



# Infrastructure Operating Plan

For Barangaroo South Recycled  
Water Plant



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# Executive Summary

Lend Lease Recycled Water (Barangaroo South) Pty LTD (LLRWBS) is the Water Industry Competition Act 2006 (WICA) license holder and has appointed Veolia Energy Solutions as the operator of the Barangaroo South Recycled Water Plant (BSRWP).

This plan explains how Veolia plans to manage the infrastructure assets to best satisfy LLRWBS contract and relevant regulatory requirements for the BSRWP. This plan complements the Water Quality Management Plans MAN-10425 by providing details regarding all key 'asset management' activities. It is further supported by the BSRWP Operations Management Plan MAN-10424, which provides an overview of the way the company addresses the requirements for Quality, Safety, Environment, Asset and Risk Management as required by the Veolia Business Management Manual and relevant standards.

The key features of Veolia's Asset Management Plan are:

- Establishment of an advanced Asset Management System linked to the SCADA system to ensure accurate and appropriate data capture from day one.
- Early and rigorous attention paid by the maintenance team to develop a comprehensive maintenance program.
- Integration of condition monitoring, renewal and whole of life cost planning processes to promote high availability and durability of assets.
- A focus on providing a competent, well trained and well supported operations team, with a view to establishing an 'asset management culture' at the Plant.
- Development of effective maintenance and renewal schedules with an emphasis on condition monitoring to minimise risks.
- Implementation of special information systems to manage UF and RO membranes, as well as capital renewal.
- Selective use of RCM through the operations phase to address reliability issues.

# O&M Contractor Management Plans Hierarchy

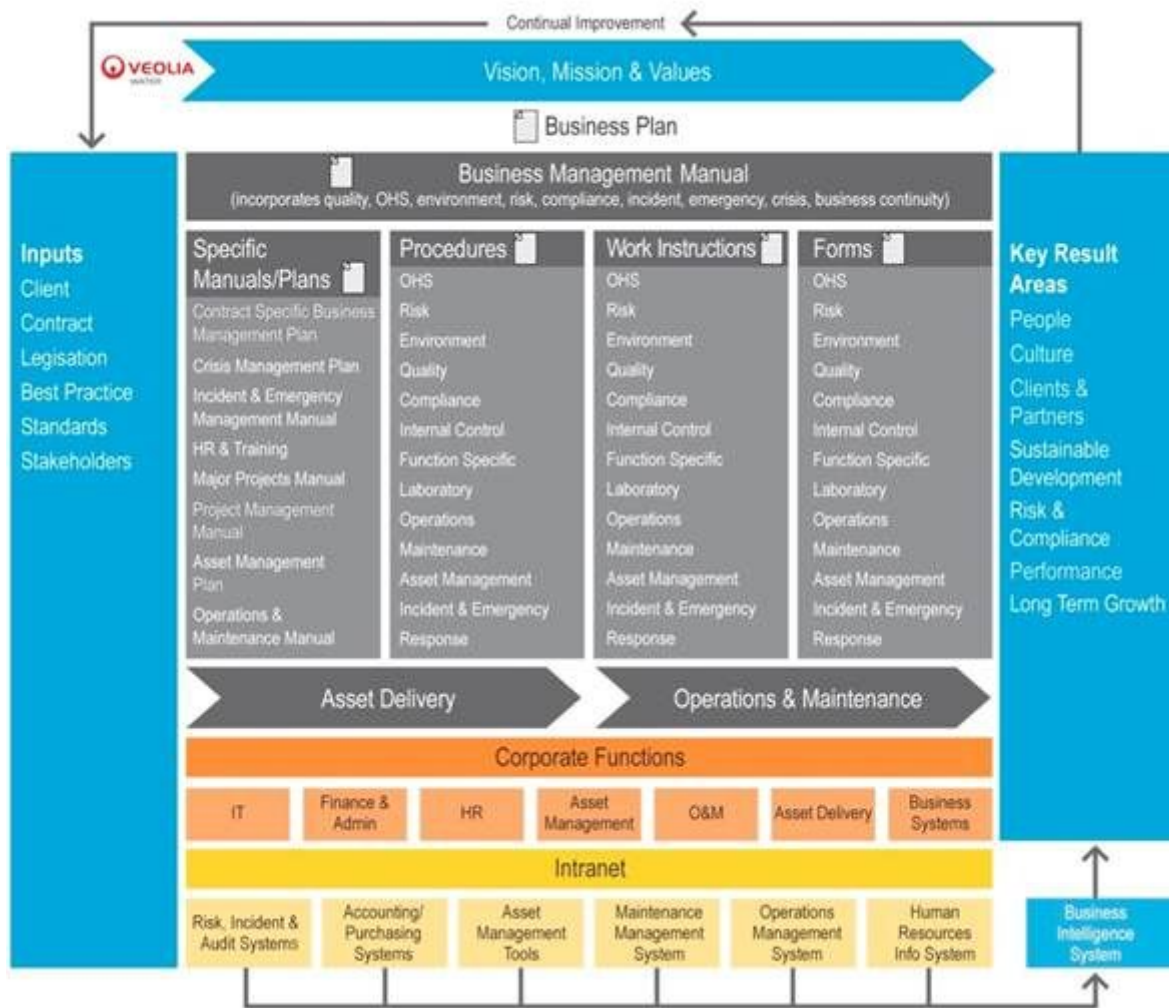


Figure 1 Asset Management Plan's Position in Management Documents Hierarchy

# Abbreviations

The following abbreviations are used in this Plan:

**Table 1 Abbreviations**

<b>AMP</b>	Asset Management Plan
<b>BSRWP</b>	Barangaroo South Recycled Water Plant
<b>CIP</b>	Clean in Place
<b>CMMS</b>	Computerised Maintenance Management System
<b>EIS</b>	Environmental Impact Statement
<b>FMEA</b>	Failure Mode and Affects Analysis
<b>VAMS</b>	Veolia Asset Management System
<b>IBMS</b>	Integrated Business Management System
<b>IOP</b>	Infrastructure Operating Plan
<b>KPI</b>	Key Performance Indicator
<b>LLRWBS</b>	Lend Lease Recycled Water (Barangaroo South) Pty LTD
<b>LOS</b>	Level of Service
<b>MOS</b>	Membrane Operating System
<b>MTBF</b>	Mean Time Between Failure
<b>NF</b>	Nano Filtration
<b>O&amp;M</b>	Operations and Maintenance
<b>OH&amp;S</b>	Occupational Health and Safety
<b>PLANT</b>	The Barangaroo South Recycled Water Plant
<b>PM</b>	Preventative Maintenance
<b>RO</b>	Reverse Osmosis
<b>RCA</b>	Root Cause Analysis
<b>RCM</b>	Reliability Centred Maintenance
<b>SCADA</b>	Supervisory Control And Data Acquisition
<b>UF</b>	Ultra Filtration



# Definitions

The following definitions are used in this Plan:

**Table 2 Definitions**

<b>The Plant</b>	The Barangaroo South Recycled Water Plant (BSRWP)
<b>The Project</b>	Barangaroo South
<b>The Principal</b>	Lend Lease Recycled Water (Barangaroo South) Pty Ltd (LLRWBS)
<b>The Operator</b>	Veolia Energy Solutions

# Introduction

## Context

This Infrastructure Operating Plan has been prepared as an outline plan in order to assist with the management of assets at Barangaroo South Wastewater Recycling Plant. As Veolia have been subcontracted to operate the plant on behalf of LLRWBS, this document has been written according to Veolia's principles and procedures.

## Scope

The Infrastructure Operating Plan has been developed to provide the following information:

- An overview of the asset management strategy and how the Infrastructure Operating Plan is developed in accordance with this;
- Descriptions of the staff organisational structure and processes to be put in place to implement the asset management aspects of the Water Quality Plans and monitor compliance with all requirements;
- Explanation of the process for developing, reviewing and updating the maintenance program.
- An outline of the asset management information systems to be used;
- Details of how preventative, corrective and breakdown maintenance is to be conducted on site;
- An overview of the process and value of assessing criticality for all assets;

- An overview of the process for performing condition and risk assessment and how this information is used for future planning;
- An outline of the capital investment strategy and the processes involved in making decisions regarding asset refurbishment and replacement;
- Details of the asset renewal program, which consists of major periodic maintenance items, including overhauls and replacement; and
- A summary of how NF, RO and UF membranes are to be managed.

## Objectives

The Infrastructure Operating Plan (IOP) is designed to ensure that the Barangaroo South Recycled Water Plant (Plant) assets are managed to the principles of Veolia's Asset Management Strategy. This strategy is an integrated and flexible approach, encompassing whole of life cycle costs.

The primary objectives of the Infrastructure Operating Plan is to enable the physical assets at the Plant to be maintained, repaired, rehabilitated and replaced in such a way as to ensure the following outcomes:

- No drop in level of service delivered over the duration of the contract.
- Optimum equipment performance, reliability and availability.
- Minimum total cost of ownership of each asset over its life cycle.
- Minimum business risks to all stakeholders.
- Compliance with all statutory and contractual requirements.

# Asset Management Strategy

## Strategy overview

Veolia's strategy for asset management uses an integrated approach which considers all aspects of the asset's life cycle including safety, operational performance, levels of service, contractual requirements, maintenance requirements and the asset's whole of life costs.

A flexible approach accommodates the continuing change in external factors associated with economic influences, customer expectations and business needs. Veolia's strategy enables ready reassessment and reiteration of inputs and outputs via periodic reviews and appraisals of all areas contained in an asset's life cycle.

The Infrastructure Operating Plan is a key component of Veolia's asset management strategy and is designed to:

- Reflect industry best practice.
- Produce an integrated structure that supports all the activities of the business.
- Ensure that the owner, operator and customers are not exposed to undue risk.
- Ensure sustainability of the environment.
- Create an objective, transparent management tool for monitoring asset performance against the relevant statutory obligations, policies, standards, levels of service and operational targets, and for reporting to authorities, customers and community.
- Minimise the cost of the managed assets over their useful life by balancing investment needs within economic and operational guidelines to ensure maximum efficiency in terms of capital investment and operational costs.
- Ensure that the Plant maintains the minimum flows for which it was designed.
- To manage and operate the Plant as an efficient business enterprise, it is essential to maintain the quality and performance of the assets at their optimum level. Detailed in this Infrastructure Operating Plan is the processes, which provide:
  - An effective mechanism for compiling a comprehensive asset register of all plant assets linked with quality, physical parameters, condition, criticality and performance of the assets.
  - Procedures for determining and recording asset condition and criticality;
  - Evaluating whole of life options;
  - Techniques for determining asset short- and long-term investment priorities and balance against the availability of funds; and
  - A program for asset management, maintenance, upgrading and replacement of assets that can cater for dynamic conditions.

## Planning Framework

Veolia utilises an integrated approach to asset management planning which considers the impact of all internal and external influences on the systems assets – technical, financial, social, political and economic.

The Infrastructure Operating Plan establishes maintenance regimes, maintenance standards, operating procedures and investment and replacement strategies that are linked to ensure ongoing service delivery in the most cost effective manner.

The asset management planning process consists of an annual review and refinement to allow for changing internal and external factors such as:

- The asset management principles, strategy and objectives of the asset owner;
- Industry-wide guidelines and standards for assessment management (including the International Infrastructure Management Manual)
- Environmental legislation;
- Funding and investment priority philosophies;
- Occupational health and safety regulations;
- Changing technology;

- Industrial relations legislation; and
- Community expectations.

The asset management framework that is to be used for developing and revising the integrated Infrastructure Operating Plan is shown in Table 3.

Table 3 Steps of Asset Management Framework

Step		Details
<b>Step 1</b>	<b>Define Performance Criteria and Service Levels</b>	These are defined using contract requirements and KPIs, EIS requirements, Licence Requirements, Environmental Plan and statutory obligations and performance standards.
<b>Step 2</b>	<b>Establish Policies and Procedures</b>	The policies and procedures required to deliver Veolia’s asset management strategy reside in the Operational Management Plan (MAN-10424).
<b>Step 3</b>	<b>Define Asset Register and Data Standard</b>	The Plant’s assets are defined and categorised into specific areas and asset types using an asset register and data standard. The asset register is created and maintained in Veolia’s Computerised Maintenance Management System (CMMS) software.
<b>Step 4</b>	<b>Define Maintenance Requirements</b>	Maintenance requirements for assets are determined and managed in Veolia’s CMMS. Preventative maintenance implemented based on manufacturers recommendations and asset condition and risk assessment.
<b>Step 5</b>	<b>Asset Condition Grading and Assessment</b>	Assets have regular condition assessments conducted with defined standards and policies. An overall asset assessment is performed to identify any areas of potential concern
<b>Step 6</b>	<b>Analysis and Review of Asset Assessment</b>	From the information collected in Step 5, an asset assessment identifies any shortfalls in asset condition and performance. A decision is then made either to continue to maintain or renew assets. Assets may be operated to failure based on whole of life costing evaluation options.
<b>Step 7</b>	<b>Review Maintenance Requirements</b>	Based on decisions made in Step 6, the options to increase or decrease maintenance

		expenditure is determined, reviewed and evaluated.
<b>Step 8</b>	<b>Asset Replacement Program</b>	Based on the assessments made in Step 6, the options available for asset replacement or refurbishment can be determined, reviewed and evaluated.
<b>Step 9</b>	<b>Review / Revise Investment Needs</b>	To assess the implications of changing inputs, business parameters, outputs, standards and targets, the results of outputs and total expenditure needs will be reviewed.

# Asset Management Organisation

## Staffing Structure and Responsibilities

Refer to the Operations Management Plan for a full organisation structure.

The asset management responsibilities of the key site-based staff are as follows:

- **Operations Manager** – Jointly review and approve the O&M Plan.
- **Plant Operator** – Key site point of contact for all maintenance issues. Organise material resources and supervise operator-maintainers, electrical and mechanical tradesmen and subcontractors engaged in corrective maintenance and technical or vendor specific preventative maintenance activities. Manage the supply and transfer of spare parts and other and other inventory to and from the onsite store.
- **Operations Supervisor** - Responsible for maintenance program planning. Develop and coordinate major preventative maintenance activities, including condition monitoring. Maintain the asset register. Develop the maintenance strategy and asset replacement program. Manage client reports and communications.

The asset management responsibilities of the key members of Veolia’s asset management team, based in the Veolia ANZ head office, are as follows:

- **Corporate Asset Manager** – Manage the provision of IT systems and engineering services support to enable assets to be managed in accordance with the asset management requirements of the O&M Plan, the asset renewal program, and the reporting requirements of The Client.
- **Asset Systems Engineer** – Assist in data collection and CMMS establishment activities and perform systems administration for VAMS. Facilitate workshops and provide technical and systems support for RCM.

- Asset Performance Engineer – Assist in the development of the asset renewal program, as well as ongoing monitoring and reporting. Track performance of asset renewals and provide IT support for the capital planning system.
- Asset Project Engineer– Conduct serviceability and reliability investigations. Provide engineering and project management assistance for major asset renewal and improvement projects. Provide engineering support to plant staff. Perform analysis of CMMS and carry out root-cause-analysis (RCA) and reliability investigations as required. Ensure that information is appropriately captured and stored in the Computerised Maintenance Management System (CMMS) VAMS, and monitor and report on Plant asset management performance.
- Corporate Maintenance Planner – Assist the site operations with maintenance related scheduling, planning, task and preventive maintenance creation, training and support of staff and CMMS users.

The engineering management responsibilities of the key members of Veolia's engineering management team, based in the Veolia ANZ head office, are as follows:

- Electrical / Controls Engineer – Administer, develop and arrange for training for the site SCADA system. Provide project management and engineering assistance for key electrical and controls projects.

## Labour Resourcing

To achieve the maintenance objectives of the Plant, the following staff are allocated:

- Veolia operator-maintainers – in addition to operating the Plant, the operators carry out routine asset maintenance.
- General subcontractors – resourcing requirements vary depending on the work scheduled, but subcontractor tradesmen are engaged on an ad-hoc basis to carry out basic maintenance routines (as required).
- Specialist subcontractors – separate commercial agreements are established for the carrying out of specialist maintenance activities such as servicing of chemical instrumentation, large pump systems, lifting equipment etc.

Key service suppliers, including subcontractors, will be identified during the development phase of the project. A continuing review process is to take place to ensure that service and supply is optimised.

## Equipment Resourcing

Veolia provides the following facilities, mobile plant and equipment to ensure maintenance at the plant is properly carried out:

- Workshop tools and equipment
- PPE and safety equipment

Equipment required for major overhauls/repairs or specialised maintenance is generally to be provided by the services contractors.

## Culture and Training

In line with the Learning and Development policy (POL-7), Veolia fosters an 'asset management culture' through communication, leadership and training. The culture is a key element that ensures that the objectives of the O&M Plan are realised. Veolia facilitate this by first appointing highly motivated, skilled and experienced staff to key positions. In addition, the following support is provided:

General systems training of all staff to enable them to:

- use the CMMS system to manage assets, maintenance activities, condition assessment and spare parts.
- understand the specific CMMS data collection and reporting needs of asset management, and how this is used by the business to reduce risk, generate efficiencies and savings, and improve performance.
- Specific asset management training to key staff to enable them to:
- perform criticality analysis of assets and condition grading and use this information to manage risk and prioritise renewals
- perform 'whole of life' analysis to understand and justify capital projects involving renewal or modifications
- use and analyse the results of condition monitoring technologies and analysis techniques (such as vibration, oil analysis and thermography) to promote 'predictive' maintenance.
- perform root-cause-analysis to fault-find complex or repeated failures.
- communication and involvement of key staff in asset management developments within the company through:
  - regular meetings with the asset management staff;
  - attendance at periodic maintenance and CMMS user-group conferences;
  - participation in workshops to plan specific asset management improvements;
  - dissemination of maintenance systems updates via electronic means

In accordance with Contractor Management Procedure (PRO-15), Veolia use its Contractor Management System to ensure that all subcontractors who carry out maintenance activities are suitably qualified and trained, and have appropriate insurances.

Similarly, Veolia staff who carry out maintenance are to have a suitable trade and/or other qualifications, and must be aware of all appropriate legislation and standards. In this way, the Plant Operator will ensure that all activities are performed in a safe and competent manner.

## Policies and Procedures

The policies and procedures required to implement the asset management strategy form part of Veolia's Integrated Business Management System. The system's documentation is stored the Veolia Document Centre and is controlled and maintained in accordance with Document Management Procedure PRO-129.

The integrated management system is used to manage all aspects of the operation and maintenance of the Plant. This includes corporate and site specific asset management documents that address the following:

- Asset Management Strategy (Infrastructure ) (STA-311]
- Developing and Managing an Asset Renewal plan Procedure (PRO-326)
- VAMS Manual
- Membrane Maintenance and Replacement (PRO-1334)
- Criticality and Condition Assessment (PRO-327)
- Reliability Centred Maintenance Manual (MAN-340)
- CARMS (Contract Asset Renewal Management System)
- Spares Parts Management (PRO-10432)
- Stores Management Procedure (PRO-325)
- Asset Management Policy (POL-12)
- VAMS Static Data Recording (TEM-38)
- Asset Location Numbering and Data Standard (PRO-331)

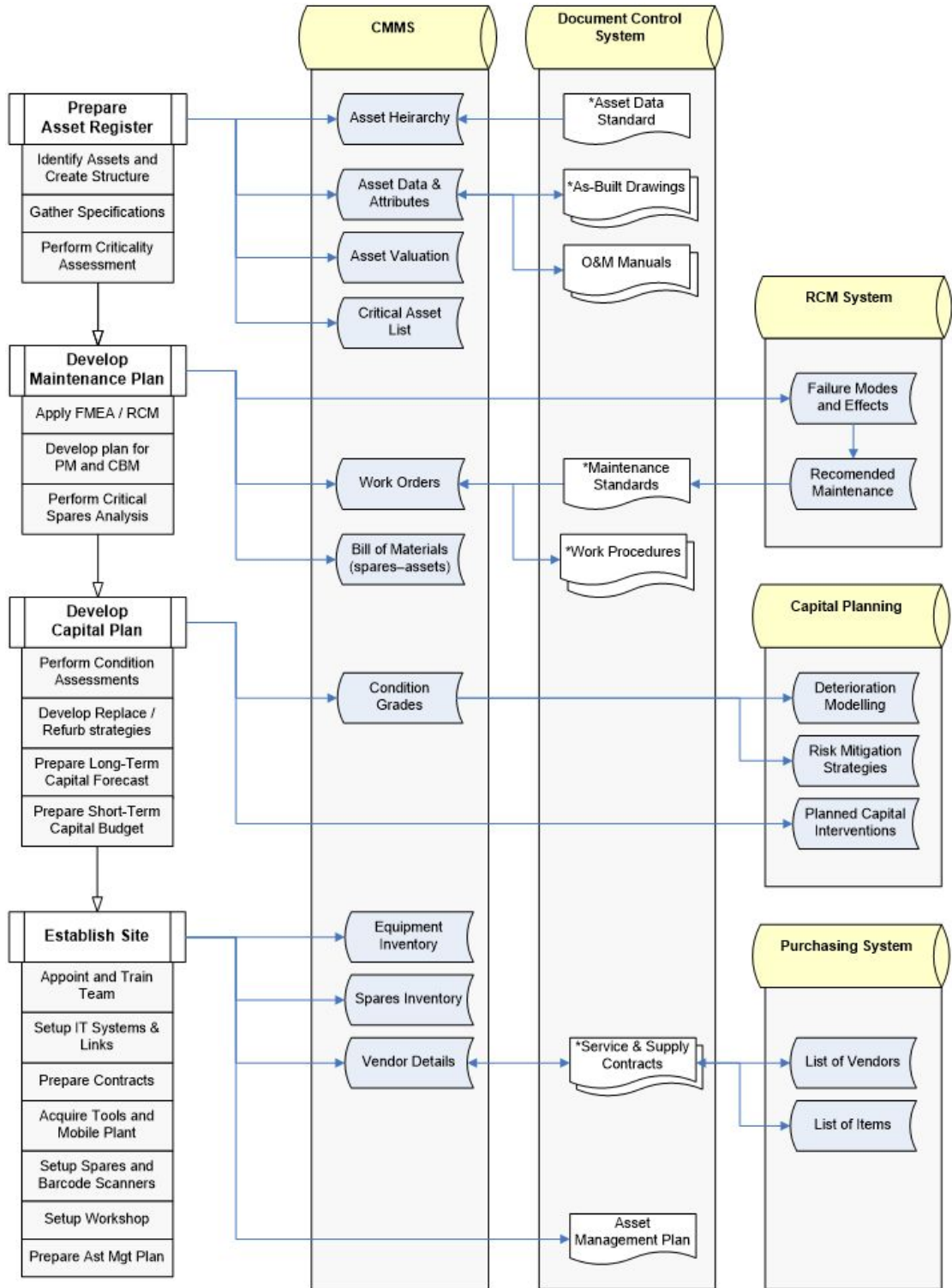
A complete list of Veolia documents pertaining to the Barangaroo South Recycled Water Plant can be generated at any time. Reports can show complete listings of recently updated documents.

## Establishment of Systems

Veolia manage data in multiple information systems to make asset management effective at the Plant. The most important of these systems is the computerised maintenance management system (CMMS). The process of setting up these systems prior to commissioning has been critical to asset management establishment, as shown below.



Figure 2 Establishment of Asset Management Systems



## Documentation and Records

Veolia capture and store, within its CMMS historical information relating to all maintenance, repair and replacement activities conducted on infrastructure assets. Overall, the CMMS records the following:

- Comprehensive asset register reflecting an up-to-date configuration of the plant equipment
- History of all preventative, corrective and breakdown asset maintenance conducted on all assets
- Instrument calibration history
- Meter information and condition monitoring results
- Inventory of spare parts holdings

In addition, the CMMS records the financial details of all purchases of materials and labour carried out in the course of conducting maintenance.

## Compliance and Management Review

If the scenario Veolia are unable to comply with the WICA requirements, Veolia and in turn Podium Asset Services must report any significant change in business that prevents having technical, financial and/or organisational capacity.

As part of the Integrated Business Management System, this Infrastructure Operating Plan is subject to internal audits and review to ensure that activities on site comply with the requirements of the plan. This process is laid down in the Management Review PRO-120 procedure.

Revision of this information takes place for the life of the operating contract to allow for changing internal and external factors such as changing technology, funding and investment priority philosophies, Environmental, OH&S and IR regulations and other factors.

# Performance Management

## Levels of Service Targets

The mandatory performance criteria for the Plant are defined in the Contract Requirements.

These operational performance requirements define the minimum level of service (LOS) in terms of water quality, water volume and general performance that is to be delivered by the Plant Operator. The LOS is defined in the Recycled Water Specification (TEM-10345).

The successful commissioning of the Plant will be a milestone for demonstrating that the initial as-constructed equipment configuration will be able to deliver the required LOS.

LOS is a key driver of asset management, particularly in setting targets for (a) plant and equipment availability; (b) maintenance productivity and effectiveness; and (c) equipment operational efficiency.

## Performance monitoring and review

Veolia monitor performance and reports to the LLRWBS on a monthly basis, performance against the agreed standards in accordance with agreed requirements.

The supervisory control and data acquisition (SCADA) system is the key source of online equipment performance monitoring at the Plant. This SCADA performance data is used in three ways:

- Key flow, process and quality information will be stored in a data historian for trending analysis, monitoring and fault finding.
- Those items that contribute to a failure are captured and can be used for client reporting.
- Performance indicators based on meters that fall below, or rise above, a pre-defined level (such as motor currents and log reduction targets) can trigger corrective maintenance activities in the CMMS.

In addition to process monitoring and optimisation of energy consumption Veolia perform periodic (typically annually) efficiency reviews of major machinery. This review entails analysing the operating efficiency of high-energy-consuming equipment.

The purpose of performing this analysis is two-fold. The first is to promote energy savings—inefficient pumps require more energy to meet the same output. Where a significant drop in efficiency is detected, a maintenance activity is to be raised in the CMMS to investigate and identify the root cause of the problem. The second is to identify early indications of deterioration in condition.

## Changes to Service Levels

If future changes in demand or other requirements (such as recycled water quality) necessitate modifications to the LOS, then it will be necessary for Veolia to carefully consider how the delivery of the new LOS will impact the performance and management of its assets.

# Asset Inventory

## Asset Register

Veolia maintains an up-to-date inventory of infrastructure assets, known as the 'asset register', reflecting the as-built configuration of the plant.

The asset register database is carefully structured with an appropriate resolution to ensure that:

- site staff, managers and engineers are able to find items easily and unambiguously;
- data capture is properly matched to analysis and reporting requirements; and
- maintenance history and cost information are captured at the right level (identified in a risk assessment process).

The scope of the asset register is to identify all infrastructure assets associated with the Plant, including machinery, structures, and electrical installations. The asset register is created, using data from numerous sources including:

- Asset list - Grouped in major system and equipment areas
- As-built equipment lists (mechanical, electrical, valve and instrumentation) - Make, model, serial number, size, capacity, warranty, asset type
- As-built drawings - primarily the process and instrumentation drawings (P&IDs) as a checklist for asset that have been included
- Financial - purchase date and price

Once collected, asset data is collated into an asset register using the agreed structure for the asset hierarchy as defined in Veolia guidelines. Veolia develops a full asset inventory in the CMMS and integrates this information, along with the O&M manuals and spare parts lists as part of the Operations Management Plan.

## Asset demarcation points (boundaries)

The limits of the agreement for the Asset Management and the Operations of BSWRP are defined in the Definition of Demarcation Points (PRO-10438).

# Asset Management System

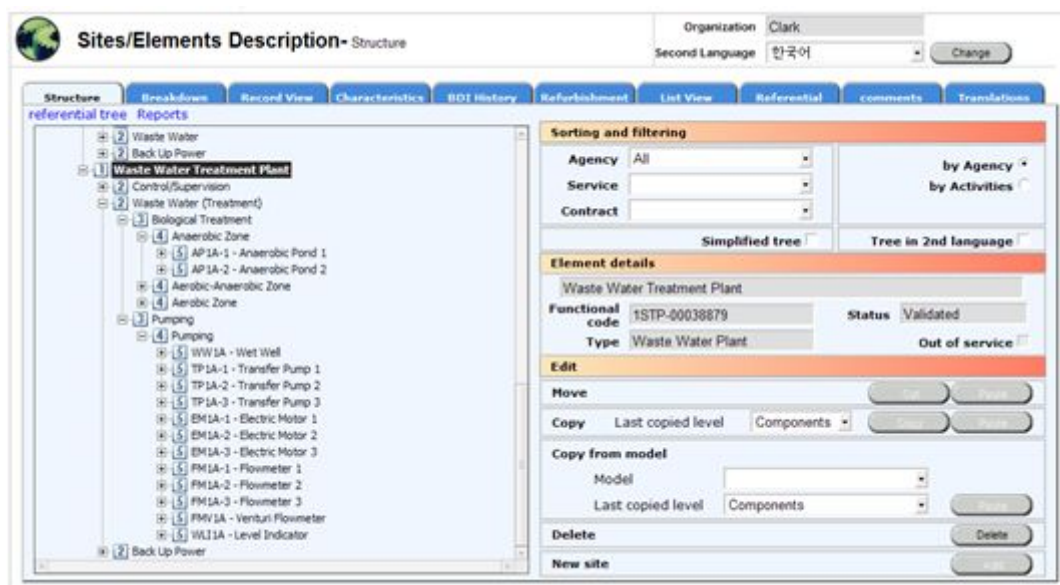
## CMMS

A Computerised Maintenance Management System (CMMS) forms the basis of Veolia’s asset management and maintenance plans and will be used for scheduling, recording and analysing all maintenance activities.

Veolia uses a new generation computerised maintenance management system (CMMS), called VAMS. The system utilises a web interface and is an important tool for the day-to-day management of asset maintenance and repairs, as well as spares inventory.

Based on the leading asset management software platform Infor EAM, VAMS has been specially developed by Veolia to suit the needs of managing water and wastewater treatment infrastructure assets. It includes many features, including: modules for managing asset details and configuration, preventative maintenance planning and scheduling, purchasing, management of spares, workflow and analysis.

**Figure 3 VAMS Computerised Maintenance Management System**



Veolia has developed an asset register and preventative maintenance work order data in the computerised maintenance management system (CMMS).

The CMMS comprise an inventory of all managed assets. It includes criticality and condition grading of all asset components, and other relevant data such as capacity, size and age. Information is archived to allow trending of asset condition over the operating period.

Most importantly, the system is to be used to capture data relating to all inspection and maintenance activities conducted at the Plant.

All required preventative, corrective and breakdown maintenance information is entered into the VAMS database, properly linked to the assets that work is to be carried out on. Upon completion of tasks, maintenance personnel record the task as completed in VAMS with the following information:

- date completed
- personnel undertaking the work
- labour hours for task
- materials used
- asset condition and performance data as observed during maintenance activities, including a brief description of work and important notes

A high quality preventive maintenance program is critical to prevent inadequate equipment performance that can result in environmental or process incidents. Adherence to the preventive maintenance program must be assessed on a frequent basis, using maintenance performance indicators.

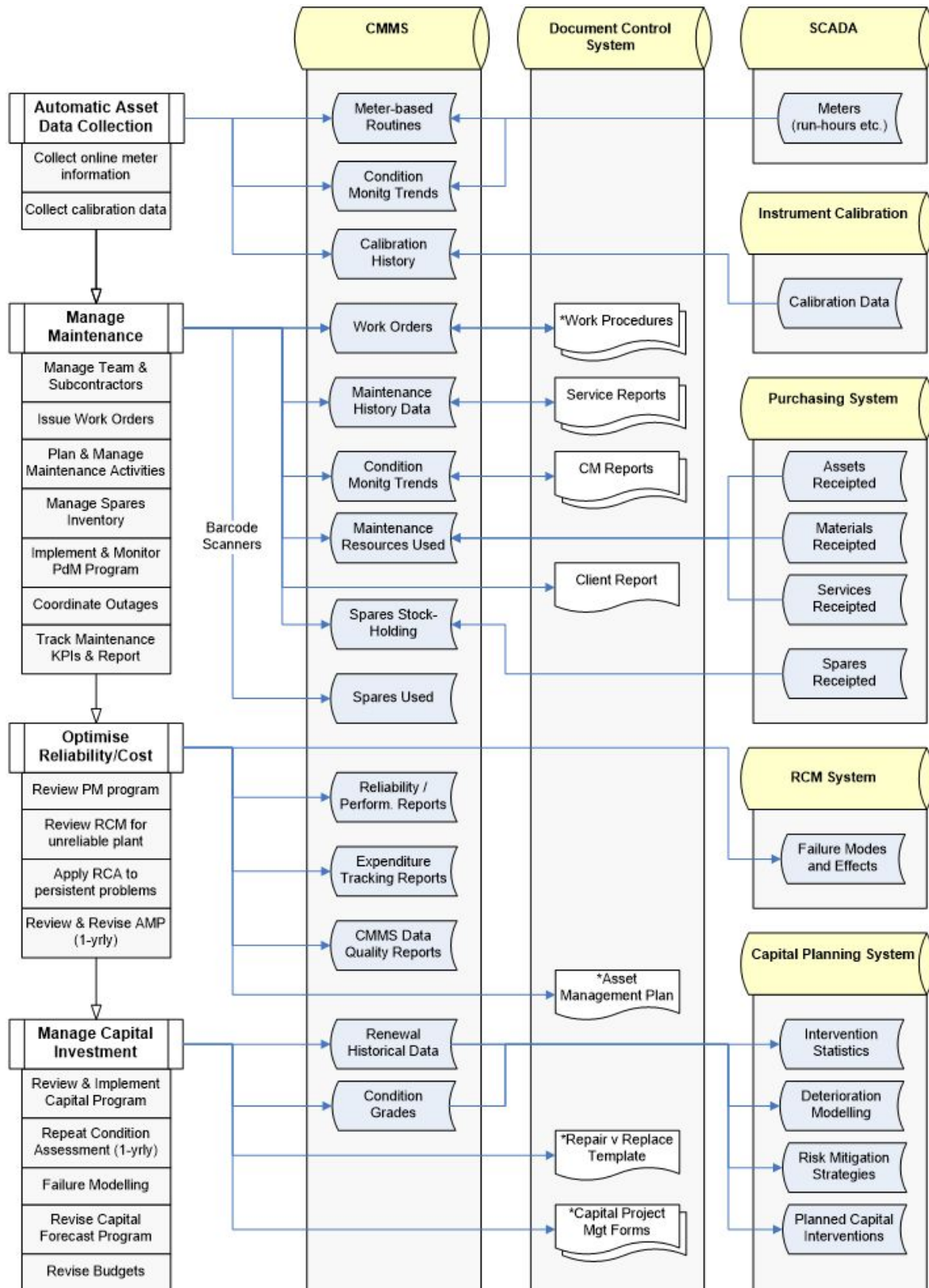
VAMS is used to monitor preventive and corrective maintenance ratios with the objective of minimising breakdowns and failures.

Regular reviews of maintenance performance will lead to progressive refinement and optimisation of the overall maintenance program. Equally important is the issue of breakdown maintenance, which must be undertaken in a timely, reliable manner.

A KPI dashboard can be individually configured to monitor performance against certain contractual measures, compliance with statutory requirements as well as benchmarking and monitoring of internal KPI's.

An overview of how the different systems are used together for ongoing asset management is shown in the figure below.

**Figure 4 Use of Asset Management System**





# Maintenance Planning and Execution

## Work Instructions

Work orders and associated task instructions are planned for and generated prior to their required start date. They are issued by the Operations Supervisor to a trade group who are responsible for:

- Preparation – review of work to be undertaken and ensuring that all materials, spares and tools are available for the timing of the work.
- Safety and Environmental constraints – permits to work, entry permits etc. to be completed as required in high risk areas such as confined spaces.
- Operational constraints – avoid incidents leading to water quality or quantity problems.
- Completion of all maintenance tasks.
- Closing of work instruction in the Computerised Maintenance Management System with all required data completed – hours worked, spares used, external resources etc.

If something unexpected is noted while undertaking the work, the person responsible for the maintenance is required to raise a breakdown maintenance order. Work instructions for each asset are regularly reviewed by all maintenance staff.

For efficiency, Work Orders are not raised for minor housekeeping items, such as keeping plant clean and tidy, and operational running checks that must be done on a daily or weekly basis.

## Maintenance program optimisation

Initially, the preventative maintenance program has been developed on the basis of vendor recommendations and Veolia Maintenance Standards. This program is reviewed regularly and in the event of reliability issues occurring. To this end, Veolia will apply an initial maintenance review and optimisation process, as well as ongoing selective application of analysis in accordance with the principles of reliability centred maintenance (RCM). For more detail refer to Criticality and Condition Assessment procedure (PRO-327).

RCM provides a rigorous analysis framework for ensuring that the most cost-effective maintenance activities are employed to manage an asset's failure modes. There are a number of different versions of RCM, but the key elements of any RCM process are defined in SAE Standard JA1011 Evaluation Criteria for Reliability Centred Maintenance. Consistent with this standard is the 'RCM-2' framework, which Veolia has successfully used in a number of applications, particularly in North America.

When properly applied, RCM typically results in a reduced amount of routine maintenance work, while introducing more inspections and diagnostic activities to identify hidden failures and enable a greater degree of maintenance that is condition-based.

Application of RCM is most effective when a 'review group' approach is employed. To achieve this, a well-trained facilitator will conduct workshops with relevant plant-based technical experts. Software is used to document the steps taken and the resulting actions.

Although it can be time-consuming to perform, the outcome of RCM will usually be not only improved reliability and cost, but also an audit trail for maintenance changes, and a much deeper understanding of the assets by all participants. This last point contributes very positively to developing a proactive asset management culture within the operations team.

At the Plant, Veolia will apply selective use of the comprehensive RCM framework for critical assets where there are major reliability issues or excessive maintenance costs.

## Preventative Maintenance

### General preventative maintenance

- Preventive Maintenance: Based on OEM's Recommendation, Experience, Statutory Requirements.
- Condition Based Maintenance: Vibration analysis, oil analysis, Temperature, Thermography.
- Reliability Centered Maintenance: Information will be gathered to contribute to a dynamic plan. It is perceived that RCM will not be utilized until after the defects liability period.
- The maintenance requirements of the plant are detailed in the CMMS. Work instructions are created in the CMMS for preventative maintenance of all plant assets. Preventative maintenance work instructions will be periodically reviewed and added to or deleted from the CMMS throughout the O&M contract.
- Maintenance of the plant is based on planned activity, with the emphasis on regular inspection, routine servicing and timely replacement or repair of asset components. Excessive maintenance will be avoided, but each asset and asset component should be capable of reaching its economic life.
- All process units are inspected regularly as part of the programmed work for routine maintenance, and mechanical and electrical maintenance.

### Maintenance Planning

The asset maintenance planning process in the CMMS includes:

- Systematic preventive operations – asset maintenance for which dates can be precisely defined in advance; and
- On condition preventive operations – asset maintenance for which dates will be approximately defined depending on the parameters – run times or plant flows.

- For a certain number of assets, the maintenance planning has been predefined from manufacturer's recommendations and operational experience. A selection of these is provided below.

#### Maintenance of Major Pumps and their Motors

- Maintenance on major pumps will be scheduled by applying a condition monitoring assessment based on three main parameters:
- Bearing vibrations - which enable detection of running defects;
- Oil analysis - which enables detection of metallic particles which maybe a result of bearing component deterioration.
- Pump efficiency.
- The condition monitoring assessment of each pump will be conducted annually and will be adapted depending on results. Periodic servicing of the pumps and motors will be scheduled based on the results of the condition monitoring assessment.
- Also, changes in typical operating parameters will be taken into account, such as Pump capacity; Head; Power consumption; and Pump efficiency.
- Any abnormal change in the typical operating parameters from the normal operating values will indicate a problem inherent in the equipment requiring a maintenance action.

#### Smaller/ Minor Pumps

- Routine pump maintenance will be scheduled periodically depending on operating hours and manufacturers' specifications. Maintenance may include checking/ changing of oil and bearings.

#### Submersible Pumps

- Submersible pumps generally require little upkeep and, therefore, will have minimal scheduled maintenance.
- In the event of a failure and in addition to the standby equipment, replacement pumps will be available onsite for quick response to submersible pump failure. The defective pumps will be overhauled by the manufacturer or replaced, dependant on duty this is usually the more cost effective method.

#### Electrical Motors

- Electrical motors will be maintained as per recommendations by OEM. Visual inspections will be done on a regular basis.

#### Mechanical-Reduction Gear

- Screening devices, agitators, valves etc will be inspected annually. Oil will be checked and changed as required by manufacturer's recommendations.
- Analysis of oil will be carried out regularly for strategic equipment. Results will allow validating heavy works, like renewal or servicing in suppliers' factory.

#### Membranes

- Refer to Membrane Management, Maintenance and Replacement Plan.

#### Circuit breakers

- Inspection of circuit breakers will be conducted within the first year with board terminations tightened to recommended torque settings. Circuit breakers will be maintained periodically thereafter.

#### Lubrication of Rotating Machinery and Other Equipment

- A lubrication program will be set up according to the manufacturer's specifications for each piece of equipment.

#### Valve Maintenance

- All valves that, due to operating circumstances, have not been exercised for one year will be subject to a partial or complete operation. If the valve is equipped with limit switches, its operation will be monitored.

#### Electrical Equipment

- Annual inspections of all the low voltage equipment will be conducted. All safety shut off devices will have operating tests conducted. Defective items will be replaced.
- Supplementary servicing actions will be scheduled according to specific recommendations from manufacturers' / inspections.

#### Instrumentation

- Instrumentation will be monitored continuously for measurement consistency through auto-checking systems and the plant monitoring systems.
- Daily data will be inspected by operational staff. Inspections will identify instrumentation to be checked, calibrate or changed.
- Manufacturers recommendations will also be included in inspection / calibration & routine maintenance requirements.
- Water quality instruments will be calibrated as per manufacturer recommendations.

#### Computer Equipment (Programmable Logic Controllers and Computers)

- Computer equipment will be equipped with an auto-checking and auto inspection systems that will detect possible faults.
- The periodic inspection and checking recommended by the manufacturers, both of hardware and software, will be carried out at the recommended frequencies.

#### Pressure Vessels and Equipment

- Recommended inspections will be carried out by a licensed subcontractor in accordance with appropriate regulations and standards on all registered pressure vessels and equipment.

#### Lifting Equipment (Monorail, Crane and Hoist)

- Quarterly inspections will be carried out in accordance with appropriate regulations and standards on all lifting equipment.

#### Air Compressors and Associated Equipment

- Maintenance will be conducted according to the manufacturer's recommendations.

#### VSD's

- All VSD cooling systems will be systematically checked and cleaned to ensure efficient cooling of the heat sinks.

### **Corrective maintenance**

In addition to planned preventative maintenance, there is a need to perform on-condition, or 'corrective', maintenance. This is essentially maintenance conducted on the basis of sub-optimal condition, with the aim of preventing further loss of performance or running to failure.

Corrective maintenance may come about as a result of a discovery from a condition inspection or test, or during the conduct of a preventative maintenance routine. Alternatively it may be triggered by online condition or performance monitoring parameters, which give early indication of deterioration.

### **Records**

Records of all maintenance activities and corresponding costs will be logged in the CMMS against the individual asset, and monitored regularly to highlight trends and pick up on problem areas where maintenance expenditure / resource is becoming excessive.

## **Condition Monitoring**

While many corrective maintenance activities cannot themselves be easily planned, the inspections, diagnostic checks and condition monitoring activities that trigger them can be. In this way, Veolia employ a number of 'predictive' maintenance activities as part of the preventative maintenance plan for the Barangaroo South Recycled Water Plant.

Condition monitoring and inspections are planned to be an integral part of the maintenance strategy for the Plant. These include, where applicable:

- Online monitoring of efficiency, performance and condition indicators.
- Vibration analysis.

- Oil analysis.
- Thermographic imaging.
- Corrosion monitoring.
- Visual inspection and condition grading.

## Breakdown Maintenance

In contrast to the more organised structure of preventative maintenance, emergency and breakdown maintenance is unpredictable and requires operations and maintenance personnel to be reactive.

Since one of the primary objectives of maintenance is to ensure that equipment is able to meet the required performance standard at all times, then all breakdowns must be attended to.

Breakdowns that constitute an 'incident' are to be addressed as outlined in the Incident Management Plan. During a preventative maintenance activity or asset failure maintenance personnel may identify a breakdown maintenance item. When a breakdown is discovered, operator-maintainer personnel identify the item and a decision is made as to how the item is addressed. This decision takes into account a number of different factors, including: the risks and consequences of not rectifying the problem; the costs and complexity of rectifying the problem; the criticality of the item that failed and its impact on operations; and the overall priorities of the client and operations team.

Information about the breakdown maintenance activity is then entered into the CMMS at the earliest opportunity, and this includes the type/mode of failure, as well as details about the suspected cause, the results of follow-up investigations and the impact on operations, personnel and equipment safety and/or the environment. In the process, the item is automatically added to the outstanding work list with an appropriate response time along with any tools or spares required.

If the breakdown maintenance item is an emergency, maintenance staff may repair the selected asset on the spot, ensuring all OH&S procedures are undertaken and input into the CMMS at the completion of the works.

In the case of a broken sewage main or other incident that could interrupt services, Veolia will provide emergency response to carry out repairs and put in place temporary measures to ensure continuity of sewage service. Example temporary pipework connected to a tanker.

In addition to providing historical information, capture of the failure information also provides input into planning activities. Where, for example, equipment is identified with unusually low mean time between failures (MTBF) and/or is incurring unexpectedly high maintenance costs, the whole of life costs of the asset will be reviewed with a view to revising the preventative maintenance and routine checks associated with that item.

# Outage Planning

Veolia plan carefully for maintenance that requires taking plant out of service. At all times, the operations and maintenance team act to ensure a balance between servicing equipment without compromising the availability of plant.

As much as possible outages are scheduled to ensure minimum impact or risk to operations. An understanding of the criticality of the assets is essential to ensure that if maintenance is performed on equipment that is normally in standby, then there is still sufficient system redundancy to mitigate against the key risks.

For this reason, it is expected that outages for major preventative items and repairs as much as practical are planned to coincide with periods of reduced output.

## Spare Parts

### Management of Spare Inventory

The spare parts inventory will be established in the CMMS.

Spare parts are linked to assets and maintenance activities and be identified as used when they are removed from the store. This in turn automatically adjusts stock levels left in the CMMS.

Minimum stock levels will be allocated for each spare part. Once reached, reorder reports can be produced for maintenance personnel. The minimum stock level are to be based on lead time of replacement, frequency of used, price and criticality of the spare part. Each spare is linked to a preferred supplier to assist in purchasing of new stock.

The CMMS is capable of producing a number of reports including the monthly reports. These cover:

- Volume and value of spare parts on shelf
- Volume and value of spare parts used during the month
- Volume and value of spare parts purchased during the month

Stocktake audits are conducted four times per year to determine the accuracy of the system.

### Critical spares identification

The criticality of the spare parts is an indication on how important it is to have a spare part on site. Having the right spare parts at the right time can save the plant from a long-term loss of production. However, having expensive and poorly chosen spare parts on site can be considered as unutilised capital and a waste of space in the plant's storeroom.

The criticality assessment for spares is a decision making tool to help decide, according to the suppliers' recommendations and the team's experience, whether a spare should be purchased or not.

The spare parts criticality is assessed on a figure calculated from asset criticality and lead time. The result of the assessment is the spare criticality and can be used to assist with the decision to hold an item.

For more detail refer to Spare Parts Management procedure (PRO-10411).

# Criticality Assessment

## Priorities

Evaluating asset criticality is one of the most important asset management activities that Veolia will conduct at the Barangaroo South Recycled Water Plant.

As an indicator of the 'consequence' of asset failure, criticality grading enables assets and associated management activities to be prioritised based on risk. At the Barangaroo South Recycled Water Plant, Veolia use criticality for the following:

- Monitoring asset risk levels. Performing asset assessment, based on combining the results of criticality with the latest condition grade (see condition assessment below). Asset risk levels are then used to set priorities for renewals.
- Listing critical spares. Identifying critical spares required to be held on site, based on asset criticality and lead time.
- Prioritising reliability analysis. Setting priorities for analysing assets to improve maintenance costs or reliability, including analysis for reliability centred maintenance (RCM).

## Criticality Grading

Veolia defines an asset as critical if a significant adverse impact is expected in the event of total failure. When determining the criticality grade, the assessor must understand how the asset fits into the larger process, and how its failure will impact overall operational performance, operator and customer safety, and the environment.

The grading is conducted in accordance with Criticality and Condition Assessment procedure (PRO-327). Criticality grading of assets in the Plant has been conducted following commissioning of the Plant. Since criticality is determined by plant configuration, future criticality assessment will be performed three (3)-yearly or more regularly when modifications are undertaken or if high risk events occur.



# Condition Grading and Asset Assessment

## Purpose

The purpose of the condition grading and asset assessments is to provide a structured and consistent approach to review the condition and expected life of the asset, maintenance and renewal requirements, and the management of risk which feeds into the asset renewal plan.

A risk-based approach represents best practice in determining the method of assessment, and the frequency of monitoring activities. Asset condition rating and criticality factor are determined to produce an asset risk level assessment.

## Condition Grading

The condition grade for an asset is an indicator of the likelihood of total asset failure within 12 months of the assessment.

Operational staff is required to perform the assessment in groups of two as a minimum to reduce the level of error from subjectivity. The assessment is based on factoring in multiple criteria, taking into account the dominant failure modes of each asset and the signs of deterioration in condition that best predict where the asset lies in its life-cycle as per Criticality and Condition Assessment procedure (PRO-327).

## Inspection frequency and records

Asset condition inspections are programmed on an annual basis as a minimum and opportunistically carried out with repairs and scheduled works.

## Asset Assessment

The asset assessment is conducted using the condition and criticality gradings in accordance with Criticality and Condition Assessment procedure (PRO-327). There are four levels of grading;

### **Low Asset Risk Level**

For assets with a 'low' score (1-4) the assessment has determined that given the criticality and the condition, they are of minimum current risk to the treatment plant operation.

If it turns out that renewals are planned for a given period, then a low score suggests that the renewal is not required if the main justification is on the basis of condition. Therefore such activities, in the right circumstances can be delayed.

**Moderate Asset Risk Level**

For assets with a 'moderate' score (5-6), the criticality and condition are such that there is not high enough risk to clearly justify a renewal (although it could be considered), but sufficient risk to warrant closer monitoring of the asset's performance and condition. If the condition deteriorates further, then it is necessary to address the 'high' risk level.

**High Asset Risk Level**

For assets with a 'high' score (8-10), the asset risk must be immediately and actively managed. The Operator must investigate the asset more thoroughly then determine whether to plan a renewal for the earliest opportunity or put in place a failure contingency strategy. The latter may involve purchasing a spare part or arrange for a work-around in the event of asset failure.

**Extreme Asset Risk Level**

Only critical assets can have an 'extreme' score (12-15), which is designed to set the priority of action above assets with a 'high' level. In reality having an extreme score means that failure of the asset will result in adverse consequences and the likelihood is possible or expected. Immediate intervention or a failure management plan is required to be in place.

## Asset Assessment Reporting

Gradings for criticality and condition will be recorded in time-series data in the CMMS to enable trending and review of historical indicators.

# Asset Renewal and Durability

## Forecasting challenges

The main asset management system at the Plant will be the CMMS. However, it should be noted that a CMMS is primarily designed as a maintenance transaction system, to schedule and record details of maintenance as it is carried out.

Such systems are not suitable for long term forecasting of capital renewal requirements, since these items will depend heavily on individual failure patterns and deterioration curves that apply for different assets. At any Plant, the number of different failure patterns is as varied as the number of assets themselves, and to deal with this complexity, it is necessary to use a separate planning system.

## Planning and Managing Renewals

To manage the expenditure on asset replacement and refurbishment, and ensure that they are planned in such a way as to minimise operational risks while remaining cost-effective, Veolia will implement its Contract Asset Renewal Management System (CARMS).

CARMS is a decision support system (DSS) that combines a structured process with a simple user interface for developing and managing the asset renewal program.

At its heart is a methodology for combining the results of the asset risk level assessment, as well as a historical renewal summary and a future renewal strategy, consisting each of a renewal 'profile' based on the following parameters:

- renewal intervention frequency;
- number of refurbishments per life-cycle of the asset;
- replacement cost; and
- refurbishment cost.

Veolia use the CARMS system not only to determine whether renewals for low risk-level assets should be delayed and for high risk-levels brought forward, but also to track and report past expenditure, as well as prepare future budgets and long term models.

Further information regarding the CARMS process can be found in UG-ANZ-21-376

## Handover and Residual Life

The CARMS system has been designed in such a way as to accommodate plants in which the assets are handed over at the end of the contract term.

Where assets have a stipulated handover life requirement. Where the system identifies that the normal program could lead to the asset not meeting this requirement, it will automatically program an extra intervention at the end of the contract to ensure this requirement is met. The Operations Manager may then bring this extra intervention to the second last or third last years of the contract to ensure that the workload is manageable.

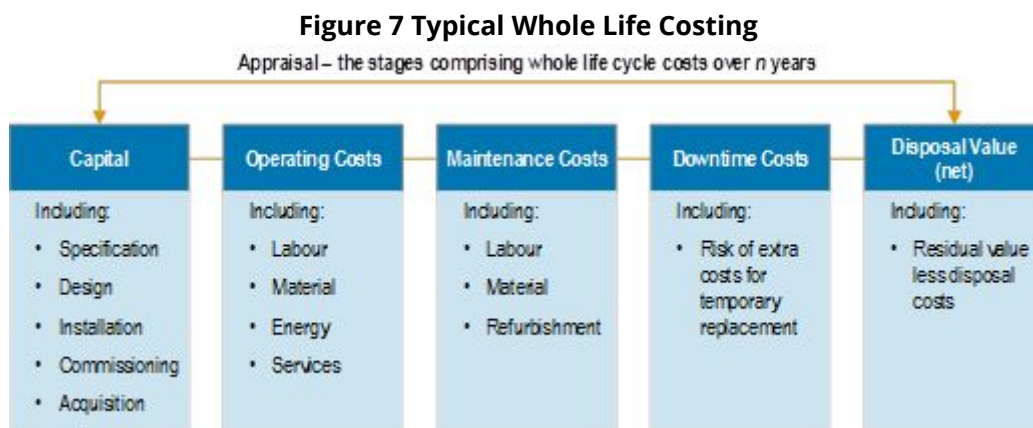
This value may be used in the CARMS to assist the Operations Manager in determining whether planned replacement of the asset needs to be brought forward to avoid unplanned failure.

## Analysis of Whole Life Costs

The CARMS is a planning system based on combining simplified predictive modelling of failure with assessment of the asset risk level. It can be used to generate both short-term budgets and long-term forecasts. However, when the time comes to perform major interventions, more investigation is required.

The methodology to be adopted by the Operations Team in the recommendation to create, renew or dispose of an asset will be based on the 'whole of the life' costs associated with the asset, using discounted cash flows and economic evaluation.

Whole of life costing analysis brings together all the costs of ownership and operation over the whole life of an asset. An example of the type of costs involved with whole life cycle costing is shown in Figure 8.



When recommending to renew assets, Veolia will consult as required all relevant contract and technical documents, in particular as-built drawings, manufacturer-supplied information and the durability plan. This will ensure that material selection, and other factors that influence asset durability, are properly addressed during the Operations phase.

The outcomes of the condition grading and asset assessment are to identify critical and non-critical areas of operation, and review the type of future asset maintenance or replacement that is required.

The analysis of the assessment score is linked to a whole life cycle cost analysis. Each asset is evaluated for risk and whole of life cost for its specific future maintenance needs.

Part of the analysis and review is to determine the actions required to be undertaken. The options available include:

- Current preventative maintenance activities are reviewed and increased or decreased;
- Pre-emptive asset replacement or refurbishment is employed;
- Increased condition monitoring;
- Purchasing of critical spares to mitigate this risk;
- Run to failure (for assets that are not critical)

A continuing emphasis is to be placed on utilising information collected and analysed to review the breakdown maintenance expenditure, preventative maintenance expenditure and asset renewal program.

Properly organised maintenance takes into account economic aspects and operating constraints. Increasingly, non-repairable components are used for basic equipment. The cost of repairing

these components is often very high, and therefore a cost-benefit analysis must be undertaken to justify whether such a repair is economically viable compared with replacement of the component.

As a general rule, replacement of small items of equipment is preferred with the faulty item being removed and repaired in specialised workshops. Certain repairs are more economically performed by specialists who have advanced training and specialised tools at their disposal and are able to complete the work faster and cheaper. This brings about the need to subcontract selected maintenance work. This practice takes account of experience acquired in other applications and increases operational security.

## Asset Disposal

In instances where a decision is made to dispose of an asset due to replacement or obsolescence, then the disposal activity will be conducted in accordance with below Asset Creation and Renewal procedure .

In its general form the analysis is a cost comparison made between creating a new asset and renewing the asset taking into consideration the details outlined in Table 1.

**Table 4: Asset Creation & Renewal Comparison**

Asset Creation	Asset Renewal
Capital cost of the new asset	Cost to renew or overhaul
Installation costs	Maintenance, operations and refurbishment costs over the assets expected life using discounted cash flow techniques
Maintenance, operations and refurbishment costs over the assets expected life using discounted cash flow techniques	Salvage costs

The costs for each alternative are converted to a net present value and the decision based on the most economical solution.

Properly organised maintenance takes into account economic aspects and operating constraints. Increasingly, non-repairable components are used for basic equipment. The cost of repairing these components is often very high, and therefore a cost benefit analysis must be undertaken to justify whether such a repair is economically viable compared with replacement of the component.

As a general rule replacement of small items of equipment is preferred with the faulty item being removed and repaired in specialised workshops. Certain repairs are more economically performed by specialists who have advanced training and specialised tools at their disposal and are able to complete the work faster and cheaper. This brings about the need to subcontract selected maintenance work. This practice takes account of experience acquired in other applications and increases operational security.

For the infrastructure assets within the Plant, the owner will be LLRWBS. Disposal will necessitate that the Operations Manager takes responsibility, obtains the appropriate approvals and conducts, as required, a risk assessment to ensure that the means of disposal is not only cost-effective, but also safe and environmentally friendly.

If the asset includes any data stored within it, then it will be the Operations Manager's responsibility to ensure that the information is properly erased prior to, or in conjunction with the disposal.

# Asset Review and Planning

## General

Following a review of preventative maintenance tasks or an asset assessment, maintenance may be increased to reduce risk and prolong asset lives and ultimately reduce expenditure. The decrease in maintenance on a specific asset is only undertaken if there is no increase in risk to plant operation.

Maintenance may also be decreased or ceased and the asset may be run to failure if it does not affect plant operation.

Any decisions made on changes to maintenance requirements on a specific asset initiate a review of maintenance requirements of assets of similar type across the plant. All assets of similar types will be reevaluated with specific emphasis on the effect of the changes on risk to operations.

## Asset Review and Reporting Program

A tapered review process is utilised to minimise plant resources and to implement a process that accurately reflects the rate of change in condition of the asset and associated risk of failure.

Where practical ongoing condition based monitoring and review will be undertaken.

A tapered review process will be utilised to minimise plant resources and to implement a process that accurately reflects the rate of change in the following measurable items:

- Operations Performance
- Asset Reliability
- Backlog Monitoring
- Outstanding Works
- Data Quality

Detailed ad-hoc reports can be generated from the VAMS CMMS. These reports include:

- Asset Registry – Listing of all asset , numbers and description, location no and description
- Hours Worked Summary - Hours worked summary by Employee, Trade and Class.
- Maintenance Dashboard - Work orders completed by class, hours worked completed by class and work order costs by class.
- Work Order Report - Displays Work Orders
- Opened Work Order Summary Report - Displays a summary of all open Work Orders, their scheduled start date and their estimated hours
- PM Scheduling Tools - List and visual graph of scheduled Work Orders over a specified date range.
- Element Maintenance Summary - Cost report by user specified asset register elements including work order numbers, costs and hours.
- Pareto Distribution Diagram - Pareto Analysis at Unit and Assembly level of the asset register hierarchy.
- Associated PM Schedule per Equipment - Asset listing with associated PM tasks.
- Criticality and Condition Breakdown - Summary of the number of assets with condition and criticality completed.
- Spare parts inventory and cost breakdown - Summary of spare parts and their costs and quantities.
- Work Order Hours & cost breakdown - Summary of all completed work orders and their associated costs.
- WO On-Time Delivery By Employee - Summary of work order on-time delivery by employee, department or work order type.
- WO On-Time Delivery by Trade - Summary of work order on-time delivery by trade, department or work order type.
- Print Physical Inventory List - Print stocktake summary
- Physical Inventory Discrepancy - Print inventory discrepancy
- Over time, the review period for individual assets, or groups of assets, is optimised based on asset history data, and appropriate techniques for decay and risk analysis.

# Capital Investment Strategy

## Asset Renewal

LLRWBS will develop schedules for asset renewal. In the process it has identified the estimated costs associated with all asset overhaul and replacement activities through the life of the Contract.

## Initial Planning

Planning for future capital investment needs and options aim to focus on the objectives and investment categories shown in Table 9.

**Table 5 Objectives and Investment Categories**

Objective	Capital Investment Category
Estimate the investment needed over time to maintain the serviceability of existing assets	Renewal: Capital - Maintenance investment for assets
Meet higher water quality and environmental standards	Water Quality: Capital - Water quality investment Environment: Capital - Environmental investment
Meet higher service levels and performance standards	Improvements: Capital - Service levels investment
Meet growth in demand	Growth and New Demand: Capital - growth and demand investment

Adopting an integrated approach to asset management planning establishes the appropriate links between investment needs and outputs to:

- Identify the current level of service, performance, condition and serviceability of the assets
- Establish appropriate targets, standards and forecasts of service levels
- Establish planned and justified investments by priorities
- Balance investment, operational and maintenance needs with outputs



The outcome of the iteration process is to identify the preferred investment needs and options.

## Project Appraisal and Investment Studies

When needs have been identified, the resulting capital investment needs are evaluated, justified and prioritised as part of the project appraisal process.

Investment studies should be undertaken to deal with strategic options, while project appraisals focus on individual schemes and projects. Investment studies will cover:

- Investment strategy
- Investment justification
- Unit costs
- Investment compilation by asset type/investment category
- Assessment of outputs
- Assessment of total investment

Project study and appraisal reports will cover:

- Justification of need
- Statement of facts (including current situation and forecasts)
- Design criteria (including planning horizon)
- Options consideration
- Investment costs
- Operating costs/ operating method
- Whole of life cycle cost/net present value options - summary of all options and costs
- Investment type, allocation and priority ranking
- Investment program and profiling

## Capital Program – Compilation and Priority Ranking

The capital investment proposals and options derived from the asset management planning studies have to be expressed in varied formats to assist the priority ranking of projects. Using an integrated format to collate the Asset Renewal Plan allows sensitivity analyses to be undertaken to determine the effects of varying and re-profiling investment needs with outputs.

The effect of sensitivity tests on the various investment categories could include the following.

- Maintenance of assets: changes in asset maintenance and replacement policies could be assessed and linked to service levels, standards and asset lives. Performance criteria could be reviewed
- Growth development: forecast rates of growth and new development could be reassessed

Compilation of projects into a Capital Investment Program would begin at the project appraisal stage, where project need, justification and benefits (both technical and financial) would all be subject to scrutiny. Within each investment category (i.e., Renewal, Water Quality, Environment, Improvement, Growth and New Demand, and Other), projects would be graded by priority. This would involve various techniques including whole of life cycle analysis and timed targets.

Investment category is prioritised by analysing investment levels by category and asset type to a capital investment expenditure ceiling. Scenarios examined would include least cost options, economic appraisal, maintenance options and establishing hurdle grades to supplement the serviceability and actual performance criteria.

The final preferred Capital Investment Program derived from the investment review and iteration process leads into the Asset Renewal Plan.

The systematic structured approach to asset management planning integrates key aspects into an overall strategy to operate the system effectively and economically.

By introducing an integrated process to justify the investment needs, economic optimisation comes from ensuring that resources are effectively directed at assets to achieve their maintenance, operation and service outputs.

The Asset Renewal Plan is an integral part of the asset management system and ensures that the performance of assets provide the service level objectives in the longer term.

By establishing the condition and performance of existing assets, a benchmark can be established to justify asset investment needs in conjunction with funding threshold and priorities.

Asset management planning is an important part of Veolia's management strategy to support the efficient and effective operation and maintenance of the Plant.

## Membrane Management

Heading Effective management and maintenance of the membrane system will ensure that the water quality objectives are met and the most cost effective operation of system from an energy and chemical consumption and membrane replacement perspective is achieved.

A clearly defined membrane maintenance program involves a number of processes. These include performance monitoring and process testing.

Another key component of monitoring fouling rates is the ability to autopsy the membrane modules. In addition to using the resources of the membrane supplier, the membrane modules can be sent to third party services provider capable of conducting membrane autopsies.

Autopsy diagnostics allow identification of the cause of potential membrane degradation and fouling problems as well as optimisation of the CIP solutions depending on the fouling characteristics.

Three types of membranes are used

- Ultrafiltration (submerged) - UF Membranes
- Reverse Osmosis - RO Membranes
- Nano Filtration - NF membranes

## Membrane Management

### Optimum management

A key aspect of optimising the asset lives is the effective management of the Plant's membrane inventory.

### Proven records

In Australia, Veolia manages successfully ultrafiltration (UF) and reverse osmosis (RO) membranes in several plants including:

- For UF membranes - Bendigo plant with average (output capacity 126 ML/day)
- For UF and RO Membranes - Fairfield Recycled Water plant (output capacity 20ML/day)
- For RO membranes - Sydney Desalination Plant (output capacity 250 ML/day).

### Membrane Maintenance and Replacement Procedure

For detailed information regarding membrane management refer to Membrane Maintenance and Replacement procedure (PRO-10334).