies for highway maintenance. However, as already been stated, a reactive approach to maintenance to satisfy a particular requirement, in this case road users, does not provide for efficient use of resources. Therefore, a balance must be found between delivering a service that is reactive to local needs and one that delivers a sustainable approach to highway maintenance.

Stakeholder groups, including motoring, pedestrian and cycling organisations, have an important part to play in raising awareness of the issues surrounding highway maintenance and providing a service that is responsive to all customer needs.

In September 2011 all local highway authorities published information on their websites describing how they have used the Department for Transport funding for potholes allocated in March 2011. This information needs to be reviewed to identify examples of best practice in transparency and communication with the public.

Issue to consider: Consideration should be given to how a communications strategy can be developed for all stakeholders involved in highway maintenance to ensure the issues are fully understood. Local highway authorities and stakeholder groups must actively work together to promote common interests in determining priorities and demonstrating the importance of a sustainable approach to maintenance.

Gap: Some local highway authorities have produced information on this subject for both members and the public. Such information should be considered in the next phase of this Review, with a view to producing a framework document for use by all. This will be supported by reviewing how local highway authorities have spent the March 2011 Department for Transport pothole funding.

International comparison

The FHWA scan tour 2011 also addresses the issue of how highway authorities address customer service issues and report the following:

'The Finnish Transport Agency conducts road user satisfaction surveys each winter and every other summer. Because of the importance the agency places on addressing customer needs, they have established a director's slot that focuses exclusively on stakeholder relations.

The priority that the Norwegian Public Roads Authority places on customer service and the societal impact of roads is evident through their vision, which states "On the road to a better society."'

New Zealand's 'State Highway Asset Management Plan 2012-2015' highlights their Customers First approach, which links customer input from focus groups and consultation with the Automobile Association (AA) and the Road Transport Forum (RTF) with our programmes of works. The document states:

'Our customers' expectations of our services are continually growing and we must respond, focusing capital and operational activities on areas that deliver maximum effectiveness. To better understand the needs of our customers and combine their views with our planning, we developed an engagement programme called 'Customers First'. Its aim is to identify the key outcomes customers want and incorporate these expectations in our overall strategic intent. This allows us to identify both the best actions to undertake and where best in the country to deliver them'.

The report goes on to outline methods of engagement:

*'**We use a number of methods to engage with our customers, including user satisfaction surveys and targeted stakeholder engagement on specific plans and proposals. Our stakeholders include national organisations, local and central government, and community groups. Our largest stakeholders (the Automobile Association and the Road Transport Forum) were consulted during the development of the State Highway Asset Management Plan'.***

One of the lessons for the UK following the severe winters of 2009/10 and 2010/11 was the benefits of engaging directly with the media: getting reporters to go out with the salt spreaders crew, working with local radio stations to give updates on route information and placing reporters into the heart of the winter maintenance operation to fully understand the challenges and issues faced. Recently, with the closure of the Hammersmith Flyover another lesson was getting the media to see what exactly the issue was to encourage more balanced reporting.

Interestingly, the United States said that short videos where a local highway maintenance worker explained what they did; and how, with a bit more resources, they could make a road last for longer. The feedback on such an approach was very positive.

Singapore takes a pragmatic approach to highways work saying that highway maintenance activities will inevitably affect the public either as road users or nearby residents. It is a good practice to inform the affected parties in advance of the carrying out of maintenance activities. The timing of the maintenance activities have to take into consideration the community e.g. night works, works near schools during examinations etc. Norway said they use the internet to inform the public about their pavement programme and other works that will affect traffic operations– what works were taking place, where and when. Finally and probably as a good general point, Sweden said it was tricky to communicate maintenance but a focus on communications should be to manage expectations.

Conclusion and Recommendations

In conclusion, the UK appears to perform at a similar – or better - level, in terms of highway maintenance operations, to leading international countries. As the scan tour by the Federal Highways Administration reported, it particularly targeted countries that it considered were advanced at asset management:

The transportation agencies and industry representatives selected for the scan had demonstrated the use of sound management principles and philosophies for managing their road (and other) assets.

Transportation agencies in selected countries in Europe [including study of the Highways Agency, Transport Scotland and Transport for London], Australia, and New Zealand have already faced these challenges [declining condition of highway pavements], rising costs, increasing traffic, expansion, a worst-first approach to selecting capital projects, and the age of our infrastructure] and forged policies and programmes to effectively deal with rising costs, declining revenues, and increasing demands for mobility and growth. They appear to have developed and fostered a culture to effectively manage pavements over the whole life of the asset, often foregoing expansion or capacity improvements, when forced to make a decision between those capital programmes and preservation and maintenance.

The scan tour did not, however, focus on Local Highway Authorities (LHA) in the United Kingdom – the organisations that are focused on for the review by the HMEP and the Scottish Roads Review. As such, there is likely to be more limited application of some of the above elements, particularly in regards to effective management of pavements over the whole life of the asset and this issue would be more acute in smaller LHAs. In simple terms: many LHAs are unlikely to be as advanced at applying asset management as the Highways Agency, Transport Scotland and Transport for London are.

Some elements picked up on the scan tour, such as the use of 10 year financial plans are already in use in parts of the UK. The scan tour study notes:

Transport for London has a 10-year business plan that presents the total investment that will be made over that 10-year period. Money can be moved from one year to another to address fluctuations in needs and/or special considerations that arise. For example, during 2012 when the Olympics will be held in London, no road projects will be conducted. Therefore, Transport for London has accelerated some projects into 2011 to use the 2012 funding. The long-term business plan has helped the agency focus on long-term needs, improved efficiency, and provided a greater degree of certainty to the agency's modeling and forecasting.

Additionally, the asset management approach at Transport for London is discussed in scan tour:

Transport for London considers risk, customer satisfaction, and cost as the three factors that must be considered to provide an acceptable level of service, as shown in figure 1. The relationship between these factors and the point at which a zone is established for making investment decisions differs based on the

particular asset being investigated. For instance, since most highway users are less aware of bridge conditions than road conditions, risk and whole life costs are the key decision drivers for that asset and the decision zone shifts to the right to ensure that risks are suitably mitigated. For roadways, customer satisfaction is a much higher decision factor, and so the decision zone reflects an effort to maintain it at a high level.

The implication from the above points is: there are approaches **within** the UK that could be implemented more widely.

In summary, there are a number of recommendations:

- Learn lessons from innovative approaches used within parts of the UK should also be taken account of more widely – in this regard, TfL's 10 year plans and approach to asset management should be considered by LHS;
- Further research on how Australia has implemented the mandatory use of 10-year financial plans (for three out of six Australian states) is recommended as longer term financial planning would help LHA implement asset management;
- Review how Quebec manage their programmes of works to operate a focus on summer highway maintenance;
- Further research on Sweden's approach to asset management is recommended, with particular focus on their BaTMan system for managing their bridge and tunnel stock, the network hierarchy that they have defined for various levels of service should also be reviewed;
- Further research on how Singapore work with utility companies is recommended;
- Further research on how New Zealand prevent water getting into the road surface is recommended;
- Review the case study provided on the Netherlands approach to Asset Management and follow up research/investigation is recommended;
- The World Road Association should develop guidance for determining economic benefits of highway maintenance;
- Finally, the UK could consider a scan tour to maximise the exposure to international practices and policies to improve performance within the UK.

References

United States Department of Transportation, Federal Highway Administration (2011) Managing Pavements, Monitoring Performance Scan Tour, June 9-26, 2011 Australia, New Zealand, Sweden, United Kingdom, and the Netherlands

New Zealand's 'State Highway Asset Management Plan 2012-2015' http://www.nzta.govt.nz/resources/state-highway-asset-management-plan/docs/state-highway-asset-mgmt-plan-2012-2015.pdf

Highways Maintenance Efficiency Programme (HMEP) Potholes Review: Progress Report (2011) http://www.dft.gov.uk/publications/potholes-review-progress-report

Norway's website to inform the public about their pavement programme: http://www.vegvesen.no/Trafikkinformasjon/Reiseinformasjon/Trafikkmeldinger

Norway has also worked out a strategy to meet the challenges associated with severe weather and climatic events. There are some reports about this work on: http://www.vegvesen.no/Fag/Fokusomrader/Forskning+og+utvikling/Klima+og+transport/Publikasjoner

Appendix A – responses from individual countries

United States

How road maintenance policy/management/operations are delivered

There are more than 33000 transportation agencies within the United States. Each is responsible for the road maintenance. The Federal Highway Administration (FHWA) sets policy for specific networks of roads that receive federal funding. That policy requires that states adequately maintain those facilities. They rely on the discretion of the individual agencies to determine what is "adequate". It is anticipated that future (near-term) legislation may require more stringent performance measures. At least at the state level these performance measures will be negotiated between the FHWA and the various States with a practical base line level of performance.

Areas of best practice

Nearly all of the transportation agencies have some sort of winter maintenance, routine maintenance, or asset management programme in place. There is no common standard or definition. Leading State Departments of Transportation (DOTS) are North Carolina, Michigan, Utah, Washington, Vermont. Other states have excellent pavement management systems, while many others have decent bridge management programmes. Unfortunately in most agencies, maintenance is a "nice-to-have" not a necessity. It is good practice when we have 'extra' money, but when we don't have extra money it if often the first place to cut. The United States tend to see more and more agencies opting to go with performance based maintenance contracts, these new contracts handle all routine and preventive maintenance across the entire length and width of the transportation facility. They often include pavement, bridges, lane markings, lighting, ITS, culverts, signals, overhead signs, high-mast lighting, etc. These are only just beginning to emerge in the US.

Road surface damage

Is uncommon - typically one or less incidents per kilometre travelled.

Cause of damage

On motorways/freeways the cause of the damage is the poor condition of the road generally. For main roads, secondary roads and other roads the poor quality reinstatements after part of the road has been excavated causes damage.

Processes/controls in place to reduce the incidence of road surface damage

Most agencies conduct routine inspections of the roads for damage; but these are hampered by lack of available funds to repair them.

Set of national or local standards for the design, construction and maintenance of the road network

The United States do not have a set of national or local standards.

Sweden

How road maintenance policy/management/operations are delivered

Sweden buy all maintenance from private contractors with their policy derived from the 12-year national plan of transport which is a commitment between the government and Trafikverket. Nationell plan för transportsystemet 2010-2021 (publikationswebbutiken, öppnas i nytt fönster)

Details are available at: http://www.trafikverket.se/Foretag/Planera-och-utreda/Planer-och-beslutsunderlag/Nationell-planering/Nationell-plan-for-transportsystemet-2010-2021/

Areas of best practice

This cannot be described in a few words, but we believe we have an interesting approach to how to be a successful asset manager. Sweden's intelligent transport system (ITS) is also very important and the transport administration has a very good bridge management system called BaTMan.

Road surface damage

Road surface damage in Sweden is rare with virtually none at all.

Cause of damage

Poor condition of the road generally is the reason for damage on secondary and other roads.

Processes/controls in place to reduce the incidence of road surface damage

Sweden's contractors have different inspection intervals depending on what road it is: this falls between two to 14 days.

Set of national or local standards for the design, construction and maintenance of the road network

Sweden does have a set of national standards.

New Zealand

How road maintenance policy/management/operations are delivered

Physical works and professional services are all supplied under contract using Alliance, Performance Specified Maintenance Contract, Hybrid or Measure and Value contract forms.

http://www.nzta.govt.nz/resources/state-highway-asset-management-plan/docs/state-highway-asset-mgmt-plan-2012-2015.pdf

Areas of best practice

Asset Management is generally in accordance with the provisions of the *International Infrastructure Management Manual (*IIMM), the corridor inventory and condition information administered through Road Assessment and Maintenance Management Manual (RAMM) IT system in all regions of NZ.

Road surface damage

Is uncommon - typically one or less incidents per kilometre travelled

Cause of damage

On motorways/freeways and main roads the cause of damage is the poor condition of the road generally and poor quality reinstatements after part of the road has been excavated.

Processes/controls in place to reduce the incidence of road surface damage

The approach across all hierarchies of road is similar in principle but with more frequent inspection cycles, shorter response times, and reduced tolerance of surface defects on the higher classification roads. All roads are inspected routinely at one to six week cycles, commonly with a video record being kept and analysed in a regional office to identify defects for treatment by routine road maintenance crews.

Annual road condition surveys are made across the entire network (predominantly thin surface unbound granular pavement construction) using a mix of high speed data for rutting, texture, skid resistance etc., and site specific investigation for surface cracking or pavement strength. The results are used to filter and inform detailed field inspections leading to nationally prioritised annual programmes of surface or pavement repairs, surface dressing, pavement recycling/rehabilitation, pavement reconstruction. The mix and timing of repairs to pavement reconstruction is selected to minimise the long term costs of providing reliable access along the State highway network, and to reduce safety and comfort service level risk appropriate for each classification of road arising from the occurrence of surface defects.

Techniques used

Full range of techniques deployed dependant on the nature of the deterioration; this includes anything from minor potholes or surface patches through to global pavement construction and drainage upgrades dependant on the cause of the damage. Techniques include:

- filling small defects with asphaltic concrete
- excavation and replacement of sections of failed granular pavements with new material and surface
- excavation of ex. surface and top granular pavement layers, addition of 1% of cemntatious or similar binder to excavated material, and rebuilding of pavement with mixed recycled material with new chipseal surface
- overlay of ex pavement with 100mm (depending on load) high spec base course resurfaced with chipseal
- filling ruts with chip or slurry seal either standalone or prior to resurfacing full width
- surface dressing alone on low annual average daily traffic (aadt) roads

Set of national or local standards for the design, construction and maintenance of the road network

New Zealand has a set of national standards, available at: http://www.nzta.govt.nz/resources/results.html?catid=330. There is no formal process on how to depart from these standards.

Belgium

How road maintenance policy/management/operations are delivered

The ordinary road maintenance is generally carried out by the road districts or under their control. The small works are carried out by the staff of the district. The works that requires more resources are generally subcontracted to the private sector. The procurement is done through a public contract, usually for a period of one year. In this case, the role of districts is to establish the specifications and to ensure the control of the realisation on site. The work of reconditioning, upgrading or major repairs included in extraordinary maintenance are programmed according to the results of auscultation and expertise operations measured on the field.

Areas of best practice

The existence of specifications: http://qc.spw.wallonie.be/fr/index.jsp

Road surface damage

Is common – with two or three incidents of damage every km.

Cause of damage

On motorways/freeways and main roads the cause of damage is poor condition of the road generally and poor quality reinstatements after part of the road has been excavated.

Processes/controls in place to reduce the incidence of road surface damage

Technical and visual inspections.

Techniques used

Common and well-known techniques.

Set of national or local standards for the design, construction and maintenance of the road network

Belgium has a set of national standards, available at: http://qc.spw.wallonie.be/fr/index.jsp

There is no formal process for departing from standards.

Norway

How road maintenance policy/management/operations are delivered

All works are contracted out with the contracts mainly divided into: operation contracts (includes some maintenance, i.e. mostly repair jobs), maintenance (pavements and improvements), operation (including repairs) of electric and electronic installations - and in some places, tunnel operation, mostly related to electronic and electrical facilities.

The Norwegian Public Roads Administration (NPRA) participated in working out the so-called Performance Based Service Agreements (PBSA) report, please refer to http://www.vegvesen.no/s/anbud/PBSA/PBSAv3-1.zip

Areas of best practice

Winter operation/maintenance - please refer to http://voffweb.net/div/Winter_Technology_Norway.zip where interesting areas and fields are described.

To follow up activities which are executed by our contractors, the NPRA has developed a web based system named "ELRAPP". At the moment, there are no presentations in English, but the NPRA would be more than happy to share information about this system. This system is used to follow up the operation contracts, and the users are the contractors as well as the NPRA. This covers all the administrational tasks, including reporting to the NPRA, quality management, winter data (operational data) etc.

Road surface damage

The main damage/condition factor that triggers road surface (pavement) maintenance in Norway is rutting, caused by both studded tires and permanent deformation. This is most dominant on roads with high traffic volumes. On roads with lower traffic volumes longitudinal roughness (IRI), cracking, edge deformations etc…are the main causes of maintenance needs. Norway only measure rutting and roughness – the international roughness index (IRI) - other damages are assessed visually but without recording the data in a systematic way.

Norway measure road surface condition every year on most of the national and country road networks. Values for every 20 meters are stored in the National Road Data Bank. At the same time images are taken and stored for every 20 meters.

In the performance based contracts (for road operation works- area contracts covering all operational activities on national and county roads for a 5-year period) there are procedures in place for handling damage types that can have severe traffic safety consequences, e.g. pot-holes. These should be fixed within 3 days (annual average daily traffic - AADT>1500) or 1 week (AADT<1500).

Techniques

Most common maintenance technique for road surfaces on National and County roads is laying a new layer of bituminous materials (resurfacing), with 80-100 kg/m2. Sometimes the

existing pavement is milled before resurfacing. Sometimes a milled surface is left for a year or two before resurfacing with a new asphalt layer. Patching a smaller area is also common on less important/trafficked roads. Techniques such as repaving/remixing have been in use, but not at a very large scale. Fixing minor damages, such as potholes are taken care of in the performance based contracts. The information above applies for National roads (10,500 km) and County roads (44,000 km) which are under the management of NPRA. The NPRA does not have the responsibility for Municipal roads (38,000 km).

Only recently (December 2011), a manual (tutorial) on this subject covering all aspects of operation and maintenance was published. This manual is in Norwegian - but explains Norway's "State of Art" programme: http://www.vegvesen.no/_attachment/290248/binary/512522. The Norwegian standards are published on http://www.vegvesen.no/s/bransjekontakt/Funksjonskontrakt%20dokumenter/Hb%20111%20Endelig%20utgave%202003.pdf and a text book explaining this standard is published on http://www.vegvesen.no/s/bransjekontakt/Funksjonskontrakt%20dokumenter/Temaheftet%202003web.pdf

Singapore

How road maintenance policy/management/operations are delivered

Singapore manage the maintenance of their road network and the maintenance works are carried out by contractors through maintenance term contracts. The road inspections are done by road inspectors as well as annual network condition surveys by machine to obtain riding quality in term of IRI and skid resistance by SCRIM. Singapore manage and control road diggings for utilities layings with power given under the Street Works Act. They also manage and control road usages such as obstruction on footway and carriageways with the power given under the Street Works Act.

Best practice

They use different asphalt mixes that are considered more appropriate and durable under different traffic conditions based on the field working experience. In general dense-graded asphalt mixes are used for major arterial, collector and local roads. At traffic junctions with high traffic loading and stresses, rigid or semi- rigid pavements are used. For motorways, they use opened graded mix or drainage mix due to its ability to reduce splash/spray and aquaplaning and traffic noise.

Road surface damage

Uncommon - typically one or less incidents per kilometre travelled.

Cause of damage

Across the whole network severe climate events/natural hazards cause damage to the road condition and poor quality reinstatements are the cause behind damage on the main roads, secondary roads and other roads.

Processes/controls in place to reduce the incidence of road surface damage

Singapore carries out regular inspections with higher frequency for roads subject to higher traffic loading. They also carry out preventive maintenance to reduce the need to carry out structural maintenance.

Techniques

Due to the adoption of preventive maintenance practice, generally the road surface damage such as ravelling or surface cracking can be repaired by milling and patching.
For older surfaces, generally resurfacing is used to renew the surface or to improve the skid resistance.

Set of national or local standards for the design, construction and maintenance of the road network

Available at: http://www.corenet.gov.sg/einfo/

Quebec

How road maintenance policy/management/operations are delivered

The organizational structure of Québec's Ministère des Transports (Department of Transport) is largely decentralized. It is composed of two operational branches which cover 59 service centres located across 14 distinct territories within the entire province of Québec. These territories have considerable autonomy in managing resources and work together with regional and municipal organisations in the surrounding area. Responsibility for maintaining the system is given directly to service centres, which for this purpose typically establish contractual agreements with the private sector.

http://www.mtq.gouv.qc.ca/portal/page/portal/accueil

Areas of best practice

For winter maintenance, the use of the private sector accounts for 68% of the network – motorways, main roads and secondary roads. Contractual agreements are also arranged with municipalities for 13.5% of the network – secondary roads, collector roads. The Ministère's staff are responsible for maintaining 18.5% of the network (motorways and main roads). The partnership used by the Ministère to maintain the network relies on contractual expectations with respect to anticipated results. Depending on the type of network maintained, there are specific requirements for snow and ice removal and patrolling the network within each contract awarded (administrative and technical documents). The Ministère ensures compliance with contractual agreements made with the private sector and municipalities by performing regular audits during the work.

Winter maintenance – Best practice:

1. Determining the level of service (LOS) to be provided to users of the entire network falls under the responsibility of the Québec's Ministère des Transports. Two main criteria are used to determine levels of service, including the functional network classification and the average daily traffic (ADT) flow in winter recorded within the network. Determining the LOS helps to identify the resources required to fulfill these commitments.
2. Using external resources (private or municipal) for maintaining a portion of the network that is under the responsibility of Québec's Ministère des Transports. This sharing of responsibility for maintenance of the network enables the Ministère to maintain the expertise of its management teams and develop valuable external expertise.
3. Using technologies (fixed and embedded) such as road weather information systems (RWIS) for monitoring conditions and guiding the operations to be performed on the network.
4. Providing information to users, enabling them to learn about road conditions in winter. Good information enables users to better plan their travel and in some cases defer travel to a later time. The quality of the information disseminated to network users should be based on a specific collection process and a simple and uniform terminology.

Summer maintenance – Best practice:

Québec's Ministère des Transports follows two different methodologies in order to detect

damage to road infrastructure. The first principle consists of a constant patrol of the network that aims, among other things, to identify damage to the road infrastructure. This is done by patrol officers who patrol the road network every day at a frequency that varies depending on the size of the road. The information is entered directly into a computer system on board the vehicles. The patrol detects the following damage: potholes, asphalt sinkage over culverts, verges washed away by rain, burned out lights, damaged guard rails and bridge joints. The information is sent within minutes to various foremen who will plan the repairs according to the urgency of each situation.

The second principle consists of inspections at scheduled intervals in order to assess the state of infrastructure. Computer systems also support these inspections. Road marking quality is assessed every spring. The condition of the carriageway (cracking, rutting, ride quality) is evaluated every two years. For culverts and structures, the frequency varies from one to five years, according to their state. For structures that support oversized signs, the frequency is between two and five years. These inspections are part of the asset management process in place for the various infrastructures and are conducted by qualified personnel (engineers, technicians).

Set of national or local standards for the design, construction and maintenance of the road network

Yes http://www3.publicationsduquebec.gouv.qc.ca/produits/ouvrage_routier.fr.html

Finland

How road maintenance policy/management/operations are delivered

The Ministry of Transport and Communications is responsible for transport policy. The Ministry's responsibilities include transport systems and networks, transport of people and goods, traffic safety, and issues relating to climate and the environment. The Finnish Transport Agency is responsible for policy/management/operations. The Centres for Economic Development, Transport and the Environment manage the regional implementation and development tasks of the state administration. All works are contracted out. Further information is available online:

www.liikennevirasto.fi

www.lvm.fi

www.ely-keskus.fi

Best practice

Road surface damage

Common - 2 or 3 incidents of damage every km

Cause of damage

Across the network severe climate events/natural hazards.

Processes/controls in place to reduce the incidence of road surface damage

The road network is divided into 80 contract districts. There is a requirement of regular inspections and fixing of damages in certain time period in every contract.

Techniques

Mastic Asphalt and special fixing mixtures are used to repair damages, especially if repairing is needed during winter time. Asphalt Concrete is only used on summer time. Cracks are sealed with bitumen or special mixtures on main roads during summer time.

Set of national or local standards for the design, construction and maintenance of the road network

The standards are available from:
http://www2.liikennevirasto.fi/thohje/ohjeluettelot/2011_1_livi_tienpidon_tekniset_ohjeet.pdf
(in Finnish). There is no formal process for departing from standards.

Spain

How road maintenance policy/management/operations are delivered

The 518 km of the state road network in Murcia, is divided into 4 sectors of integrated maintenance each one of this sectors is contracted to specialist companies. These companies are responsible for the routine maintenance (365 days a year and 24 hours a day). The main operations to be performed consist of: accident assistance, road operating condition maintenance/monitoring/policy, managing inventories, evaluating performance indicators, and programming subsequent maintenance operations, establishing a schedule of road conditions and compliance with standards. Moreover, in the sections with elevations over 500m winter maintenance operations are applied.

www.carreterasmurciadatos.com

Areas of best practice

In relation to winter maintenance, whenever the temperature drops 3 ° C, the humidity exceeds 75%, and the pavement temperature falls below 0 degrees, Spain performs preventive treatments to prevent formation of ice sheets through the application of brine, with a eutectic salt concentration (23 degrees Baume) and residual strength of 8 g/m2. In certain cases this brine is made by the company in charge of the sector. If the snow settles on the road, measures are put in place to restrict heavy vehicle traffic and perform curative treatments NaCl (and if the temperature is below -10 ° C, mixed with CaCl2).

Road surface damage

Road surface damage is uncommon - typically one or less incidents per kilometre travelled – and caused by the poor condition of the road generally.

Processes/controls in place to reduce the incidence of road surface damage

Annual inspections, monitoring, performance indicators evaluation each six months, and agenda.

Techniques

If the issue is a simple pothole, Spain repair it with cold bitumen mixes, but when the damage is more important, Spain use milling and repositioning on the damaged surface. Also they consider it very important to seal surface cracks to prevent entry of water into the road and the subsequent rapid deterioration of the pavement.

Set of national or local standards for the design, construction and maintenance of the road network

Spain have a set of national standards.

Netherlands

How road maintenance policy/management/operations are delivered

The Dutch Government sets the overall policy framework for roads and road transport, including roads policy, toll policy and legislation, road safety policy, bus and taxi policy and road pricing and user charging policy. The Government is not accountable for the day-to-day operation and management of the road network; these duties are discharged to other public bodies (e.g. Rijkswaterstaat, ProRail, provinces, municipalities). The public bodies responsible for day-to-day operation and management can be categorized by the road types they look after, namely, local, regional or highway.

Areas of best practice

The team of directors of Rijkswaterstaat (DT-RWS) decided in September 2008 to use Asset Management as the leading principle for the management of the infrastructure and instructed the Centre for Transport and Navigation (DVS) to develop a concept for further implementation. Rijkswaterstaat sees Asset Management as an important support of the existing SLA management. Asset Management is considered to be one of the key factors in executing the project “Reliable and Efficient Partner” in the Realisation Programme of Agenda 2012. Asset Management being one of the key factors is affirmed in the Business Plan 2015 that forms the basis for the organisational developments in the period 2012 – 2015.

Road surface damage

Road surface damage is uncommon - typically one or less incidents per kilometre travelled – and caused by the poor condition of the road generally and by severe climate events and natural hazards.

Processes/controls in place to reduce the incidence of road surface damage

In the Netherlands there are regular, yearly inspections of the road surface. The results from these inspections are input for a damage prediction model; usually Rijkswaterstaat replaces the surface just before damage is expected ('preventive maintenance'). The motivation for this is as follows: -
- no unexpected interruption of service or damage of vehicles;
- long term this strategy is cheaper than repairing (heavier measures are needed when repairing and tender-prices are higher when sudden measures are needed and the tendering and realisation is under pressure).

Techniques

In the Netherlands usually replace the upper 50 mm of pavement.

Set of national or local standards for the design, construction and maintenance of the road network

The Netherlands have a set of national standards and a process for departing from the standards. Standards are (in future) attached to service-levels (reliability, availability and safety) that are agreed with the Ministry, the risks of the current state of objects for this levels and the contribution of measures in reaching the agreed level. Since budgets are less than required for all measures, Rijkswaterstaat uses a RAMS SHEEP-bases prioritization system (details on page 12).

Switzerland

How road maintenance policy/management/operations are delivered

The state is the regulator and makes the policy in regards to freeways. The Federal office is responsible for freeways. Main roads and other roads are managed by the cantons (member states) to the communes (also known as municipalities, are the smallest government division in Switzerland). The state gives also the money for the motorways and 11 units are responsible for the operations. They have to do the maintenance for winter service, cleaning, care of the trees, the technical service and the electro-mechanical-service. They also have to patch holes on the road network.

www.astra.admin.ch

Areas of best practice

Information available at:
http://www.astra.admin.ch/themen/nationalstrassen/02693/index.html?lang=de

Road surface damage

Road surface damage is uncommon - typically one or less incidents per kilometre travelled – and caused by the poor condition of the road generally and are caused by severe climate events and natural hazards.

Processes/controls in place to reduce the incidence of road surface damage

The unit carries out weekly inspections to control if there is damage or not (freeways). If there is damage, a repair has to be executed and this is a relatively fast process.

Techniques

Switzerland repair damage to the road network with a cold micro-covering or bitumen.

Set of national or local standards for the design, construction and maintenance of the road network

Switzerland have a set of standards (www.vss.ch) but no process for departing from them, however they are currently developing a risk assessment process at the moment.

New South Wales (Roads and Maritime Services, RMS)

How road maintenance policy/management/operations are delivered on State Roads

Maintenance policy, strategy, standards, procurement policy, regional budget allocations are determined centrally. Six rural regions develop the detail of annual maintenance programmes and coordinate delivery. Maintenance delivery mechanisms through a mix of Performance Specified Maintenance Contract (PSMC) contract and internal blue collar in Sydney. In rural areas delivery is approximately 50% length by local councils (under single invitation maintenance contracts) with RMS blue collar delivering other 50% (tends to be the higher trafficked rural roads). Overall maintenance expenditure is approximately 50% internal workforce and 50% contracted or subcontracted. RMS currently developing a strategy, at request of the state government, to increase contestability in road maintenance delivery.

Areas of best practice

Winter maintenance is not a high focus (in one region only), pavement management system under development based on New Zealand's Deighton's Total Infrastructure Management System (dTIMS) which will allow management of funding and performance via road categories across the state. A long term maintenance strategy is prepared for Treasury each year outlining sustainable funding needs and levels of risks across asset types for varying funding scenarios (risk based approach). Also, moving to financial asset management indicators describing the level of asset sustainment from a financial depreciation perspective (as a means of better engagement with Treasury and common reporting across state assets).

Road surface damage

Road surface damage is uncommon - typically one or less incidents per kilometre travelled – and are caused by a combination of factors: severe climate events and natural hazards, poor quality reinstatements after part of the road has been excavated and finally, as a result of a poor condition of the road generally. Recent heavy rain patterns over the last 2 years have however accelerated damage on many roads which had hitherto been operating within a "drought" environment for the provious 10+ years.

Processes/controls in place to reduce the incidence of road surface damage

Annual automated road condition surveys complemented by regular visual inspections of roads to identify road maintenance needs and inform road maintenance programmes. Routine maintenance standards specify intervention levels and response times which vary according to the road hierarchy. Routine maintenance specifications specify inspections. PSMC contract specifies long term asset standards required at handover after 10 years.

Techniques

Rural roads are predominantly a sprayed seal that have a granular base course. Depending on severity sprayed seal pavements are patched by repairing base course and applying sprayed layer. Asphaltic concrete (AC) pavements repaired by cold planning and replacing

the AC. Severity of the distress dictates the depth of patch. In rural areas there is a high focus on regular resealing as a preventative measure to sustain the waterproofing.

Set of national or local standards for the design, construction and maintenance of the road network

These are available from http://www.rta.nsw.gov.au/doingbusinesswithus/index.html with any departure from the standard signed off by a regional asset manager.

Appendix B – Case Study on the Netherlands Approach to Asset Management

This page is intentionally blank. The case study follows on the next page.

Asset Management Methods in The Netherlands

Case Study for PIARC Technical Committee D1 – Wg 1
Management of Road Infrastructure Assets

Date July 21st, 2011
Status Final

Asset Management Methods in The Netherlands

Case Study for PIARC Technical Committee D1 – Wg 1
Management of Road Infrastructure Assets

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Glossary

Asset Management	Systematic and coordinated activities and practices through which Rijkswaterstaat optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their life cycles for the purpose of achieving Rijkswaterstaat's strategic plan.
Asset Management Improvement Programme	Rijkswaterstaat's programme of activities that seeks to make positive improvements to management practices while taking full account of existing management practices.
Asset Management Objectives	a) specific and measurable outcome or achievement required of asset system(s) in order to implement the asset management policy and asset management strategy; and/or b) detailed and measurable level of performance or condition required of the assets; and/or c) specific and measurable outcome or achievement required of the asset management system.
Service Level Agreement	Measurable results of Rijkswaterstaat's management of its assets and/or asset system(s). The service levels are stated in in terms that the customers can understand. Levels of Service typically cover condition, availability, accessibility, capacity, amenity, safety, environmental impact and social equity. 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 customers and maintaining its physical integrity at an appropriate level.
Asset Management Plan	Document specifying activities and resources, responsibilities and timescales for implementing the asset management strategy and delivering the asset management objectives.
Asset Management Policy	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	Long-term optimised approach to management of the assets, derived from, and consistent with, the organisational strategic plan and the asset management policy.

Asset Management Regime	Organisation's asset management policy, asset management strategy, asset management objectives, asset management plan(s) and the activities, processes and organisational structures necessary for their development, implementation and continual improvement.
Asset system	Set of assets that interact and/or are interrelated so as to deliver business function or service.
Asset Valuation	The calculation of the current monetary value of an asset or group of assets. The calculated value is the Net Asset Value but it is normally referred to as the Asset Value.
Backlog	The monetary value of work required to close the gap between the current performance provided by an asset and the required performance. Required performance targets which are defined nationally may be lower than some locally set performance targets.
Information Management	A formal approach to the identification of information needs and the associated collection, storage, usage and maintenance of the information.
Lifecycle	Time interval that commences with identification of the need for an asset and terminates with the decommissioning of the asset or any associated liabilities.
Lifecycle Plan	A considered strategy for managing an asset, or group of similar assets, from creation to disposal. A lifecycle plan should give due consideration to minimising costs and providing the required performance.
Maintenance	Collective term used to describe all the activities and operations undertaken to manage and maintain road assets, e.g. inspection, assessment, renewal, upgrade etc.
Organisation Strategic Plan	Overall long-term plan for the organisation that is derived from, and embodies, its vision, mission, values, business policies, stakeholder requirements, objectives and the management of its risks.
Performance Measure	A generic term used to describe a measure or indicator that reflects the condition and/or performance of an asset, e.g. Best Value Performance Indicators and other Performance Indicators.
Risk Management	Coordinated activities to direct and control an organisation with regard to risk.
Highway Network	The main strategic routes.
Value Engineering	The development of optimal solutions for prioritised maintenance needs using option appraisal, whole life costing, scheme development, and synergies with other road schemes.
Value Management	The assessment and prioritisation of identified maintenance needs.

Whole Life Cost	The total cost of the asset over the term of its life including planning, design, construction, acquisition, operation, maintenance, rehabilitation and disposal.

List of Abbreviations

BINK	Project for Professional Investment in Networking
BLM	Basic Levels for Maintenance
BSI	British Standards Institute
CBS	National Statistics Bureau The Netherlands
DBFM	Design Build Finance Maintain Contract
DC	Design & Construct Contract
DCM	Design Construct Maintain Contract
DG	Director General Rijkswaterstaat
DG-Mo	Directorate of Mobility
DISK	Asset database for structures
DT-RWS	Board of Directors of Rijkswaterstaat
DVS	Centre of Transport and Navigation, National Advisory Division of Rijkswaterstaat
GOMA	Good Asset Management Organization
I&E	Ministry of Infrastructure and Environment
I-AMP	Integrated Asset Management Plan
IF	Infrastructure Fund
IIMM	International Infrastructure Management Manual
I-MJP	Integrated Asset Management Plan
ITS	Intelligent Traffic Systems
IVON	Asset database for pavements
LCC	Life Cycle Costing
MIT	Multi year plan for large investments in infrastructure
MMS	Maintenance Management System
NIS	Network Information System
OMR	Object Maintenance Regime
P * Q	Price * Quantity
PAS-55	Publicly Available Standard on Asset Management
PB TMC	Performance Based Term Maintenance Contract
PDCA cycle	Plan, Do, Check, Act cycle (Deming Cycle)
PIARC	Permanent International Association of Road Congresses – World Road Association
PIM	Program Infrastructure Management project (2006-2009)
PIN	Key Performance Indicator
PLOV	Project for Planning National Maintenance Waterways
PPP	Public Private Partnership
RAMSSHE€P	**R**eliability **A**vailability **M**aintainability **S**afety **S**ecurity **H**ealth **E**nvironment **€**conomics **P**olitics
RD	Regional Director
RINK	Project for Risk Inventory Wet Structures
RWS	Rijkswaterstaat, Agency of the Ministry of Infrastructure and

	Environment
SCB	System Based Contract Control
SG	Secretary General
SLA	Service Level Agreement
SNIP	Rules for Wet Infrastructure Projects
T-report	Progress Report on development of Asset Management Plan, works and budgets
URP	Project for Uniform Rijkswaterstaat Planning
VIP	Project Improved Instrumentation Performance Management
VOCO	Project for comparison study on cyclic maintenance

1 Introduction

The contents of this report illustrate the asset management processes and practices as developed by Rijkswaterstaat. Although most of these processes and practices can also be found in other management organizations (i.e. provinces, municipalities) on a detailed level there can be differences.

1.1 The Netherland's Transport Network

The transport network of The Netherlands includes highways, regional roads, local roads, railways, waterways, airports and ports. It provides means for transportation for the 16 million inhabitants of The Netherlands, tourists and foreign transport companies. Authority and responsibility for the transport network is delegated to public and semi-private bodies.

The transportation network is considered to be of vital interest for the social and economic welfare of The Netherlands. It connects Centres of population and allows transport of persons and goods both national as well as international. Table 1 provides an impression of the elements within the transportation network.

Table 1: Elements in Transport Network in The Netherlands (source: CBS Statistics Netherlands)

Element	National	Regional	Local	Total
Road network	3.250 km	7.848 km	123.237 km	134.335 km
Rail Network	2.888 km	0 km	0 km	2.888 km
Waterways	2.548 km	1.675 km	1.992 km	6.215 km
Airports	1	4	Unknown	5
Seaports	6	0	0	6
Inland ports	not specified	not specified	not specified	not specified

1.2 Highways, Regional and Local Road Network

The Dutch Government sets the overall policy framework for roads and road transport, including roads policy, toll policy and legislation, road safety policy, bus and taxi policy and road pricing and user charging policy. The Government is not accountable for the day-to-day operation and management of the road network; these duties are discharged to other public bodies (e.g. Rijkswaterstaat, ProRail, provinces, municipalities). The public bodies responsible for day-to-day operation and management can be categorized by the road types they look after, namely, local, regional or highway.

Highways

The highway network includes the economic most important roads. It mainly contains dual carriageway multi-lane highways which are of (inter)national importance. Road maintenance, investment and road infrastructure projects are the responsibility of Rijkswaterstaat, an agency of the Ministry of Infrastructure and Environment.

Regional Roads
The regional road network includes roads that connect the major cities within the provinces. It mainly contains single carriageway roads that are of national and regional importance. Road maintenance, investment and road infrastructure projects are the responsibility of the provinces.

Local Roads
The local road network distributes the traffic within cities, villages and rural areas. It mainly contains single carriageway roads that are of local importance. Road maintenance, investment and road infrastructure projects are the responsibility of the municipalities and Water District Boards.

1.3 Rijkswaterstaat and the Highway Network

Overview
Responsibility and accountability of Rijkswaterstaat for the Highway Network is amongst others defined in the "Waterstaatwet 1900". The constitution of Rijkswaterstaat is further detailed in the "Organiek Besluit Rijkswaterstaat". Responsibilities include:

a) Exercising the superintendence of all water management;
b) In general the treatment of all water management issues, including to ensure the security of the country against water, the water in quantitative and qualitative terms, the waterways and harbours, roads and river crossings, a safe and smooth traffic flow on land and water;
c) The construction, operation and maintenance of dams, works for water management, (country)roads and shipping ports, roads and river crossings, the execution of works for the purpose of land reclamation;
d) The preparation of concessions in the domain of water management;
e) Ensuring the implementation and enforcement of the prescribed rules relating to the assigned public works tasks, in connection with the granting of licenses and exemptions, ensuring compliance with conditions attached to such licenses and exemptions, and concessions in the field of water management. To ensure compliance with conditions attached to such licenses and exemptions, as well as to concessions in the field of water management.

The powers of Rijkswaterstaat to implement the described management tasks are included in various laws. These mainly concern the following laws: "Wet Beheer Rijkswaterstaatwerken", "Waterstaatswet of 1900", "Wegenwet", "Wegenverkeerswet", "Scheepvaartverkeerswet".

Highway Network
Rijkswaterstaat is responsible for the management and maintenance of the Highway network in The Netherlands. The Highway network is comprised of route corridors that are considered to be of strategic importance to the economic stability and growth and social wellbeing. The Highway network is vital because it connects cities, and ports both national as well as international. Key Highway network statistics are (in 2010):

- 3.250 centre line kilometers (6.250 carriageway kilometers) of Highways and Main Roads.
- 9.086 bridges and other structures.
- 3.195 objects associated with Traffic Management / Intelligent Traffic Systems.
- 20.977 ha of grassland, bushes, ditches, etc. along the road network.
- Accountable for approximately 35% of all traffic movements.

Appendix A lists the quantities of assets that Rijkswaterstaat maintains.

Annual Budget

The Dutch government allocates the Ministry of Infrastructure and Environment annual budget. In 2011 the budget was set at € 12.570 million; Table 2 provides a high level breakdown[1]. As Rijkswaterstaat receives budgets from two major sources (i.e. Infrastructure Fund and National Budget) for each of the budget heads the sources are listed in the table.

Table 2: Annual budget Ministry of Infrastructure and Environment 2011 (source: Miljoenennota)

Budget Head	2011 Budget (€mill)	Funding
Rail Services	2.435	IF
Roads & Highways	5.283	I&E + IF
Dams & Dykes	1.009	IF
Waterways	2.705	I&E / IF
Major projects	0,658	IF
Regional & Local Infrastructure	0,422	I&E / IF
Other	0,058	I&E
Total	**12.570**	

Table 2 includes € 3.275 million allocated to the maintenance and management of the highway network and major capital works. Table 3 shows a high level breakdown of the former.

[1] Total budget for 2011 is set at € 11.600 mio.

Table 3: Annual budget Rijkswaterstaat – Road Network 2011 (source: Rijksbegroting 2011)

Budget Head	2009 Budget (€mill)
Management costs (personnel / housing / …)	1.036
Major capital works	1.024
Inventory, Inspection and Testing AND Routine and Cyclic Maintenance	1.215
Structural Maintenance	
Minor Improvements	
Miscellaneous	
Total	**3.275**

2 Alignment with Corporate Asset Management Direction

2.1 Organizational Commitment

The team of directors of Rijkswaterstaat (DT-RWS) decided in September 2008 to use Asset Management as the leading principle for the management of the infrastructure and instructed the Centre for Transport and Navigation (DVS) to develop a concept for further implementation.

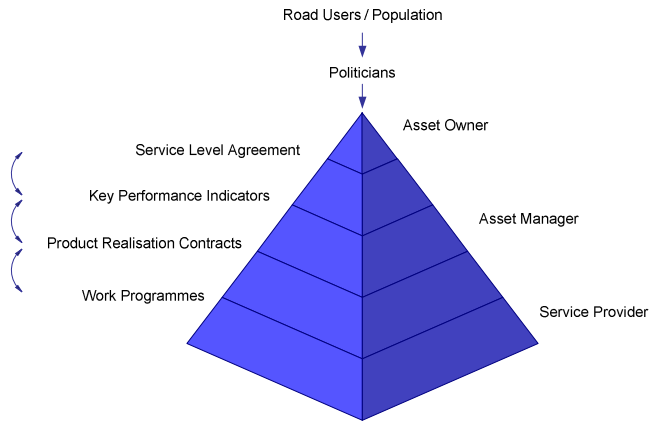
Rijkswaterstaat sees Asset Management as an important support of the existing SLA management. Asset Management is considered to be one of the key factors in executing the project "Reliable and Efficient Partner" in the Realization Program of Agenda 2012. Asset Management being one of the key factors is affirmed in the Business Plan 2015 that forms the basis for the organizational developments in the period 2012 – 2015.

When Asset Management has been carried out completely we will have a complete picture of the area under our control, we will know the state of maintenance and we will also have a long-term insight into our works portfolio and the costs that are related. Our methods of working and the standard costs will have been determined and will be non-controversial. We will make transparent and professional agreements with the customer and the owner and execute our projects with a minimum nuisance for the user. We will involve private companies in the best possible way. Our internal agreements will be transparent and we will learn from our experience.

2.2 Asset Management and the Management Hierarchy

Figure 1 provides a framework for the Asset Management Hierarchy for the Highway Network within The Netherlands. Similar structures can be found at provincial and municipal level.

Figure 1: Asset Management Hierarchy The Netherlands



Strategic

On strategic level the interests of the road users and population are balanced by the Government i.e. politicians in Parliament. The Parliament provides the Ministry of Infrastructure and Environment with a budget. The budget is based on a policy agenda combined with running costs to sustain the capital assets and personnel costs.

The provided budget up till 2011 was divided in two parts:

1. A budget for (re)construction projects (i.e. all projects costing more than € 30 mio).
2. A budget for maintenance and management of the road network.

There was no option for exchange of budget between the different parts. It is envisaged that in the coming years the budget differentiating will be less pronounced. Due to integration of maintenance and (small) reconstruction works in so called Performance Contracts an integration of works and budgets will occur. All construction projects will be managed from the Project Management Office whereas before 2011 part of these projects was managed from the Regional Divisions.

The budget is based on a Service Level Agreement between the Ministry and Rijkswaterstaat and the amount and type of assets managed by Rijkswaterstaat. The SLA translates the public's interest into Key Performance Indicators. With the SLA as input the Director-General of Rijkswaterstaat makes Performance Agreements with the 10 Regional Directors. SLA and the resulting Performance Agreement provide the basic framework to guarantee that the strategic targets are met and the budget is spent according to the public's interest.

The overall long term direction for transport, e.g. policy, aims, objectives and targets are set down in the Corporate Business Plan.

Tactical

At tactical level the Centre for Transport and Navigation with input of the Regional Infraproviders translates the overall aims and objectives into specific plans and performance targets for the different asset types, aligning these with Network Manager responsibilities. This includes processes for identifying the required, most beneficial and cost effective maintenance activities and when they should be carried out.

The result of the work of the Centre for Transport and Navigation is presented to the Board of Directors of Rijkswaterstaat by means of the Integrated Asset Management Plan (I-AMP). It is based on the optimized technical maintenance plans for the three cost-drivers, i.e. Pavements, Structures and ITS. The Board of Directors of Rijkswaterstaat

The I-AMP is used by the Board of Directors in making the agreements with the 10 Regional Directors on the projects and Service Levels / Key Performance Indicators they will deliver in the coming year.

Operational

At operational level the Regional Infraproviders develop and implement detailed short-term work plans and schedules that align with the principles, processes and

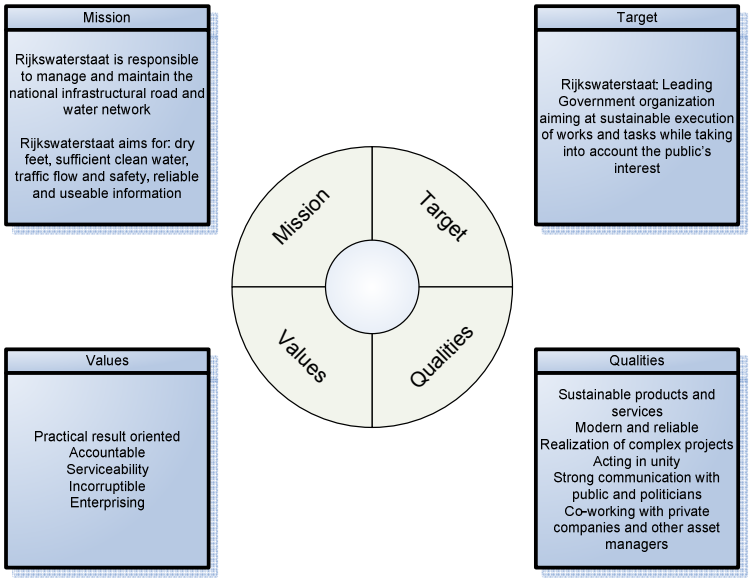
work volumes and phasing defined in the Integrated Asset Management Plan (I-AMP). Engineering processes include inspection, routine maintenance, scheme design, work scheduling and implementation. The focus is on choosing the right techniques, Value Engineering of schemes, carrying out the work in the most efficient way and scheduling works in consultation with Network Managers.

2.3 Asset Management Regime

Rijkswaterstaat Corporate Business Plan

The Corporate Plan (Agenda 2012) sets out Rijkswaterstaat delivery priorities, as derived from the Memorandum on Mobility (Nota Mobiliteit). Agenda 2012 details the vision and strategy of Rijkswaterstaat to help achieve its objective; the general vision is detailed in figure 2.

Figure 2: Vision Rijkswaterstaat organization



The Corporate and Business plans are described in section 5.2

Road Assets

The highway network includes a wide variety of asset types, including carriageway, bridges and structures, embankments, drainage, lighting, signs and barriers. Appendix A provides an overview of the highway assets.

Road Asset Management Policy and Strategy

The Asset Management Policy is derived from the Corporate and Business Plans and sets out RWS's overall intent and commitment for effective management of the highway network. The highway Asset Management Policy is discussed in Section 5.3. The Asset Management Strategy describes how RWS will achieve the Asset Management Policy. The highway Asset Management Strategy is discussed in Section 5.4.

Organization and Governance
Organizational structure and governance arrangements in relation to asset management, including the roles, responsibilities and relationships with the supply chain, are set out in Section 3.

Standards and Assurance, and Safety and Risk Management
Engineering standards and technical assurance/approval activities are vital to safe and effective asset management, in particular the delivery of maintenance and improvement schemes. Standards and approval activities relevant to the effective delivery of asset management are discussed in Section 5.2.

Safety and risk management are relevant to all RWS activities. RWS is implementing an overall safety and risk management system based on the RAMSSHE€P[2] principles on the three levels of governance: Service Level Agreement, Management Contract and Performance Contract.

Asset Management Planning
Asset management planning is the logical and systematic process that RWS uses to elaborate long-term investment and financial planning; a key outcome of this process is the development/updating of the Integrated Asset Management Plan (I-AMP).

Asset management planning is characterized by:
- Translation of objectives and priorities into Service level Agreements (SLA)
- Analysis of assets to determine performance gaps (Basic Levels for Maintenance) and identify long-term maintenance and improvement needs.
- Evaluation of the long-term work volumes, phasing and associated expenditure needed to deliver the agreed Service Levels.

The generic RWS asset management planning process is set out in Section 6.2.

Maintenance Implementation
The lifecycle maintenance activities related to the different asset types are summarised in the Object Maintenance Regimes and fully specified in the Performance Contracts. Many of the maintenance activities are routine and cyclic in nature (including planned and reactive), e.g. repair of defects, road markings, lamp changes, grass mowing, cleaning traffic signs etc.
Other maintenance activities, such as structural pavement maintenance, are identified by the inspections translated into the I-AMP. These activities are mainly contracted out by means of DC- or DCM-contracts.

Information Management and Systems
In the present situation Rijkswaterstaat has a good grasp of the current status of all its assets although access to the data stored in different systems and on different locations is complicated.

Rijkswaterstaat aims at improving the present situation by redeveloping its information management procedures and supporting systems. The present overlap

[2] Reliability, Availability, Maintanability, Safety, Security, Health, Environment, Economics, Politics

and duplication of data storage and 'cloudy' relations between systems should be removed.

Performance Management
Rijkswaterstaat uses Performance Indicators (PIN's) to define whether it meets the set standards and agreed Service Levels. These PIN's are reported in a rather abstract definition but are supported with data on a detailed level. The Basic Levels for Maintenance is widely used as reference.

The performance can be regularly monitored from the Network Information System on management level. Three times a year a report on the variations around the baseline is defined. These variations are discussed by the Board of Directors.

For management of the performance of the maintenance contractors regular procedures are followed.

3 Organizational Structure and Asset Management

3.1 Overview

Rijkswaterstaat acts as an Agency of the Ministry of Infrastructure and Environment. Rijkswaterstaat reports to the Directorate-General for Mobility (DG-Mo) and the Secretary General (SG).

3.2 Rijkswaterstaat Organizational Structure

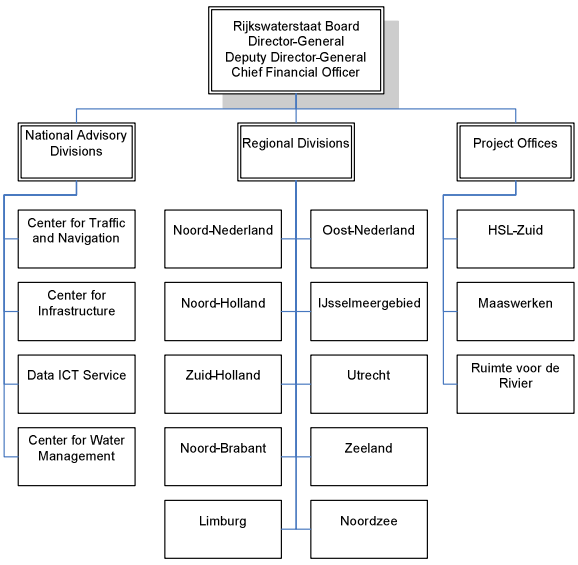
Rijkswaterstaat's purpose is to guarantee dry feet, sufficient and good quality water and a safe and fluid traffic flow. Figure 3 details the Rijkswaterstaat organization.

Rijkswaterstaat has a central office that controls the 10 Regional Divisions. Within these Regional Divisions 18 Road District Offices and 14 Water District Offices can be discerned. The Regional Divisions are responsible for day-to-day management of the road network. It is envisaged that in the coming years – based on efficiency considerations – the number of Regional Divisions and District Offices will be reduced.

The Rijkswaterstaat organization also contains 4 National Advisory Divisions. These are responsible for detailing standards and procedures to be followed within the Rijkswaterstaat organization and auditing on the use of these standards and procedures. As part of the Business Plan 2015 the organizational setup of these National Advisory Divisions will be redefined.

Last but not least also several Project Offices are present in the organization. These manage project of national interest.

Figure 3: Rijkswaterstaat organization (status 2010)



3.3 Supply Chain

Management and operation of the road network is executed by Rijkswaterstaat. Reconstruction and maintenance works are executed mainly by private sector companies (contractors). Rijkswaterstaat has the adagio "Private Sector, unless….". In contracting and managing these works Rijkswaterstaat is supported by private sector consultancy firms.

Rijkswaterstaat's procurement strategy for maintenance works has two angles. It aims for granting daily/routine maintenance contracts on district level (app. 250 – 400 km highway) for a longer contract period (3 to 5 years with a possible extension of 2 x 1 year). These contracts will be Performance Based. In granting these Performance Based Term Maintenance Contracts not only price but also quality will be decisive. The larger maintenance and reconstruction projects will be tendered separately and will be granted on price/quality too.

Regarding the reconstruction projects Rijkswaterstaat, aims for developing a larger involvement of the private sector by means of Public Private Partnership (PPP) and other contract options. Several of these projects (A15 MAVA, A12 LuVe, A6/A1/A9 corridor) will be tendered as DBFM contracts with a horizon of 20 up to 30 years.

Traditionally works are executed by contractors. Consultancy and inspection is executed by consultancy engineering firms. Presently more and more cooperation between contractors and consultancy firms can be found although the contractors also start to build their own internal consultancy departments (engineering contractors).

3.4 Auditing

Rijkswaterstaat reports on its Key Performance Indicators as detailed in the Service Level Agreement with the Directorate General for Mobility. To ensure correct reporting the Centre for Traffic and Navigation has an auditing task set by the Director-General. It reports directly to the Rijkswaterstaat Board.

The spending of budget is audited by both the Internal Auditing Office of the Ministry of Infrastructure and Environment and the Internal Auditing Office of the Government. Spending of budget is audited on rightfulness and suitability.

3.5 Training, Communication and Education

Training Rijkswaterstaat's Staff is becoming an ever increasing priority. Reason is that in the coming years a substantial outflow of older (experienced) staff is expected. Furthermore, Rijkswaterstaat aims for a more directing – instead of acting – role when preparing and executing works. This change in role also demands new skills of Rijkswaterstaat's Staff.

For career development Rijkswaterstaat discerns three roles: Project Manager, Advisor and Organizational Manager (e.g. Department Heads). For all roles several profiles of knowledge and competences are defined. For education Rijkswaterstaat has developed its own Corporate Learning Centre. If possible all training is managed and provided by this centre.

4 Development of Approach

4.1 General

Asset Management as a means for managing the Rijkswaterstaat organization is under development. Presently an Asset Management Program is in place to ensure further development and implementation of Asset Management within the Rijkswaterstaat organization.

4.2 Gap Analysis

In 2006 Rijkswaterstaat Regional Division Zeeland carried out an audit within the Program Infrastructure Management (PIM) to test to what extent the organization complied with the PAS 55 (BSI). The result was that although several aspects detailed in PAS-55 were already present within Rijkswaterstaat further development was still needed.

In 2008 Rijkswaterstaat Centre for Traffic and Navigation ordered a new GAP-analysis. It was executed by a private consultancy firm. Out of the GAP analysis it became clear what the status was on the development of the field of Asset Management within Rijkswaterstaat's organization. The analysis included:

- Literature research, interviews and workshops
- Benchmarking with various profit en non-profit organizations in The Netherlands
- Assessment of the current situation by means of the GOMA model (Good Asset Management Organization).

The results were used in development of the present Asset Management Program (see Section 4.4).

4.3 Benchmarking

As detailed above, part of the GAP analysis was execution of a benchmark study. The purpose of the benchmark was to ascertain how various organizations applied asset management in their operational management and to what extent it was developed.

The selected organizations were all very different, although all, save one, were entirely (100%) owned by the government. Conclusions drawn from the benchmark were:

- All organizations use a more-or-less similar definition of Asset Management. All the definitions are based on the current definition found in (inter)national literature.
- Scope, performance indicators and targets are defined closely related to the key activities of these organizations. Differences could be found.
- Although differences are encountered in the details of the Asset Management Strategy several common indicators were found:
  - Asset Management aims at a total life cycle approach.
  - Data and information have to be accurate.

- To ensure proper Asset Management purpose, policy and targets have to be clearly defined.

- All organizations use Asset Management as a means to ensure structured and cost-effective management of their assets.

Assessing the position of Rijkswaterstaat it was defined to be in development of its own Asset Management strategy and practice. Table 4 details the (present - 2011) position of Rijkswaterstaat in development of Asset Management as set out in the Good Asset Management Organization Matrix.

Table 4: Good Asset Management Organization (model developed by Sarras, 2004)

	AM leadership with urgency	Integrated whole life decisions made on risk delivery	Good asset info management	Integrated QA AM processes	Shared explicit AM model	Continuous AM change program
World Class 5	Powerful Director committing their career to AM leading to change overtime	Full whole life risk-based prioritization across assets / interventions / types. Day to day and long term	Integrated decision support, with fast and easy access to the key information	Excellent relationship management across functional interfaces including service partners	"Everyone a risk manager"	7 plus years – continuous
Competent 4	Powerful Director championing AM	Risk economics to integrate against assets and interventions / functions	Integrating & displaying asset information usefully	Ops / maintenance / projects all working well to clear good practice roles, continuously improving	Taking AM out to the field and service partners, and developing it further with them	3 – 5 years Major step changes evident
Developing 3	Board level agreement that AM is important	Prioritization consistent within asset types / within types of intervention	Adequate asset performance data. Data architecture that recognizes the centrality of info about assets	Explicit asset management roles, processes working efficiently within silos	Key people share the models (asset managers, one or more directors)	Coherent program < 3 years – Some quick wins delivered
Aware 2	Middle management pushing AM	Concept of prioritization in place– patchy implementation	Recognizing importance of asset inventory, asset data seen as a corporate priority	AM processes being developed, recognition of '5 bubble model' functions in AM and that organization has to change to meet these	High level vision being developed by some in the organization	Patchy initiatives
Unaware 1	No leadership	No attempt to systematically prioritize interventions	Inadequate asset inventory and no focus on assets in other corporate systems	No focus on AM processes	Not on the radar	No initiatives

Aspects found in the organizations used in the benchmark were incorporated in Rijkswaterstaat's Asset Management Program.

4.4 Asset Management Development Program

In September 2008, the Board of Directors of Rijkswaterstaat initiated the Asset Management Program. Execution of the program must result into a future-oriented and service-oriented organization whereby infrastructural assets are 'managed' cost-effectively. It should be possible to achieve cost optimization, primarily within networks but also across networks, and to make uniform considerations in maintenance planning.

Central elements for Rijkswaterstaat in Asset Management are:
- Service Level Agreements (SLA)
- Information Infrastructure: Quantity and quality (condition) of the network
- Programming: Long term planning of maintenance and implementation of RAMSSHE€P aspects in the programming cycle
- Basic Levels for Maintenance / Object Management Regimes
- Monitoring and auditing on processes and results (Deming Cycle: Plan, Do, Check, Act)
- Market cooperation: Procurement based on the economically most valuable bid.

Asset Management enables a more integrated and systematic approach to the operation and maintenance of the Rijkswaterstaat networks. This allows Rijkswaterstaat to clearly demonstrate how it is performing, what methods are being used, what the associated costs are and how this contributes to the satisfaction of the road user.

Asset Management is a joint program for all Rijkswaterstaat-services. It should lead to a more controlled and efficient implementation of the SLA agreements and therefore support the implementation of uniform processes in the Rijkswaterstaat organization.

The National Advisory Divisions are responsible for the program. Cooperation and full participation of the Regional Divisions is essential. The Regional Divisions have an interest in assuring that Asset Management really solves their regional issues. Furthermore, Asset Management will also have consequences for the working processes of the Regional Divisions.

At the moment, there is a range of projects and programs, that in one way or another aim to strengthen and detail the asset management practices in the organization. These are amongst others:
- Comparison study on Cyclic Maintenance (VOCO): The exploration of pros and cons of cyclic maintenance.
- Network management Information System (NIS): The establishment of a system that makes it possible to take the right decisions and give account on corporate and regional director level.
- Partnership Infrastructure Management (PIM): To better tackle planned management and maintenance of main roads from a broader perspective.

- Professional Investment in Networking (BINK): The improvement of the process of investments in road networks.
- Integrated Long Term Planning / Integrated Asset Management Plan (I-MJP): Definition of a long term vision on the subject of maintenance.
- Planning National Maintenance Waterways (PLOV): Development of an application that supports the planning process for national maintenance and about which the information can be made easily available.
- Uniform RWS Programming (URP): the improvement of regional programming.
- Risk Inventory Wet Structures (RINK): the development of a risk assessment and reporting framework for the 'wet structures' including condition assessments.
- Lifecycle Costing (LCC): the development of a framework to implement in programming and procurement procedures to include the lifecycle cost effects of variants in the selection of maintenance and construction strategies (see also appendix C).
- Improved Instrumentation for Performance Management (VIP): Reducement of obstacles in further implementation of Performance Management (SLA PIN management framework) in RWS organization.

For the period 2011 – 2012 focus will be on:

- Ability to tender choices supported by detailed scenarios in Service Level Agreement between Minister and Director – General and between Director-General and Regional Directors.
- Implementation of network management on network link instead of object level.
- Implementation of Risk Based Maintenance techniques including Performance Management.
- Further improvements in effective management techniques aiming at "programming a-priori" instead of "repairs a-posteriori".

4.5 Continuous Improvement

As part of the Asset Management Program Rijkswaterstaat will execute a process of continuous improvement over the next years. It will perform:

- Monitoring and auditing on current practises.
- Regular Gap Analysis and benchmarking exercises with national and international asset managers.
- Regular liaison and sharing with other national and international road authorities, both formal and informal (e.g. PIM-program).
- Encouraging staff to challenge practices on an on-going basis, looking for areas for improvement and efficiencies.
- Keeping abreast of best practice through involvement in appropriate groups (e.g. PIARC) and attendance at conferences and seminars.
- Being actively involved in key research and development work.

5 Framework for implementation of Asset Management

5.1 Existence of Plans, Improvement Plans and Strategy

This chapter specifically deals with the presence of plans, improvement plans and improvement strategies for Asset Management as detailed in PAS-55 and the International Infrastructure Management Manual.

Regarding Asset Management within Rijkswaterstaat a lot of aspects as described in PAS-55 and the International Infrastructure Management Manual can be found. These are detailed in several documents. One overall Asset Management Plan is presently not defined.

5.2 Objectives and Priorities

Government's Purpose and Priorities

The Governments general policy regarding transportation and mobility is mainly defined within the Memorandum on Mobility (Nota Mobiliteit). Regarding the management of Road Infrastructure Assets it basically aims for:

- A stronger economy by improving accessibility.
  The economic structure must be strengthened. This requires well functioning infrastructure networks and streamlined government intervention. The Government is taking responsibility for the entire main infrastructure. The main routes between the national networks and urban economic core areas are given priority.

- Make growth of traffic and transport possible.
  Due to demographic, economic, regional and international developments the traffic continues to grow strongly. This growth is facilitated in legal and policy frameworks for environmental, safety and environment due to the social and economic interests.

- Reliable and predictable journeys from 'door to door'.
  The reliability improves, so people know what time they arrive and just-in-time carriers can provide. This improvement takes place throughout the journey, 'from door to door '. National, regional and local road networks, water and public transport are interrelated. Therefore, an integrated network approach is necessary.

- Catch up on maintenance on the short term.
  In recent years, too little investment in the management and maintenance of all infrastructure networks was made. This gap is addressed. The goal is the lowest cost over the lifetime. It is examined whether the maintenance cost can vary by location.

- Good safety on the road network
  The Netherlands remains one of the safest countries in the European Union. Road Safety improves despite the growth of mobility. A decrease of the annual number of deaths to 900 deaths in 2010 and 640 deaths in 2020 per year is possible. Innovation and strengthening of the European vehicle policy would be required.

- Pricing necessary
  The Government is preparing for the introduction of road pricing by the next government, without choosing a particular form yet. The system is effective, efficient, robust and sustainable to society. This requires support by the public. Not only for road pricing in general, but also for the development.

Some other aspects of Government policy are also important for Rijkswaterstaat's operations:
- Decentralize what can and centralize that what must.
- More public-private cooperation (PPP).
- Put frameworks on decentralized policies.
- A decisive government.
- Actively and self confidently deploy international policy.
- Public Transport: use it's strength
- Inland- and Ocean shipping: compete fairly internationally

Legal, Regulatory and Statutory Requirements

Several legal, regulatory and statutory requirements influence Rijkswaterstaat's performance:
- Law on Supervision of Rijkswaterstaat Works (Wbr)
- Public Works Law 1900 (Waterstaatswet 1900)
- Road Act (Ww)
- Road Traffic Act 1994 (WVW 1994)
- Directive Policy on Amenities
- Rules on Policies for Incident Management
- Circulars concerning sound proofing along the national highways
- Memorandum construction of telecommunication cables along highways
- Conservation Act (Wm)
- Act concerning air pollution (Wlv)
- Groundwater Act (Gww)
- Act on soil protection (WBB)
- Environmental planning Act
- Environmentally hazardous substances Act (Wms)
- Sound pollution Act (Wgh)
- Nature Preservation Act
- Rush-Act and Crisis-Act Construction Projects

Corporate Plan

In Agenda 2012 the corporate plan is detailed. Objectives for Rijkswaterstaat are:

- Dry feet and sufficient, clean water
  The first priority of Rijkswaterstaat is always to ensure dry feet: prevention, order and ready for crisis. Therefore Rijkswaterstaat ensures that all dykes and dams meet the standards. The challenge lies in the audience focused communication with the various users of the water.

- Smooth and safe traffic movement on water and road infrastructure
  The fundamental requirement is safety. The water is clear on places where transport shipping and recreational shipping meet. Rijkswaterstaat is committed to a safe flow of the traffic.
  Rijkswaterstaat focuses on traffic operation. That means faster incident management, solid organization and guiding traffic diversions from the Traffic Management Centre. In the coming years Rijkswaterstaat defines the framework and rules for guiding traffic.

- Reliable travel times and useable information
  Rijkswaterstaat is stricter in planning maintenance works because reliable journey times for road users are important. The plan is drawn up with other operators and the traffic forecasts are expected to be improved. Public information requirements are included in contracts. Where possible, Rijkswaterstaat actively seeks for other options to allow people to move from A to B. For example combinations of car and public transport.
  To achieve reliable journey times Rijkswaterstaat improves its organization. An important aspect is better information for the road users.

Business plan

In the business plan several targets are defined. These are detailed in figure 4.

Figure 4: Rijkswaterstaat Business Plan

	2008	2009	2010	2011	2012: Target
Public oriented network manager	GO-approach implemented in RWS organization Feedback of public organized	Lessons crisis management test analyzed and implemented	User information in order; new BPRW used	Alliance forming works. Trademark RWS visible	(Water)way users appreciate the public focus and reliability of travel times with 7.5
Leading client	Procurement strategy ready	Approach of private sector in order	Procurement in which quality and price are balanced works	Sustainable procurement of works	Private sector other clients give RWS a 7,5 for innovation and reliability
Reliable and efficient partner	Choices made in core activities and formation	Multi year SLA management works	RWS is fully in control of all works	Safety management incorporated in works	80% of all projects is achieved within scope (time, budget, quality)
People are decisive	SPA ready	Match between construction and ICT made	Recruitment in order. Knowledge partners committed to RWS organization	Fascination and growing works	Personnel give a 7,3 for satisfaction
Renewal process	Agenda 2012 'lives' in organization	Managers are the inspiring force behind the innovation	Vision and strategy experienced and implemented in organization	RWS personnel lead renewal process	Personnel scores a 7,5 on core values

1. RWS as public oriented network manager

Objectives:

- Dry feet
- Sufficient and clean water
- Safe movement of traffic on roads and water
- Reliable travel times and usable information

Targets:
- (Water)way users appreciate the public focus and reliability of travel times with 7,5.
- All construction and maintenance executed according to GO-approach.
- Timely contribution to the embankments test 2010.
- Lessons from crisis management test analysed and implemented
- Working alliances with NDW-partners, water boards, other public authorities and private sector.
- New Asset Management Plan Waterways implemented.

2. Rijkswaterstaat as leading client

Objectives:
- Professional commissioning
- Stimulation of private sector
- Addressing and implementing new approach

Targets:
- Private sector other clients give RWS a 7,5 for innovation and reliability
- In 90% of all tenders also quality is involved in selection of the consultant / contractor.
- 98% of all invoices are paid within 30 days.

3. Rijkswaterstaat as reliable and efficient partner

Objectives:
- Management on results / outcome instead of input / output.
- Safe execution of works
- Transparent and reliable

Targets:
- 80% of the projects is realized within its scope (time / budget / result)
- Productivity (30%) and efficiency (500 fte) realized
- SLA-management implemented with multi year optimizations
- Rijkswaterstaat Works efficient and safe

4. People are decisive

Objectives:
- Recruit the correct personnel
- Correct staff at the right job
- Personnel is fascinated by their jobs

Targets:
- Personnel gives a 7,3 for satisfaction
- 90% of the needed formation is present. 95% of all vacancies are filled within 3 months. Diversity targets met.
- 10% of the formation is flexible
- 95% of personnel is qualified for their tasks
- Rijkswaterstaat is within the top-5 of all public employers

5. Renewal process

Objectives
- Rijkswaterstaat inspires
- Rijkswaterstaat disciplines
- Rijkswaterstaat learns

Targets
- Personnel scores 7,5 on core values
- Benchmarking ends bad practices and inspires to implementation of good practices
- By the end of 2009 90% of all personnel and 70% of the public knows the slogan "Water, Works, Roads, Rijkswaterstaat".
- Communication strategy Works effective and is supported within the organization.

On tactical level manuals and plans can be derived from SLA/PIN and BML/OMR. The multi-year Asset Management Plan is derived from the I-AMP.

Road User Priorities

Rijkswaterstaat continuously polls its road users. From these polls road user priorities were defined:
- Reduce quantity and length of traffic jams.
- Improve safety on parking lots.
- Provide rapid availability of the road after an accident.
- Provide better information on diversions.
- Provide a reliable travel time.
- Improve the rates of flow on the network.
- Improve the timeline of (road)works.

5.3 Asset Management Policy

In September 2008, DT-RWS initiated the Asset Management program. Conducting this program must lead to a future-oriented and service-oriented organization whereby infrastructural assets are 'managed' cost-effectively. It should be possible to achieve cost optimization, primarily within networks but also across networks, and to make uniform decisions in maintenance planning.

Central elements in Asset Management are:
1. Service Level Agreements (SLA)
2. Information infrastructure: Quantity and quality (condition) of the network
3. Programming: Long term planning of maintenance including lifecycle costing and RAMSSHE€P
4. Basic Levels for Maintenance
5. Monitoring and auditing on processes and results (PDCA cycle)
6. Market cooperation: economically most valuable tender based contracting

Asset Management enables a more integral and systematic approach to the operation and maintenance of the road network. This allows Rijkswaterstaat to clearly demonstrate how it is performing, what methods are being used, what the associated costs are and how this contributes to the satisfaction of the road user.

In 2010 an update of the Implementation Plan Asset Management was published. This update aims at fast-tracking the implementation of several aspects of the programme to improve total business processes within Rijkswaterstaat.

5.4 Asset Management Strategy

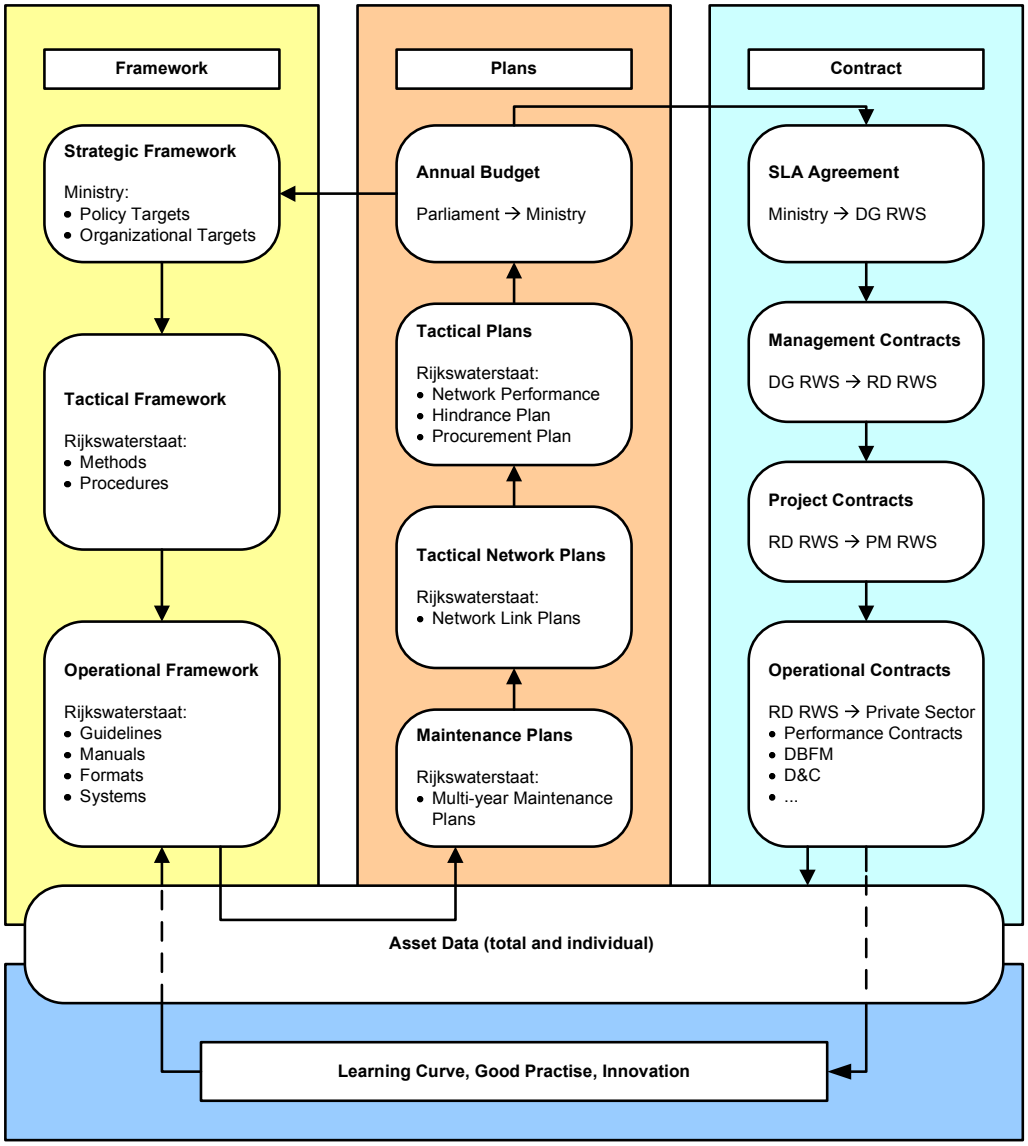
Overview
The goal of Asset Management is: Deliver agreed service levels (SLA's, Rijkswaterstaat's targets) in a cost effective manner by managing assets for current and future users (lifecycle approach) with acceptable risks

Asset Management includes many activities in the broad sense of the Rijkswaterstaat organization. Asset Management is introduced to improve the SLA-control. It aims at enabling Rijkswaterstaat to produce multi year plans, on which agreements can be made and on which all parts of the Rijkswaterstaat organization are accountable. This includes reliable data on all assets, accepted and agreed inspection regimes, delivery of data in a certain frequency to the NIS etc.

By understanding the costs involved in maintaining and renewing assets for the coming decades, Asset Management will provide Rijkswaterstaat with the means to better enable management of the risks and available multi year budgets. As such Asset Management will form the basis of business processes in Rijkswaterstaat.

Figure 5 depicts the relation between the three main business processes (Framework, Plans and Contracts). Figure 5 shows the processes:
- Process between Client (Minister, Policy Departments, Secretary – General) and Rijkswaterstaat in which Performance Agreements (SLA-PIN) are made, budgets are granted en risk sharing agreements are made.
- Internal Rijkswaterstaat process in which the Performance Agreements (SLA-PIN) are related to works programs and contract specifications.
- Process between Rijkswaterstaat and Private Sector in which the works program is checked and balanced against capabilities.

Figure 5: Improved Instrumentation Performance Management (VIP)



Framework: From strategy to operations

The improved instrumentation aims at realizing the link between policy and organizational goals on the one hand and the efforts and choices in primary business processes of Rijkswaterstaat on the other. In this framework, the applicable policy and organizational goals at the strategic level are translated into methodologies, practices and procedures at the tactical level, which in turn take the form of pointers, working hands, tools and formats to operational level. Thus enabling the preparation and implementation of plans and works.

The framework can be considered as the basis for determining the necessary maintenance works and as an explanation or a set of underlying documents in the SLA and SLA-tender, which offer performance levels.

Examples include:
- A statement that links the policy goals to the performance of the SLA for that network;
- A description of how the network disintegrates into network links, which is the basis for the differentiation of performance requirements to parts of the network;
- A description of how maintenance strategies are determined, for example starting with LCC / investment strategy, inspection regimes, risk assessment, technical standards and funding. This is in fact the reference level for maintenance.

In practice there are many frameworks that have different formats.

Plans: From operational framework to maintenance plans
The various interrelated frameworks facilitate an internal process, which in its simplest form consists of:
- inspecting the condition of areas and objects;
- using specific guidelines and instructions that are drafted in the context of realizing the level of performance under the applicable SLA;
- analyzing the results of these inspections;
- on this basis formulate measures to maintain including an indication of the period in which they must be implemented;
- the budgeting of these maintenance measures using a standard cost system;
- including these measures in the long-term maintenance schedule for that object or part of the total area.

For technically similar objects this process goes through the generic corporate and national services. In the present situation is the case for pavements (IVON) and structures (DISK). The aim is to include other (sub) categories of similar objects such as banks and bottoms (water) to promote the development of national inspection regimes. Inspections than take place in the context of an agreed national regime and the maintenance recommendations arising from it are more uniform.

Where national inspection regimes – because of the unique nature of the objects – are not obvious, the district organizes and analyzes the relevant surveys themselves (with advice from the national services) and records the results in the maintenance records.

Plans: From operational maintenance plans to Network Link Plans
For development of the network optimization plan combining management and maintenance measures to different objects within a network link is the key aspect.

A network link is a part of the network in terms of features and use that can be considered as a discrete element in the network. The idea is that on network link lever different performance levels can be agreed. Network links can exceed the management area of a single regional service area.

Besides the input of the maintenance plan optimization also included is the capabilities of private sector. A network Link Plan is thus a complete plan for the management of a portion of the network.

SLA Tender: From plans to contracts
Average once every four years, the maintenance and network switching plans are reviewed and then translated into the SLA tender. This offers a number of variants to the Client (i.e. Minister) for approval.

These variants consist of certain combinations of benefits, risks and costs. In content they represent the manner and extent in which RWS can facilitate 'social performance' of the networks in terms of functionality, performance and in terms of modalities "for example, user inconvenience, safety, durability or cost, in the long term (LCC). The finally selected variant is included in the budget preparation.

Contract: From SLA to works
The internal translation of the new SLA is done in the Priorities Letter. In this letter, the new targets, as defined in the SLA's for each network, including revenue for the differentiated services network links, the accepted risks and the available multi-year budget, is divided among the various regions.

On this basis, in the regions in the maintenance plans are update. This amounts to the appropriate reassessment of its measures in response to the new SLA performance. Then the measures and projects are further prepared and detailed. The updated maintenance costs associated with the estimates then serve as the new base in the SLA and management cycle.

The implementation starts with identifying and signing the management contract. With this signature the corporate SLA is translated to the individual Regional Divisions. Furthermore, the necessary budgets for achieving these targets are made available. Both in terms of the internal control (DG-RD) as well as controlling the market are in their nature future-proof.

Regarding multi-year plans and contracts if in the new SLA another performance is agreed than the ongoing performance, then it is reconsidered what the consequences are.

Learning Curve
On the bottom of the figure the experiences included in the SLA-cycle is returned after evaluation in the system. The system as such is a self-sustaining learning system.

Monitoring of the primary processes on maintenance (i.e. SLA / PIN management) is tasked by the Board of Directors to the National Advisory Divisions since 2009. Monitoring is seen as a key aspect in implementing a more risk based approach of maintenance by Rijkswaterstaat. Main interests are:

- Guarding that works listed in the I-AMP are executed by the Regional Divisions according to plan (scope and budget). This includes addressing variations.
- Presentation of overviews on network level of the realization of the I-AMP and possible / needed amendments.
- Support to the Regional Divisions on their periodic SLA / PIN reports.

Monitoring on organizational aspects (capacity and competences of personnel) is (not yet) included. The monitoring procedures are still under development.

The monitoring plays a role in the Check-Act part of the Deming-cycle:

- **Plan:** The National Advisory Divisions prepare the I-AMP with input of the Regional Divisions. The I-AMP is agreed by the Board of Directors and basis for the SLA / PIN agreement between the Director-General and the Regional Directors.
- **Do:** The Regional Divisions execute works as planned in the I-AMP.
- **Check:** The National Advisory Division together with the Regional Divisions check whether all agreements in the I-AMP are executed according to plan. Deviations are reported. These deviations are detailed with regard to the questions why, what and effects.
- **Act:** The National Advisory Divisions investigate whether the deviations are consistent with the national program and defined priorities. If they fit a proposal is made for amendment of the contract between Director-General and Regional Director.

The PDCA-cycle is supported by the following instruments:

- T-report
  This is the regular report on the proceedings made by the Regional Divisions on execution of their works.
- Procedure "New-Facts"
  Regional Divisions have to provide the National Advisory Divisions on time (i.e. before the T–report) on new facts that influence their works program.
- Consulting round
  During the year at least one consulting round is made by the National Advisory Divisions to the Regional Divisions.
- Testing
  Based on statistical procedures a random check is made on the agreed works program.

Full implementation of the PDCA-cycle in the asset management process is expected in 2011.

Asset Data

As basis for all works, plans and agreements accurate data on the present and planned asset play a major role. Therefore, within the Asset Management Program area data is a key factor.

Information needs

This subproject will provide an answer to the information needs regarding the 'what-question ": what information to collect. Primarily, the project aims at understanding what quantitative and qualitative data is needed to support the different areas within the SLA and the guidance given by management and maintenance section.

Maintenance Management System (MMS)

The MMS subproject determines the RWS-wide functionality and process equipment for a maintenance management system.

Exploration of the Maintenance Management Organization

The sub-project Maintenance Management Organization aims to explore implementing a function within the Maintenance Management Organization for the collection, storage and distribution of information in the broadest sense.

Identifying, validation and quality
The project aims at finding procedures for validation and quality assessment in generating area data.

5.5 Service Level Agreements (SLA)

As part of the agency's formation three ways of control were agreed between the Secretary-General for Public Works and Water Management (I&E-SG) as Client and the Director-General Rijkswaterstaat (RWS-DG) as 'Contractor':

- Performance Control based on Service-Level Agreements (SLA's).
- Project Control for construction projects and for the so-called variable (large) maintenance projects (more than 30 million euros and included in the MIT / SNIP).
- Control based on organizational capacity agreements.

For maintenance the SLA's are especially important. The DG-RWS has the responsibility for the management and maintenance of the main infrastructure (dry and wet). For guidance in this area (excluding the variable maintenance projects), there are three basic packages prepared:

1. Traffic Management of the Road Network
2. Traffic Management of the Water Network
3. Management of Embankments, Dams and Locks.

The SLAs are agreements that define outcome in terms of traffic movement, availability of infrastructure and the resources available to the Regional Divisions. This provides the Regional Divisions with a basis to define what the possible policy effects are and what will be the agreed output. The DG-RWS is responsible for drawing up the SLA. In the future, the SLA's will be multi-year agreements and a basis for the annual contract agreements between the SG-I&E and the DG-RWS.

Within the SLA there are two types of performance indicators (PIN's): "norms' and 'targets'. The norms relate to objects or activities that are crucial for the functioning of the network. In determining the status of a norm or target safety is often prime consideration. Norms should in principle always be met.

The SLA describes the basic packages necessary to meet the output criteria. In determining the amount of funds available the Basic Levels for Maintenance is used as reference.

5.6 Basic Levels for Maintenance (BLM)

The Basic Levels for Maintenance (BLM) shows the minimum set of projects (in terms maintenance treatments) that are necessary to maintain the network infrastructure in the longer term. It also portrays the average annual costs attached. Important principles in maintenance are guarantee of safety, the correct functioning of the infrastructure, maintaining the current standards and guidelines for implementation of maintenance and prevent capital destruction.

The BLM is prepared for three major programs related to infrastructure management within the Department of Public Works:

1. Traffic Management of the Road Network
2. Traffic Management of the Water Network
3. Management of Embankments, Dams and Locks.

In the management model of Rijkswaterstaat fulfills the BLM a key element in management of the maintenance task. In the Service Level Agreements (SLA's) between Secretary General and Director General (on facility level) and between Director General and Regional Director (in translation of the targets to the Regional Divisions) budgets are linked based on the principle of "price times areas or quantities' (P * Q). The BLM provides this basic information at national level and an outline / overview of the areas, practices, standards and guidelines that are used and the costs which have been linked in the long term. This is an indispensable link in the BLM management procedures. The BLM is in practice the framework for implementing the SLA's and serves as reference for maintenance.

The core of the BLM is that for all objects the reasons why infrastructure is managed and maintained and what maintenance treatments are necessary are defined combined with the annual average costs attached. Rephrased: the BLM shows the general picture, explicit guidelines for management and conservation of the infrastructure and identifies financial resources that should be committed in the long term.

Table 5: SLA and asset management framework at organizational levels

Organizational level[3]	SG - DG Asset Owner	DG - RD Asset Manager	RD - DD Service Provider
Contract	SLA	Management Contract	Service Contract
Framework for managing the assets	New BLM: Framework for Performance Demands, risk assessment, norm costs and asset management plan	Object Management Regime en regional translation of asset management plan	Maintenance plans
Asset level	Network, system, sub-systems	Sub-systems, objects, object categories	Maintenance objects, maintenance parts, inspection parts
Risk Management mode	Risk profile for every network	Generic risk matrix for every function	Risk matrix implemented on every object
Analysis of alternatives	System for development of alternatives for the SLA bid.	Dominant failure modes defined for every object category, generic maintenance strategy	Performance analysis, failure analysis, maintenance analysis

5.7 Review and Audit of Asset Management Plans

On the contextual part, an element in the total Asset Management Program is review of the status and role of the present Asset Management Plans. Aspects for improvement are identified.

On the content of the Asset Management Plans the Check-Act procedures as described in section 5.4 provide information.

5.8 Management Reporting and Indices

Rijkswaterstaat uses its NIS as a central element in reporting its performance on management level. In the NIS all Regional Divisions supply performance data on the agreed Service Levels and Performance Indicators. Examples of these performance indicators are elaborated in Section 7. In section 8.6 more detailed information on Rijkswaterstaat's NIS is provided.

[3] SG = Secretary General of the Ministry of Infrastructure and Environment
DG = Director-General of Rijkswaterstaat
RD = Regional Director of Rijkswaterstaat
DD = District Director of Rijkswaterstaat

Figure 6 gives an impression of the reporting on the Service Levels made periodically by the Regional Divisions.

Figure 6: Reporting on PIN's in SLA monitor

Results on PIN's			RWS Total					
Basic Level of Traffic Management			Norm RWS 2008	1st Report	1st - 2nd Report	VR	Prognosis 1st Report	Prognosis 2nd Report
1	Availability		95,0%	96,1%	96,0%	96,0%	94,9%	95,2%
2	Response times	IMplus areas (15 minutes)	80,0%	82,4%	83,0%	82,0%	79,6%	82,5%
		Not IMplus areas (30 minutes)	80,0%	95,0%	94,0%	93,0%	87,1%	92,6%
Basic Level of Maintenance								
3	Pavements	% area	95,0%	96,7%	97,0%	97,0%	97,0%	97,1%
		Skid Resistance & Rutting	100,0%	99,6%	99,6%	99,7%	99,6%	99,8%
4	Civil Structures		78,0%	84,0%	85,0%	88,0%	88,0%	84,9%
5	Avalability DRIP's		85,0%	96,0%	91,0%	91,0%	90,0%	89,7%
6	Opening of extra lanes (rush-hour)		95,0%	98,9%	99,0%	99,0%	95,0%	97,1%
7	Safety		100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
8	Aleviation of blockades (bridges, rivers, tunnels)		90,0%	100,0%	100,0%	100,0%	95,0%	96,0%

Satisfactory

Marginable satisfactor

Unsatisfactory

Insufficient data

n Not available

6 Steps in Asset Management Cycle

6.1 Overview

Rijkswaterstaat comes from a situation in which technical priorities for individual asset classes defined the work plan. Presently a more integrated approach is used in which prioritization is made across asset classes. The technical planning is input still. In the nearby future Rijkswaterstaat aims for a fully risk-based maintenance approach in which the politicians are presented a 'budget-quality menu' with the associated risks.

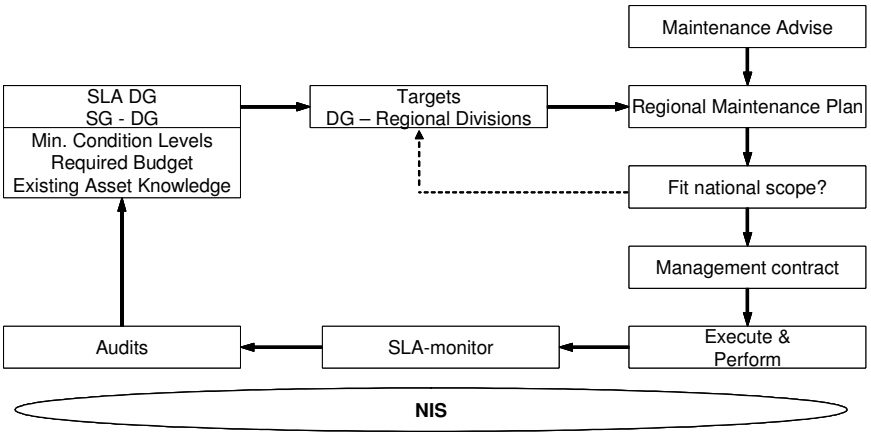
Presently, both a more functional / risk-based maintenance approach and the traditional approach (technical priorities) are combined.

6.2 Overview of Rijkswaterstaat AM Planning and reporting Process

The present Rijkswaterstaat Asset Management Planning and Reporting Process are detailed in figure 7 in general terms. Steps are:

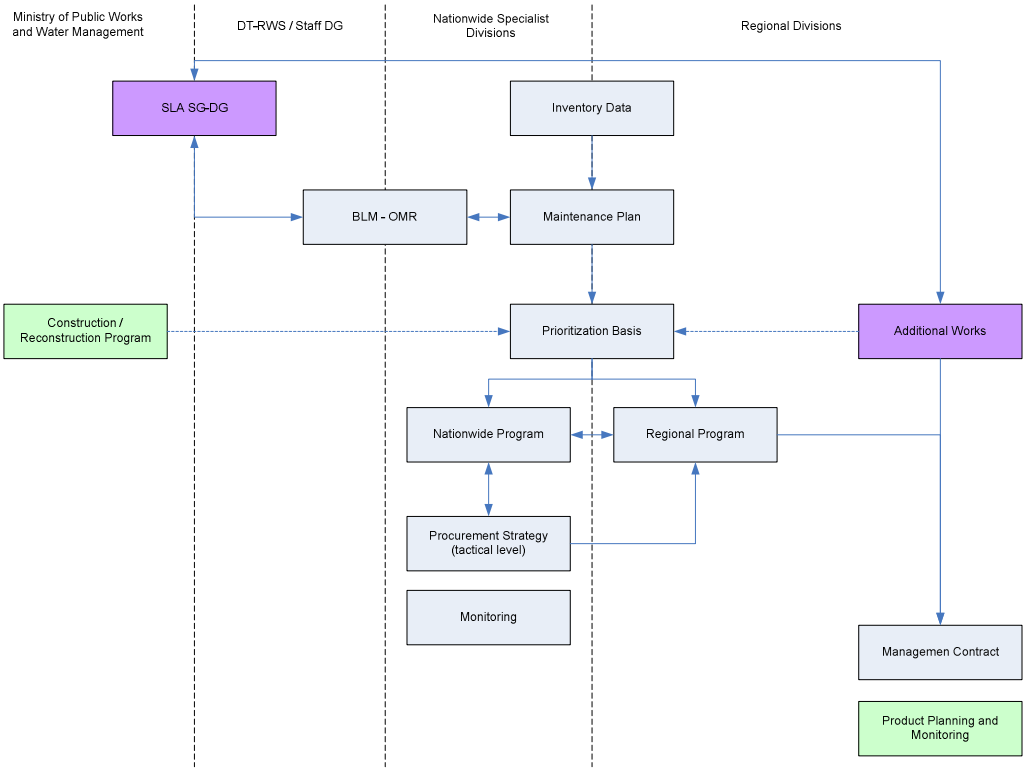
1. A Service Level Agreement is made between the Director General of Rijkswaterstaat and Secretary General of the Ministry of Infrastructure and Environment. Associated is a budget based on existing asset knowledge (primarily quantities and general prices). Within the Service Level minimum condition and performance levels are defined.
2. Based on the minimum condition and performance levels as detailed in the Service Level Agreement the Director General defines targets for the Regional Divisions.
3. The Regional Divisions define their maintenance plan based on the targets from step 2 and condition data / maintenance plans provided by their own district offices and the National Consultancy Divisions.
   Presently, in this step priorities are primarily based on technical issues. A risk-based maintenance program cannot be implemented yet due to lack of knowledge.
4. The scope of the Regional Maintenance Plan is tested on the available national priorities and available budget. If needed priorities and Regional Maintenance Plans can be altered.
5. The final Regional Maintenance Plans are basis for the Management Contracts that Director General and Regional Directors make. Associated to these Management Contracts the necessary budgets are made available.
6. Based on the Management Contract and Maintenance Plan a works program is executed.
7. The results of the works program are on quarterly basis monitored in the SLA-monitor.
8. The whole process is audited by the Centre for Traffic and Navigation. Results are made available to be used in the Asset Management Process for the next budget year.
9. All results of works programs and SLA-monitor are available in the Network Information System.

Figure 7: Rijkswaterstaat Asset Management Cycle



In figure 8 the planning and programming process is elaborated in more detail. In the figure the different organizational domains are depicted.Basis for the prioritization form maintenance plans. These are defined on basis of the Basic Levels for Maintenance (BLM) and Object Maintenance Regimes (OMR), inventory data and condition data. In combination with construction & reconstruction projects and additional works (mostly politically influenced) these maintenance advises are prioritized resulting in a nationwide network program and regional program. The final regional work programs are basis for the management contracts

Figure 8: Planning and Programming Process



6.3 Mapping the Rijkswaterstaat and IIMM Asset Management Processes

Table 6 provides a mapping of the Rijkswaterstaat and IIMM asset management processes. As can be seen from the Table, there is considerable overlap between the two processes.

Table 6: Mapping between IIMM and RWS Asset Management Planning Process

Developing Asset Management Strategies (IIMM)	RWS Asset Management Planning Process	
Existing Asset Knowledge	§6.4.1. Asset inventory, condition and performance data	
Identify Levels of Service	§6.4.4. Determine performance targets 4a. Corporate Plan 4b. Business Plans 4c. AM Policy, Strategy and Objectives	Performance Management Framework (Sections 5 & 7)
Predict Demand	§6.4.3. Predict future demand	
Assess Condition, Measure Performance	§6.4.2. Determine Current Performance	
Failure Mode Analysis	§6.4.5a. Risk Management	
Assess Risks of Failure		
Evaluate/Select Treatment Options	§6.4.6. Identify maintenance needs	
Identify Optimum Solution	§6.4.7. Value Management (prioritize needs)	
Assess Financial Cash Flows	§6.4.8. Develop work and financial plan	
Prepare Asset Management Plan	§6.4.9. Prepare I-AMP §6.4.10. Implement I-AMP	
Collect Data Measure Performance	§6.4.11. Performance monitoring and feedback	

6.4 Description of Asset Management Planning Process

6.4.1 Asset inventory, condition and performance data

Reliable area data are of crucial importance for the SLA-control as well as for the primary processes of Rijkswaterstaat. At the start of reforming Rijkswaterstaat into an Agency this has been observed. Various developments and actions have been started to manage inventory data, such as the development and building of the NIS database, KernGis, Beheerkaart Nat, etc.

In the spring of 2008 the Rijkswaterstaat Board of Directors asked the Centre for Traffic and Navigation to define the current status of knowledge management on Area Data input. This has resulted in a memo on problem analysis and an outline on the main features that shows whether the inventory data are useable for the various

networks and objects. This is the basis for actions, in which the services are requested to realize substantial improvements to the area information during 2009.

The memo concluded that Rijkswaterstaat owns quite extensive databases in which asset information is stored. Unfortunately, the information is part wise outdated and the separate systems do not communicate with each other. Due to the fact that separate systems are maintained, information is part wise duplicated. Furthermore, keeping all systems running is a suboptimal process. Finally, the present architecture is not ready for new relations with contractors / service providers.

Rijkswaterstaat has started a program to develop new data architecture. Most important features will be:

- Better communications between systems by means of standard interfaces / standard exchange formats for data.
- Centralized maintenance of databases and systems
- Centralized data inventory
- Simplify database architecture ready for exchange of data with service providers in new contracts.
- No duplication of data between systems.

Part of the program will be development of data management protocols.

6.4.2 Determine Current performance

Current performance is input for the maintenance advises and largely defining planning and execution of maintenance and reconstruction projects. Furthermore, current performance of the road network is important in defining the performance of the Rijkswaterstaat organization, both internally (SLA-contract between regional director and DT-RWS) as well as externally to the public.

Two approaches are followed to determine current performance. One is the execution of continuous road user surveys and consultation with interest groups. The other is the collection of condition data both by Rijkswaterstaat's own services and private companies.

6.4.3 Predict future demand

Realistic predictions on how the demand on the highway network is likely to change in the future are important in defining the reconstruction projects that form part of the overall maintenance program. Periodically the Ministry of Infrastructure and Environment makes a forecast of the development of traffic and transportation. In these forecasts several scenarios are presented to the public (Mobility Nota). It is a question for the politicians which scenario will be used for prediction of future demand.

In general, change in demand for the highway network is taken to be:

- Changing traffic volumes and mix – for example, changes in demand caused by population growth/shift, increasing/decreasing number of road users, changing modes of transport, increasing vehicle loads, new road constructions and/or improvements, etc.

- Changing performance requirements – how are the performance/service demands of the road users likely to change in the future, e.g. more reliable journey times, reduced congestion, improved ride quality etc.

Presently, changes in future demand do not play a major role in developing the I-AMP.

6.4.4 Determine performance targets

The performance targets are on object level defined in the Basic Levels for Maintenance (BLM) with corresponding Object Maintenance Regimes (OMR). These targets are specified on a level like "no rutting allowed larger than 18 mm as an average over a distance of 100 m, or 23 mm over a distance of 50 m".

The Basic Levels for Maintenance is defined on basis of four general assumptions:

- Maintenance on the road network is applicated to guarantee functionality of the network.
- Infrastructure offers the community both active as well as passive use.
- Laws and regulations define part wise the methods in which maintenance is applied on the road network.
- Efficiency is not a prerequisite to maintain efficiency, but an isolated target.

Object Maintenance Regimes describe the way (normally) the specified targets can be obtained.

On network level several Performance Indicators (PINS) are defined. By means of the management contract (Service Level Agreement) between the Director General and the Directors of the Regional Divisions these PINS are monitored. In section 7 the Service Levels and PINS are discussed in more detail.

6.4.5 Performance gaps and lifecycle plans

The performance gap is the difference between the current performance (§6.4.2) and the target performance (§6.4.4). Computerized financial planning tools and lifecycle plans are used to analyze the closure of performance gaps, for example, how much maintenance work and funding is required to close a gap.

6.4.6 Risk Management

Risk management is seen by Rijkswaterstaat as a process of identifying, assessing and managing risk. Risk is defined as the threat that an event or action can affect an organizations ability to achieve its objectives. In more quantitative terms, risk is the combination of the frequency or probability of occurrence and the consequences of a specific hazard being realized.

Presently, Rijkswaterstaat is starting to implement a more risk-based approach in maintaining its assets. In implementing RAMSSHE€P aspects are closely defined and monitored. In 2009 a pilot project (Risk Inventory "Wet" Structures) was started. The pilot project will be followed by more extensive projects resulting finally in 2015 – 2020 in a fully implemented risk based approach for all Rijkswaterstaat's assets.

Current status (2011) on implementation of RISK management is a three pronged attack:

- Major critical objects (mainly sluices, dams/barriers): RINK-approach
  Full risk identification and evaluation. Identification and evaluation involves recalculation of structures taking into account the current situation on loads and usage and both a-priori and a-posteriori evaluation of risks. Criticallity is defined in terms of risk for inhabitants behind the structure and the effect on mobility.
- Less critical objects (mainly sluices): P-IHP approach
  Risk assessment using a more simple approach. Less recalculation, full risk assessment.
- Non-critical objects: IHP-approach
  Risk assessment based on simple techniques and standard profiles. No calculations. For risk assessment a universal risk matrix is used (see also appendix D).

In section 7.4 more details are provided on the use of risk management in planning and programming of maintenance works.

6.4.7 Identify maintenance needs

Lifecycle plans are used to identify the work required, to deliver the Performance Targets (§6.4.4). As a minimum the following are assessed:

- The work needed to sustain the current performance over the I-AMP period
- The work needed to close any current gap in performance
- The work needed to sustain the target performance over the I-AMP period
- Any work arising from other schemes planned for the I-AMP period, e.g. network improvement schemes.

Assessing these criteria across the whole network is a substantial task, and cannot be readily done by hand. Computerized models are used to assess the above and other scenarios (see Section 8).

6.4.8 Prioritize needs

Rijkswaterstaat has a limited year budget resulting in a situation in which not all required maintenance and reconstruction works can be funded. Therefore, a prioritization has to be made. To prioritize consistently within one network and across all three networks of RIjkswaterstaat (Roads, Waterways and Water Protection) a prioritization framework is in place.

The prioritization framework is based on the same policy themes on which the Basic Levels for Maintenance and the Object Maintenance Regimes are defined. These are:

- Safety
- Accessibility / Usability
- Environment
- Law and Regulations
- Risk and Accountability
- Maintain functionality of objects network
- Efficiency

The most important themes are Safety and Accessibility / Usability. For each network is a separate budget available, thus prioritization is made for each network separately.

For the road network the main cost drivers are Pavements, Structures and ITS. Presently, prioritization for the road network is done on the following basis:

1. All maintenance that cannot be postponed will be planned first.
    a. If it is not possible to plan all maintenance projects within the available budget, ITS has the lowest priority.
    b. For the pavements a difference is made between the traditional pavements and porous asphalt. Traditional pavements can be postponed up to 3 years after reaching intervention level. Porous asphalt pavements only up to 1 year.
    c. If the result of a) and b) still leads to a budget gap, then the budget for daily maintenance will be cut up to a level in which the remaining large-maintenance projects can be planned.
2. For unexpected maintenance works a separate budget will be set apart (€ 50 mio / year).
3. Maintenance work on structures can be forwarded if it can be combined with other maintenance work on the same structure and if it leads to a budgetary discount.
4. Maintenance to retain the traditional asphalt pavements on the Basic Maintenance Level will be planned first.
5. The back-log in maintenance of ITS will be planned.

The prioritization framework was evaluated in 2009 on the following aspects:

- Transparency and traceability
- Unambiguity and unbiasity
- Methodology
- Long term effects
- Needed efforts and information to implement the prioritization process

6.4.9 Develop work plan and financial plan

After the identified works have been prioritized, they are developed into an optimized Work Plan (normally 1 year with a planning horizon of 5 years) which can be achieved by the available/expected funding. The Work Plan describes the volumes of work and their phasing.

6.4.10 Prepare I-AMP

Working through the asset management planning process provides the key information required for the I-AMP. Preparation of the I-AMP is executed within the National Advisory Divisions together with the Regional Divisions.

6.4.11 Implement I-AMP

The I-AMP is implemented by translating the long-term work plans into detailed annual and general forward (maximum of 5 year) work plans. The translation is executed within the Regional Divisions of Rijkswaterstaat.

6.4.12 Performance monitoring and feedback

It is important that the components of the asset management planning process are reviewed and improved over time. As part of the overall monitoring, review and feedback process, suitable measures will be put in place to monitor and improve the effectiveness of the planning process. In particular, to assess if the outputs of the planning process agree with the realities of network management, for example, work volumes and costs.

6.5 Summary

Rijkswaterstaat is working on a fully risk based approach in planning and prioritizing maintenance works, presently this is not in place. Therefore a mix of the traditional technical approach and a more functional service level approach with abstract service levels and PIN's is used in definition of the maintenance works programs.

7 Performance Management Framework

7.1 Levels of Service and Performance Measures

Rijkswaterstaat is developing a Performance Management Framework that will:

- Link stakeholder requirements/expectations, strategic objectives and priorities, and tactical and operational targets and Levels of Service.
- Bring together audit/contract measures – presently within the Rijkswaterstaat organization, later possibly also for Service Provider contracts.
- Support the measuring and monitoring of the condition and performance of assets and reporting on managerial level on an ongoing basis;
- Support and drive corrective actions and continual improvement in performance of the Rijkswaterstaat organization.

The Performance Management Framework will be hosted on an appropriate computerized platform, with dashboard presentation capability, enabling ready access, monitoring and reporting for Rijkswaterstaat staff.

The relevant Service Levels and associated PIN's presently available and used for managing the road network are elaborated in table 7.

Table 7: Service Level Agreement and associated PIN's road network (2010)

Service Level	Performance Indicator
Traffic Management	1. On a minimum of x% of the monitored road sections Rijkswaterstaat presents the road users a reliable indication of travel time.
	2. For x% of all incidents on Incident Management Plus sections the time to arrive at the scene of the accident during rush hour is less than 15 minutes. On Non Incident Management Plus sections this time is less than 30 minutes.
Maintenance road network	3. x% of all pavement section (100 m – lane sections) has to meet the minimum levels of maintenance as described in the Basic Levels for Maintenance standard.
	4. All overpasses, bridges, aqueducts and tunnels meet the Basic Levels for Maintenance
	5. In x% of all cases it is possible to present information to the public on the Variable Message Signs.
	6. In x% of all cases rush hour lanes, plus lanes and buffer sections can be opened to be used by the road users.
	7. Within 24 hours after observation additional safety measures are put into place when pavements or structures do not meet requirements as stated in the Basic Levels for Maintenance.
	8. If a (temporary) blockade of the tunnels or large bridges across the major rivers (Rhine, Lek, Waal, Meuse, IJssel) is observed within 24 hours a solution is in place resulting in unhindered passage of the traffic.

Table 8 presents the minimum standards as defined in the Basic Levels for Maintenance.

Table 8: Minimum standards Basic Levels for Maintenance

Distress type	Description
Raveling ▪ Porous asphalt ▪ Non-porous asphalt	▪ More than 11% of the aggregate in the surface is disappeared over 25% in the wheel-tracks in a 100 m lane section. ▪ Larger sections of the surface layer are disappeared or the second layer of stones is visible.
Cracking ▪ Longitudinal ▪ Transverse ▪ Alligator	▪ More than 30% of the 100 m lane section shows longitudinal cracking or the cracks show a width of more than 20 mm or a height difference of more than 10 mm. ▪ More than 7 transverse cracks present in a 100 m lane section or the cracks show a width of more than 20 mm or a height difference of more than 10 mm. ▪ More than 30% of the 100 m lane section shows alligator cracking
Longitudinal evenness	▪ IRI ≥ 3,5
Rutting	▪ ≥ 18 mm as an average on a 100 m lane section of ≥ 23 mm as an average on a 50 m lane section.
Friction	▪ ≤ 0,37
Cross-fall	▪ ≤ 1%

In Appendix B a first draft is presented of the new SLA for the Highway Network that incorporates aspects of RAMSSHE€P.

7.2 Demand Forecasting

Presently, changes in future demand do not play a major role in developing the maintenance work plans.

The Ministry of Infrastructure and Environment regularly updates its forecast of the development of traffic and transportation. In these forecasts several scenarios are presented to the public (Mobility Nota). It is a question for the politicians which scenario will be used for prediction of future demand.

Four scenarios are discerned as depicted in figure 9. These were defined in 2006. Although the most recent scenarios are of 2006 the Mobility Nota is still based on the prior scenarios that were all based on a strong global economic growth. These can be compared to the below stated scenario of "Global Economy". Regarding the maintenance plans the most important meaning of these scenario's is that Rijkswaterstaat has to supply the means (i.e. well maintained infrastructure and ITS) to manage the resulting traffic.

Figure 9: Four scenarios used in demand forecasting.

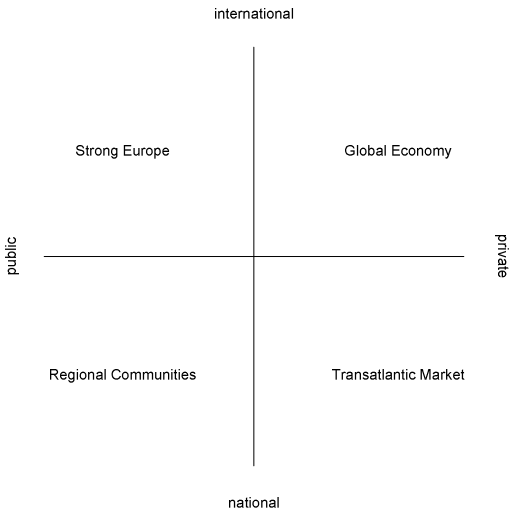


Table 9 lists the effects of the four scenario's on expected growth of the traffic.

Table 9: Effect on traffic of four scenarios

Scenario	Effect on passenger km's	Effect on freight traffic (ton km's)
Strong Europe	+18%	+26%
Global Economy	+25%	+55%
Regional Communities	+10%	+3%
Transatlantic Market	+15%	+36%
Growth rates compared to the situation in 2002.		

7.3 Condition Assessment and Performance Monitoring

The technical condition of the road network – particularly bridges / structure and pavements – is regularly monitored. All pavements (right lane) are measured yearly with the ARAN and ROAR. Furthermore, visual condition assessment is done for the distress type raveling and cracking. All bridges / structures are visually assessed every 6 years. If indicated further detailed inspection is carried out. The results of these inspections and measurements play an important role in definition of the work programs.

On the Service Levels and PIN's the Regional Divisions report every quarter of the year their results to the Centre for Traffic and Navigation. This office aggregates the figures and presents an overall report to the Director General.

7.4 Failure Mode Analysis and Risk Assessment

Rijkswaterstaat is presently developing a RAMSSHE€P framework for assessing the condition of its assets and planning maintenance works. Part of this framework will

be failure mode analysis (FMECA) and risk assessment (RAMSSHE€P). RAMSSHE€P enables Rijkswaterstaat to plan / program its works based on functionality and performance. Therefore it is vital in the implementation of the performance based maintenance contracts.

RAMS aims at consistency between the concepts: Availability, Reliability, Maintainability and Safety. Security, Health, Environment, €conomics and Politics are also aspects that are important, but are not taken quantitatively into the equation by Rijkswaterstaat yet. These are evaluated in more qualitative terms.

Rijkswaterstaat uses RAMSSHE€P to illustrate choices in the SLA-PIN contracts between RIjkswaterstaat and the Ministry. RAMS is used as 'language'. It shows options and associated risks and costs. Using RAMS the 'outcome' wishes of the minister are translated into functional requirements (in conjunction with the other parts of the network) in the form of output (e.g. availability). This availability is then realized by private sector using performance based maintenance contracts.

Example:
The Minister wants to have good traffic flow on the national roads. As Rijkswaterstaat we can not guarantee that traffic flow directly. What we can affect is the availability due to planned and unplanned maintenance and management activities (asphalt works, repairing holes, cleaning, mowing). Per type of road agreements are made on issues regarding the failure rate, availability, etc.

The role of RWS as a director is to define requirements on availability in relation to:

- Current place and function in the network: Is it a major road? How bad is it when there is a temporary failure? Is this the most optimal way to maintain? Is this the agreed service evel?
- Future function in the network: Will a new road section be constructed? Changes the function?
- Costs and risks: Are the costs acceptable and do they fit into the big picture? Is it not a disinvestment? For example, do we expect major repairs?

Choices like these require optimization at network level, not just looking at management and maintenance, but also construction, traffic and water.

RAMS shows the reliability of the functioning of a system. Understanding the RAMS performance is essential for systems with an important function. To develop, built and manage a precise definition of failure and performance is important. These definitions make it possible to apply RAMS in a uniform way. Using the definitions it can be precisely defined under what circumstances there is no (or inadequate) performance of the required function

For RAMS a system (i.e. infrastructure network) consists of several subsystems. The required performance of a system is dependent on the performance of the subsystems. Conversely, it is also possible to determine the performance of the subsystems in order to integrate the RAMS performance of the entire system. The RAMS-performance of a system and the underlying subsystems or components is interdependent. During the lifecycle of a system several parties are responsible for the performance.

For the most critical objects a full RAMSSHE€P analysis is needed. For the more simple and less critical objects that are probably about 70-80 percent of all Rijkswaterstaat's assets a more simple approach is followed. In this approach a predefined set of risks is evaluated by the asset manager (district level) in terms of chance and effect. This evaluation is made for every relevant element in the construction. All scores for all elements together define the risk number for the object. The risks are depicted in a 5 x 4 risk-matrix and used in evaluation of the investment and maintenance strategies. Appendix D provides more information on the scoring of risks and chances.

RAMS is used along with other methods, such as Systems Engineering and Asset Management. All these methods are focused on the relationship between systems and their operation during the life cycle. Each of these methods has its own focus. Rijkswaterstaat has detailed its methods in the RAMS and SE guides.

7.5 Optimized Decision Making

Within the technical planning systems (i.e. pavements and structures) several optimization algorithms are present. These algorithms look at the type of maintenance and the extent. Therefore, the base on which the Integrated Asset Management Plan is already optimized.

Within each Regional Office a further optimization is made when preparing the actual works. In these optimizations place and time of maintenance are primarily looked into. By optimizing place and time the effect on the traffic flow is minimized.

7.6 Maintenance Analysis and Management

The effect of the maintenance works is closely monitored:

- During construction as part of the integrated contract monitoring system (SCB).
- After construction as part of the regular monitoring activities. Both on SLA/PIN level as well as technical indicators.

7.7 Demand Management

Rijkswaterstaat has some means for managing demand. By using the Variable Message Signs the flow of traffic can be (re)directed. Access Dosage Systems limit access to the highway network during rush-hours.

In future road pricing will give Rijkswaterstaat additional means in managing demand. Presently, the technical, legal and other details are worked out. The Ministry of Infrastructure and Environment aims at implementing road pricing around 2016.

7.8 Valuation and Financial Issues

In the present situation the valuation of the assets does not play a role in planning and optimizing the maintenance works. Maintenance works are fully depreciated as they occur.

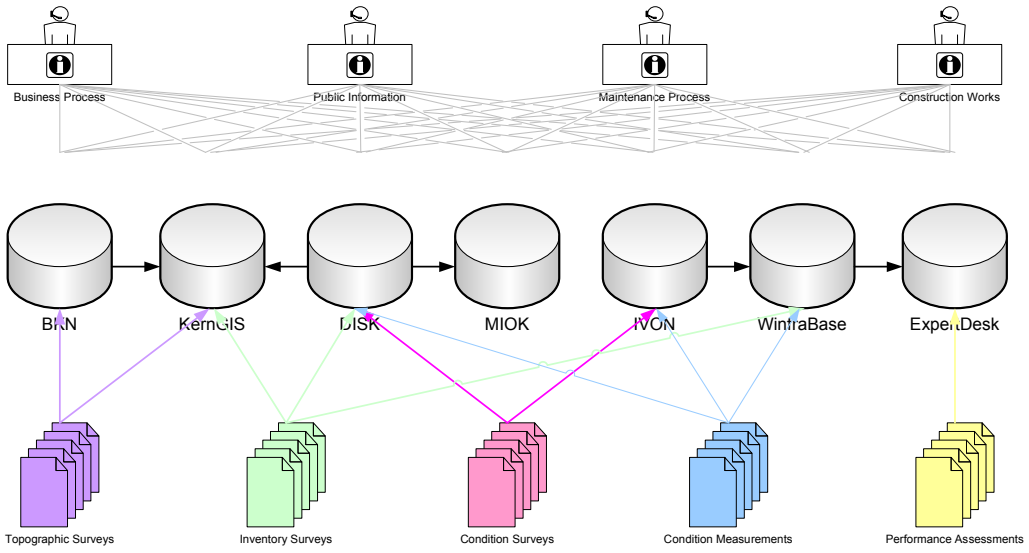
8 Information and Systems

8.1 Asset Management Information Systems

Availability of current, complete, comprehensive, accurate, valid and reliable data and information is considered vital for decision making and the effective execution of asset management. Information management systems are vital for providing access to the information in a timely and appropriate manner, enabling data storage, mining, analysis and reporting.

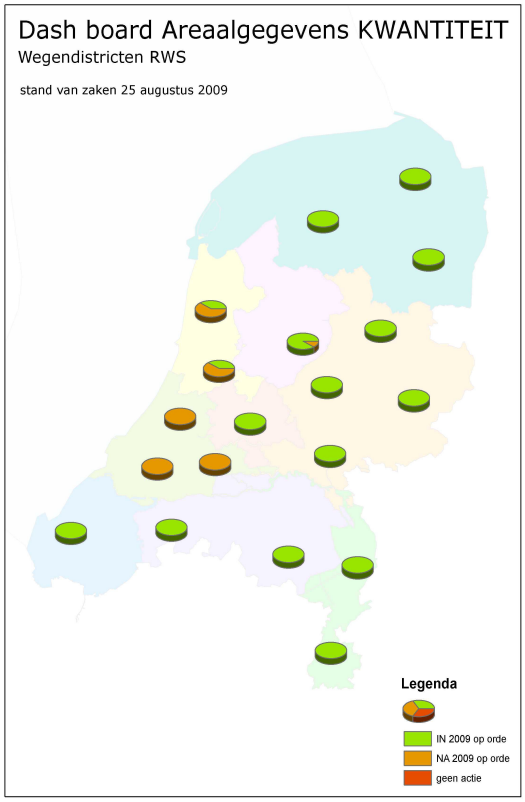
Figure 10 gives an impression of all systems presently used by Rijkswaterstaat for information storage and analysis and their links. As can be seen in all the interconnecting arrows in the figure the systems (BKN, KernGIS, DISK, MIOK, IVON, Expertdesk and WinfraBase) are used in the business processes as well as fed by the same data sources. Therefore the risk of duplicate data and out-of-date data is large.

Figure 10: Systems landscape data and information systems



In 2008-2009 a survey was made on data-quality. In quality both content as well as accuracy were reviewed. It was found that on average the data quality is sufficient for the business processes although improvements can be made. Figure 11 presents an overview on the data quality for every regional division (status 2009).

Figure 11: Results on review of data quality (status 2009)



To improve communication between systems, optimize the needed data-organization and implement better data inventory and validation procedures Rijkswaterstaat has started a project within the asset management project. The project aims at:

- Centralized Management
- Centralized Storage
- Centralized collection
- Supply and demand-oriented architecture
- Smaller databases, but with more basic information
- Specialized databases include only specialist data (no duplicates).

8.2 Asset Hierarchy

Rijkswaterstaat discerns the asset types as described in table 2 in Appendix A. These are:

- Carriageways, pedestrian and cycle facilities
- Road markings, studs and kerbs
- Structures
- Road lighting
- Fences, barriers and road restraint systems
- Road traffic signs & signals
- Landscaping

- Drainage
- Technology equipment

The level to which an asset type is sub-divided into asset groups and sub-groups are based on recognized good practice and engineering judgment. Key points considered when defining the groups included (i) inspection and cyclic maintenance regimes; (ii) the service life and/or rate of deterioration (iii) maintenance and renewal options and costs; and (iv) intervention levels and thresholds.

8.3 Asset Identification

Rijkswaterstaat is in the process of uniquely identifying all its assets by codes. In these codes the motorway number, chainage and location along the route and asset type are represented. Eventually these codes will be used within the data storage and information systems as well as the financial SAP system.

8.4 Data Collection

Data collection is provided both within Rijkswaterstaat as well as by private sector companies. The data can vary from construction data (e.g. as built files), survey data (IVON/AMP inspections) to measurement data (terrain measurements, ARAN, etc.).

Presently data collection procedures are drawn up specifically for the (type of) data to be collected. Target is to optimize data collection, validation and storage procedures.

8.5 Data Management

Rijkswaterstaat is currently developing a more formalized approach to Information Management which will link together and supplement current Information Management Practices.
With the new data management strategy, Rijkswaterstaat will adopt a formal framework for Information Management in relation to highway assets. The purpose of the framework is to clearly define the hierarchy of documentation required to support good Information Management, thereby providing all stakeholders with an understanding of how Information Management is managed by Rijkswaterstaat.

The key components of the Framework are:

- Information Management Policy - sets out the overall principles and intentions in relation to information management.
- Information Management Strategy - sets out the governance and objectives for information management and providing quality information, including:
    - Identification of information needs relative to the business goals;
    - Objectives for information management to deliver the information needs, usage, reporting, auditing and integration relative to the business goals;
    - Identification of information projects and benefits;

    - Action Plan, and prioritization provided from content of the strategy;
- Information Standards and Guidelines - the supporting documents that set out:
    - Specific information requirements, including descriptions, collection, auditing, maintaining etc. (as per the draft Inventory/Condition Manuals);
- Information Management Processes - the activities that support the Policy, Strategy and Standards (i.e. ongoing information management work), including:
    - Development and coordination of information management practices – the 'information manager' is responsible for liaising with relevant staff to ensure their information needs are interpreted correctly within the formal information management practices;
    - Development and coordination of information management practices – that optimize and consolidate the use of information;
    - Sharing and integration of information – ensuring that communication routes to pass and share information are established and work effectively e.g. interdepartmental or external to the organization;
    - Application of information technology – ensuring that the function of the technology matches and is optimized against the functional requirements of the information management practices and satisfies the information needs of the business (functional compliance as opposed to technical compliance where technical compliance is related to the business IT policy/strategy, i.e. which type of database, which type of hardware etc)
    - Information Assurance – investigating the quality of information and using common information assurance measures, e.g. completeness, accuracy, reliability etc., and instigating compliance/non-compliance certification within an improvement process.

8.6 Network Information System (NIS)

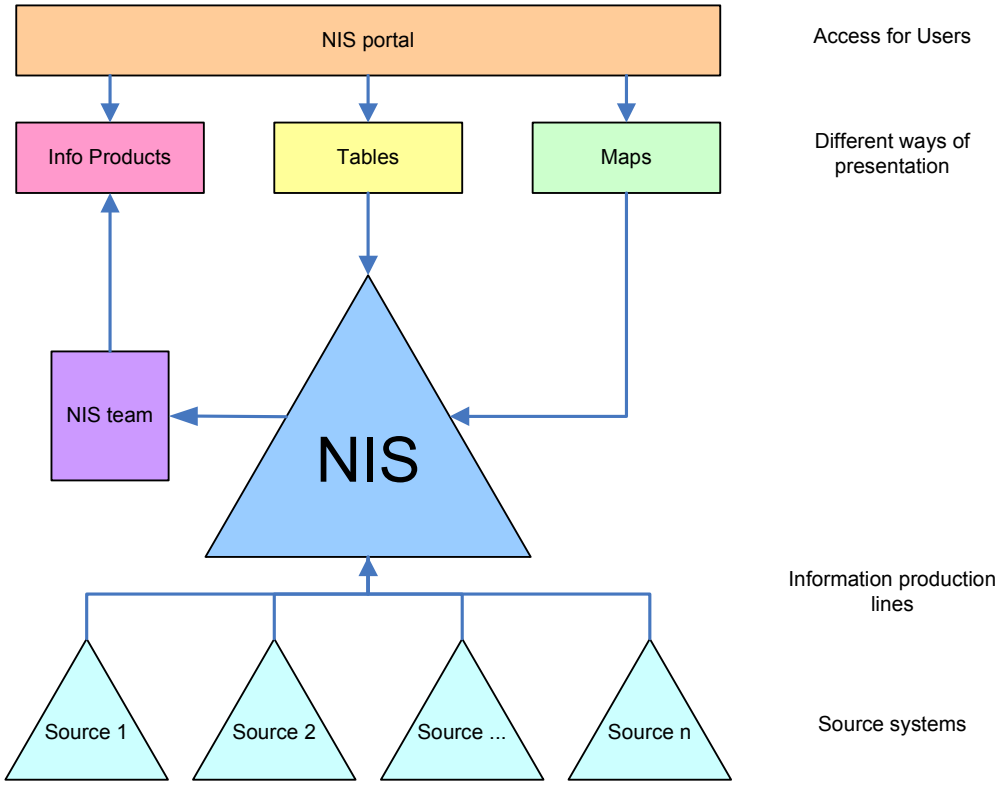
Management of the Service Level Agreements demands at any moment in the asset management process accurate and reliable data. This data is also used in terms of accountablitity of individuals within the Rijkswaterstaat organization.

To manage the information flow in the SLA-monitoring Rijkswaterstaat designed the Network Information System. Basically the system contains:

- Basic data from the different asset registration systems (see §8.2).
- Information on the (maintenance) works program.
- Description of all (24, 8 for each network) relevant performance indicators.
- Input procedure in which the Regional Offices can supply accurate data on the status of projects and performance indicators (PIN's).

All data within the NIS is available throughout Rijkswaterstaat and is currently used for performance monitoring. Entry to NIS is provided by a geographical user-interface (GIS). Figure 12 depicts the general setup of NIS.

Figure 12: Results on review of data quality (status 2011)



Focus for the information in NIS is on use by the management with an emphasis on trends. NIS is not meant to manage daily operations. Consequence is that not all detail is needed, as long as the data can be used to make management decisions and monitor performance. Credo is "Good is good enough".

Within NIS data is available on:

- Quantity
  - Asset types
  - Locations
  - …
- Quality
  - Asset conditions
  - Maintenance planning / program
- Usage
  - Traffic statistics
  - Accident statistics
  - …

For management use it provides information by means of:

- Statistics.
- Status of planning / works program.

For each data and information item the underlying processes were defined together with persons directly involved in managing these processes:

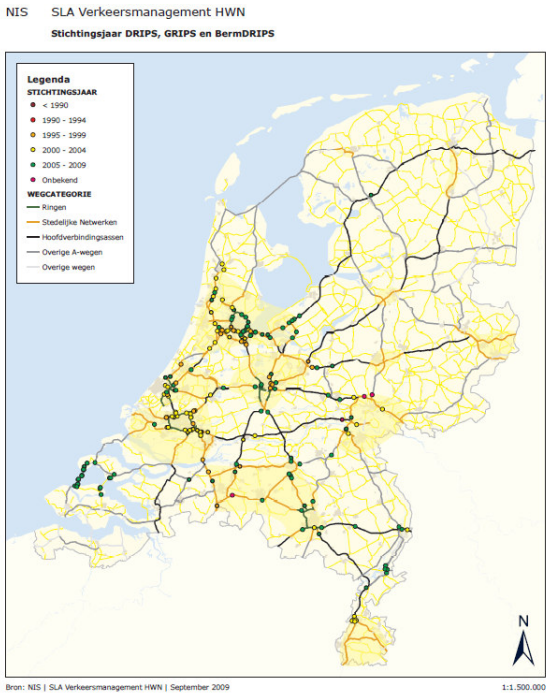
- Information document
  - Which information is needed?
  - Way of presentation: Design of tables, graphs, etc.?
- Data delivery protocol
  - Organisation (contact person, file format, update frequency, delivery method)?
  - Content of data (description, format, units, definitions)?
- Update frequency and automation
  - Manual updates?
  - Automation?

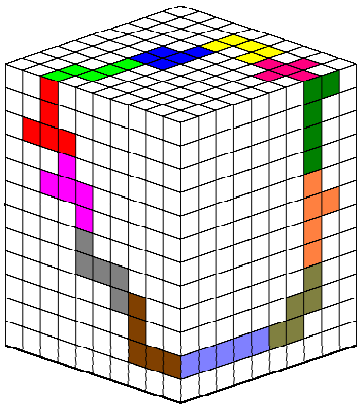
The available methods to present information, presently (2011) available in NIS are: 'Maps' and 'Cubes' (depicted in figure 13) and Tables/Graphs: More specifically functionality within these types are:

- Pre-defined tables / graphs
  - limited functionality – Tables and Graphs on most aspects predefined
  - zoom, filter, etc
- Cubes
  - choice of variables
  - zoom, filter, etc
- Maps
  - interactive
  - static information

All data can be presented in PDF or XLS format for further analysis and reporting.

Figure 13: Some presentation methods available in NIS





9 Costs of Asset Management and Benefits

Note: Figures presented in this chapter are mainly taken from the report "Vind een weg of maak er een", Evaluatie Baten-lasten Dienst Rijkswaterstaat, April 2010. For the costs of the Asset Management Implementation Program is referred to the decision of DT-RWS (November 2010).

9.1 Human Process

Rijkswaterstaat maintains and operates both road infrastructure as well as the dykes and dams and main rivers / canals. In the last 10 years, Rijkswaterstaat is actively developing itself to a more effective and efficient organization. Spring 2010 an evaluation was made of the effect of the changes in the organization on the effectiveness of Rijkswaterstaat.

In the period 2002 – 2010 the total number of persons in the organization was reduced from 11.300 to 9.340[4]. A further reduction of the organization with 10 – 20 percent is envisaged in the coming five years. The reduction of the organization is possible due to handover of work to private sector and doing certain tasks more efficient by means of automation. Most of the outflow of personnel is due to retirement.

Only a part of the total organization within Rijkswaterstaat is directly involved in Asset Management and associated Maintenance works. For this study the exact number could not be found, but it is estimated that approximately 70%[5] of the organization finds work from managing assets, mobility or maintenance works both for 'dry' as well as 'wet' infrastructure. Of these 6.800 persons about 10 – 20 percent is actively working in asset management primary processes like data inventory, data management, inspection, programming and maintenance policy advise. The remaining group is doing work related to contract specification and management, procurement and day to day operations.

9.2 Maintenance, Reconstruction and New Works

Rijkswaterstaat spends vast sums of money to maintain, operate, extend and widen its infrastructure. From the evaluation study it was found that in 2009 Rijkswaterstaat spend approximately 9,0 billion Euro for both 'dry' and 'wet' infrastructure.

Rijkswaterstaat differentiates in its spendings between External Product Costs (i.e. mainly works contracted to contractors) and Internal Costs (i.e. Staff / Overhead). The latter category includes the hiring of external staff and work executed by Consultants.

[4] "Vind een weg of maak er een", Evaluatie Baten-lasten Dienst Rijkswaterstaat. April 2010.
[5] Of the total organization costs (1.152.000) approximately (844.000) is labeled as related to maintenance

For funding two different sources can be distinguished. On the one hand the "Baten-Lasten Dienst" and on the other the "Infrafonds". The first relates primarily to maintenance works, while the latter relates to new works and works associated to increasing capacity / improving functions of the existing infrastructure.

Expenditures through "Baten-Lasten Dienst"
- External Product Costs New Works, Reconstruction € 2.285 mio
- External Product Costs Maintenance € 1.282 mio
- Internal Costs Staff / Overhead € 1.152 mio

Expenditures through the Infrastructure Fund
- New Works € 2.314 mio
- Maintenance € 1.969 mio

9.3 Asset Management Program

Since 2008 Rijkswaterstaat runs an Asset Management Program. In this program Rijkswaterstaat improves internal processes, supporting systems and its knowledge on its current infrastructure.

For the period 2011 – 2012 a budget of € 10,2 million is available to the Asset Management Program. Breakdown of these costs is as follows:
- Program Team € 0,8 mio
- Pilots € 1,0 mio
- Inspection / Inventory € 3,0 mio
- Implementation of Asset Management € 4,0 mio

Because Asset Management is directly related to current business processes of Rijkswaterstaat, part of the funding is 'hidden' in the Internal Costs (see chapter 2 and 9.2). These costs are mainly associated to Inspection / Inventory.

9.4 Qualitative Assessment of Benefits

The benefits of Asset Management are related to understanding what assets are managed, their current condition and getting value for money when executing maintenance works.
More specifically for the asset management program the benefits are discussed in chapter 10.

10 Achievements and Key Challenges Remaining

10.1 Achievements

As described in Chapter 5 central elements in implementing Asset Management for Rijkswaterstaat are:

- Further improvement and implementation of Service Level Agreements (SLA) in business processes (VIP project).
- Improvement of the Information Infrastructure: Quantity and quality (condition) of the network
- Redevelopment of the Programming & Prioritization processes: Long term planning of maintenance and implementation of RAMSSHE€P and LCC aspects in the programming cycle
- Development of a new approach in function and role of the Basic Levels for Maintenance / Object Management Regimes in the business process.
- Further implementation of (formalized) monitoring and auditing functions on processes and results (Deming Cycle: Plan, Do, Check, Act)
- Market cooperation: Further implementation of procurement based on the economically most valuable bid.

Results up to 2009 for these elements are presented in table 10.

Table 10: Results on Asset Management Program

Aspect	Status / Progress
SLA in business process	On track. • 4-year SLA progam implemented for highways, waterways and water protection.
Information Infrastructure	On track. • 90% of data is available and of acceptable quality. • Uniform data model developed. • Pilot started for new data management organization in the Regional Divisions Limburg & Noord Nederland.
Programming & Prioritization	On track. • All business processes work from a 4-year plan. • Improvements made on risk assessment in programming and prioritization. • Business process description programming & prioritization available.
BLM / OMR	On track. • BLM – wet updated. • Project started for development of new BLM and its function in SLA process. • Evaluation pilot project IHP Houtrib.
Monitoring & Auditing	On track. • SLA monitor available in NIS.

Aspect	Status / Progress
Market Cooperation	On track. • Minimum requirements for data in Design & Construct and Term Maintenance Contracts specified. • Analysis made on potential conflicts between asset management strategy and market cooperation. • Overview of all multi-year performance contracts for all three networks available.

10.2 Key Challenges

The Asset Management Program has a period up to 2012. Table 11 lists the aspects and the planned improvements for the period 2011-2012.

Table 11: Key Challenges in Asset Management Program 2011-2012

Aspect	Status
SLA in business process	• Further improvement on SLA in business process → SLA tender with alternatives for politicians and RIjkswaterstaat Management. • Further development of key performance indicators and their relation to the Service Levels. • Development of Regional Asset Management Plan
Information Infrastructure	• Further improvement of availability and quality of data (target 99%). • Definition of data exchange standards to be implemented in Term Maintenance Contracts and Design & Construct contracts. • Implementation of new data management organization in Regional Divisions • Data / Information needs for redeveloped maintenance business process defined.
Programming & Prioritization	• Further improvements on risk assessment in programming and prioritization. ○ Risk based maintenance profiles on network links. • Uniform Rijkswaterstaat Programming Tool available • Scenarios available with SLA Tender relating to different maintenance options / budget options and effects. • Network Link Plans implemented in Regional Divisions

BLM / OMR	• BLM – dry updated.
	• Risk Based Maintenance - Pilot
	• New design of BLM based on its new position in SLA process (including factor for use of infrastructure).
	  ○ Reliability centered maintenance
	  ○ Differentiation in use and related maintenance strategies.
	  ○ Better relations between BLM/OMR and SLA process.
	  ○ Implementation of effects of network vision in

Aspect	Status
	BLM.
Monitoring & Auditing	• Development and implementation of auditing strategy.
Market Cooperation	• Further developments on minimum requirements for data in Design & Construct and Performance Based Term Maintenance Contracts specified. • Connection made between SAP and programming tool. • Process description for evaluation of procurements.
Life Cycle Costing	• Further development of LifeCycle Costing techniques in programming and prioritization process. o Management decision support: improvement of LCC in decision making processes (holistic approach of whole-life cost) within both the Ministery of Transport as well as inside the agency. o LCC analysis improvement for new construction projects with an abstract (functional) scope. o LCC for selection of best bid (EMVI) o LCC in long and short term maintenance planning (priorization) o LCC ratios

Regarding above mentioned aspects a risk assessment was made. Top 6 risks for further implementation of the Asset Management Program are:

- Improvement of data quality asks more time than expected.
- Stagnation in implementation of uniform SLA programming
- New BLM based on reliability centered maintenance stagnates.
- Implementation of standard contract specification on data management for Design & Construct / DBFM and Term Maintenance Contracts is delayed.
- Regional Divisions are insufficient connected to the Asset Management Program.
- No centralized management of implementation of Maintenance Management Systems in Term Maintenance Contracts.

11 References

- Annual Budget 2011, Ministry of Infrastructure and Environment, 2010
- Budget Infrastructure Fund 2011, Ministry of Infrastructure and Environment, 2010
- Corporate Plan Rijkswaterstaat "Agenda 2012", 2008.
- Nota Mobility, 2008.
- Asset Management Implementation Plan, 2010
- International Infrastructure Management Manual
- Publicly Available Standard (PAS-55) on Asset Management, 2008
- Basic Levels for Maintenance / Object Maintenance Regimes, 2008
- Service Level Agreement, Ministry of Infrastructure and Environment & Rijkswaterstaat, 2010.
- Evaluatie Baten-Lasten Dienst Rijkswaterstaat "Vind een weg, of maak er één", 2010.

Appendix A Rijkswaterstaat Assets

Table A-1: Summary of Asset Quantities (source: Basic Maintenance Level Rijkswaterstaat - 2007)

Asset Type	**Asset Group**	**Quantity**
Carriageways	Highway Dual C/way	2.625 km
	Highway Single C/way	1.000 km
	Porous Asphalt	90%
	Not-Porous Asphalt	10%
Pedestrian & Cycle Facilities	Footway	unknown
	Cycle Facility	unknown
Road Markings, Studs and Kerbs	Road Markings (Hatched)	8.000
	Road Markings (Longitudinal)	18.975 km
Structures	Bridge	3.156
	Culvert	1.245
	Tunnels	14
	Aqueducts	8
	Sign/Signal Gantry	4.637
Road Lighting	Lighting point	1.311 km
Fences, Barriers and Road Restraint Systems (RRS)	Fences and Barriers	1.700 km
	Traffic Control Barriers	6.719 km
Road Traffic Signs & Signals	Road Traffic Signs	16.498
	Bollards	188.000
	Reference Marker Point	71.500
	Road Traffic Signals	204
Landscaping	Tree	1.760 ha
	Grass, bulbs & wildflower areas	15.278 ha
	Wildlife structures	462
Drainage	Ditches, channels	1.088 ha
Technology Equipment	Variable Message Signs	146
	Detector Loop	16.387
	Traffic Flow Eq. (TDI)	43
	Video camera’s	1.039
	Ice Sensor	250

Appendix B Draft New SLA Highway Network (2017 – 2020)

Asset Management			
Availability	On network:	93%	
	On network link:	Network link type a (5.000 veh. / hour)	95%
		Network link type b (3.500 veh. / hour)	90%
		Network link type c (1.500 veh. / hour)	80%
Reliability	Maximum number of failure each year	Network link type a (5.000 veh. / hour)	0
		Network link type b (3.500 veh. / hour)	2
		Network link type c (1.500 veh. / hour)	5
Maintainability	Maximum number of traffic jams each year due to works and duration of these traffic jams	Network link type a (5.000 veh. / hour)	2 * 2 hour
		Network link type b (3.500 veh. / hour)	5 * 3 hour
		Network link type c (1.500 veh. / hour)	10 * 3 hour
Safety	Maximum number of accidents with injuries each year	Network link type a (5.000 veh. / hour)	…
		Network link type b (3.500 veh. / hour)	…
		Network link type c (1.500 veh. / hour)	…
	Minimum number of managed VOC's each year	10	
Traffic Management			
Minimum % of instrumented road sections on which RWS delivers reliable traffic data			95%
Minimum % in which arrival time of support services for an accident are:		Network link type a: 15 minutes	80%
		Network link type b en c: 30 minutes	80%
Minimum % in which extra lanes can be opened conform regime			95%

Budget (BLS; EPK + IK)			
2017	*2018*	*2019*	*2020*
€ … mio.	€ … mio.	€ … mio.	€ … mio.
Long term effects			
Risk Description		*Risk Management*	
Norm exceedings for rutting and skid resistance on network link type c		ARAN-measurements (normal frequency), one extra visual condition survey each year. Implementation of speed regime (80 km/h) within 24 hours when norm exceedance is observed.	
Decrease of asset value / increase of risks related to future performance duet o backlog of maintenance for agreed PIN		Quantified on € … mio. / year after 2021 en observed by Client	

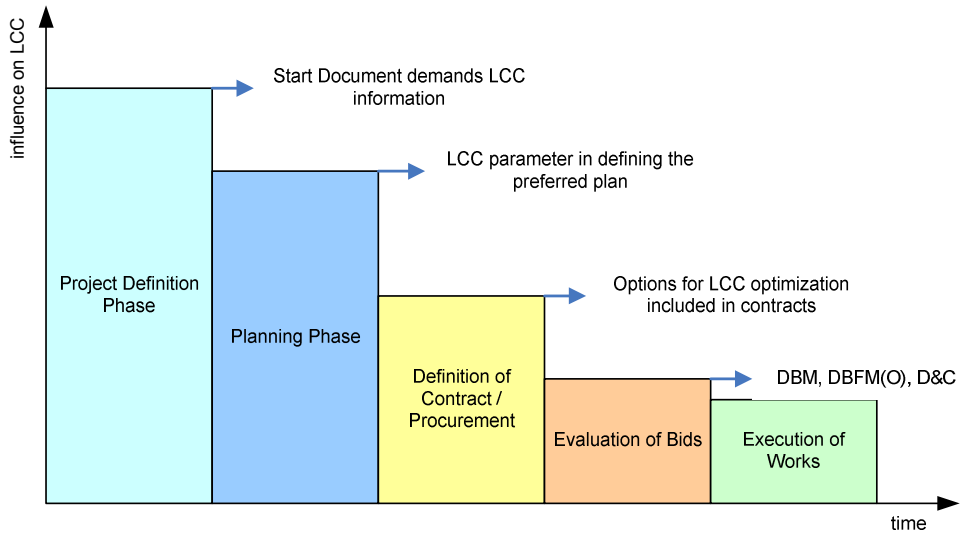
Appendix C Life Cycle Costs

Why Life Cycle Costs?
Rijkswaterstaat aims at a business process in which its available budget is spent both appropriately as well as efficiently. In reviewing appropriateness and efficiency of plans also the effects on the long term have to be taken into account. Each construction work has an effect on the long term budget availability by means of the (implicitly related maintenance effects). Therefore, Rijkswaterstaat decided in 2010 to include in all decisions relating to works programs the effects on maintenance.

What is Life Cycle Costs?
Life Cycle Costs is a methodology to define and relate the effects of different investment scenarios in terms of costs. All current and future costs are expressed in 1 number (Net Present Value). Specific to the approach of Rijkswaterstaat is that in the calculation of the Net Present Value not-spending-money is calculated as a profit.

LCC as part of the works realization process
Figure C.1 depicts the influence LCC has on the final materialization of the project. Basically, the earlier in the project, the more effect can be seen.

Figure C.1: LCC in project realization



From figure C.1 can be seen that the first evaluations on LCC are already done in the planning and design phase. LCC is not limited to planning and design. Also in procurement and contracting it still supports decisions on what alternative or what bid to take. During execution of works it is vital that materialization occurs as used during the LCC evaluation. Contract management must guarantee this.

Implementation of LCC within RWS

LCC will be implemented basically at three phases of the project life cycle (Reconnaissance – Plan Study – Definition / Design – Realization, Maintenance and Demolition). These phases are:

- Project Definition and Planning
- Procurement (definition of contract and evaluation of bids)
- Maintenance

Related to maintenance LCC will be part of the Service Level Agreements, Management Contracts and Maintenance Plans.

Roll-out of LCC started in 2010. In the next years experience will be developed and evaluated.

Appendix D Risk Assessment

	Negligible	Minimal	Severe	Catastrohphic
Almost certain	5	10	15	20
Large	4	8	12	16
Medium	3	6	9	12
Small	2	4	6	8
Negligible	1	2	3	4

Chances and effects are mainly defined by qualitative assessment of the RAMSSHE€P parameters. As help below qualitatively the effect scoring is described.

Reliability

Classification	*Effect*
Negligible	Failure to execute maintenance within the planned year has a negative impact on the reliability of the object but has a **negligible influence** on the **main function**.
Minimal	Failure to execute maintenance within the planned year has a negative impact on the reliability of the object but has a **minimal negative influence** on the **main function**.
Severe	Failure to execute maintenance within the planned year has a negative impact on the reliability of the object but has a **severe negative influence** on the **main function**.
Catastrophic	Failure to execute maintenance within the planned year has a negative impact on the reliability of the object but has a **catastrophic influence** on the **main function**.

Availability

Classification	*Effect*
Negligible	Failure to execute maintenance within the planned year has a negative impact on the availability of the object but has a **negligible influence** on the **main function**.
Minimal	Failure to execute maintenance within the planned year has a negative impact on the availability of the object but has a **minimal negative influence** on the **main function**.
Severe	Failure to execute maintenance within the planned year has a negative impact on the availability of the object but has a **severe negative influence** on the **main function**.
Catastrophic	Failure to execute maintenance within the planned year has a negative impact on the availability of the object but has a **catastrophic influence** on the **main function**.

Maintainability

Classification	*Effect*
Negligible	Failure to execute maintenance within the planned year results in **negligible more difficult maintenance operations** at a later stage within the constraints of use
Minimal	Failure to execute maintenance within the planned year results in **minimal more difficult maintenance operations** at a later stage within the constraints of use
Severe	Failure to execute maintenance within the planned year results in **a different scope of maintenance operations** at a later stage with **severe effects** on the **performance** of (part of) the network
Catastrophic	Failure to execute maintenance within the planned year results in **a different scope of maintenance operations** at a later stage with **catastrophic effects** on the **performance** of (part of) the network

Safety

Classification	*Effect*
Negligible	Failure to execute maintenance within the planned year has a **negligible influence** on safe use of the object, but remains within acceptable limits.
Minimal	Failure to execute maintenance within the planned year results in a situation in which the **limits on safe use of the object are approached** and a **minimal extra number of non-lethal** accidents.
Severe	Failure to execute maintenance within the planned year results in a situation in which the **limits on safe use of the object are surpassed** and an **extra number of non-lethal** accidents.
Catastrophic	Failure to execute maintenance within the planned year has a **catastrophic effect** on safe use of the object and an **extra number of non-lethal and/or lethal** accidents.

Security

Classification	*Effect*
Negligible	Failure to execute maintenance causes an increase in vandalism
Minimal	Failure to execute maintenance causes a security incident and/or an increase in vandalism
Severe	Failure to execute maintenance causes an external threat
Catastrophic	Failure to execute maintenance causes an external threat with effects

Health

Classification	*Effect*
Negligible	Failure to execute maintenance has a **negligible effect** on human health
Minimal	Failure to execute maintenance has a **minimal effect** on human health
Severe	Failure to execute maintenance has **severe effects** on human health
Catastrophic	Failure to execute maintenance has **catastrophic effects** on human health and results in death

Environment

Classification	*Effect*
Negligible	Failure to execute maintenance causes **negligible effect** on the use of the environment
Minimal	Failure to execute maintenance causes a **minor negative effect** on the use of the environment on **local level**
Severe	Failure to execute maintenance causes a **severe negative effect** on the **regional network**
Catastrophic	Failure to execute maintenance causes a **catastrophic negative effect** on the **whole network**

€conomics

Classification	*Effect*
Negligible	Failure to execute maintenance causes **< k€ 50** in claims and extra maintenance costs (maintenance works & inspections)
Minimal	Failure to execute maintenance causes **< k€ 500** in claims and extra maintenance costs (maintenance works & inspections)
Severe	Failure to execute maintenance causes **< k€ 1.000** in claims and extra maintenance costs (maintenance works & inspections)
Catastrophic	Failure to execute maintenance causes **> k€ 1.000** in claims and extra maintenance costs (maintenance works & inspections)

Politics

Classification	*Effect*
Negligible	Complaints
Minimal	Regional image loss
Severe	Nationwide image loss
Catastrophic	Position of Minister questioned