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Surf Coast Shire

Report for Stormwater Master Plan - Torquay North

Master Plan Maintenance Guidelines

December 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 General

Surf Coast Shire Council engaged GHD to undertake the Torquay North Stormwater Master Plan in September 2010. This report provides general guidance on maintenance to accompany the Stormwater Master Plan covering:

- Wetlands;
- Retarding Basins; and
- Gross Pollutant Traps.

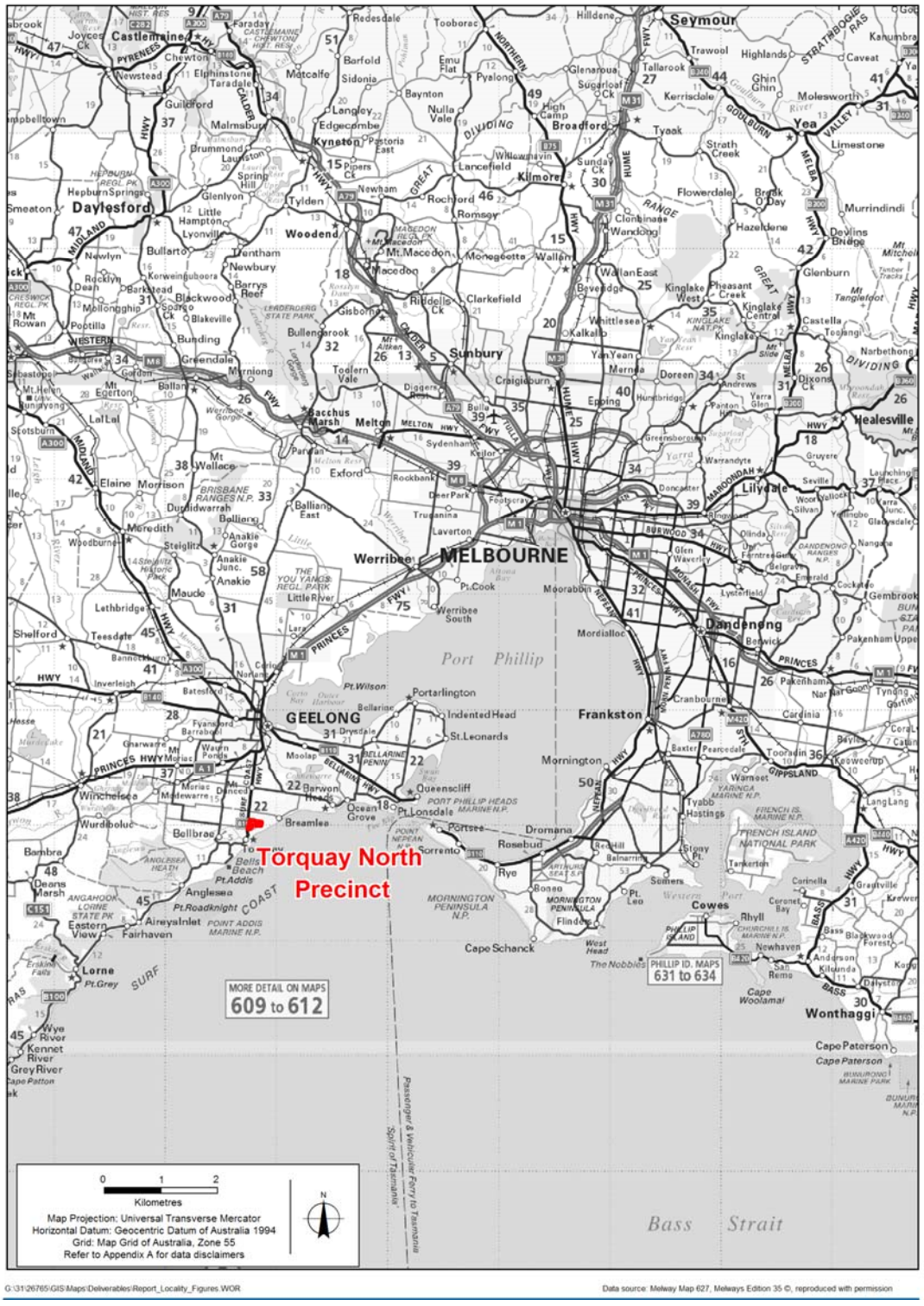
In addition to this report, the following documents have also been prepared as part of the Torquay North Stormwater Master Plan:

- Stormwater Master Plan (GHD, 2010a); and
- Stormwater Master Plan Technical Report (GHD, 2010b).

The Torquay North precinct is located adjacent to the Surf Coast Highway, approximately 20 km south of Geelong as is shown by the location plan in Figure 1-1.

This stormwater management plan has been based on a number of assumptions relating to the proposed development within the precinct (see Technical Report). The application of this stormwater management plan will therefore need to be reviewed when the details of the development have been finalised.

Figure 1-1 Torquay North Location Plan



1.2 Scope

The scope for this stormwater master plan, as defined by Surf Coast Shire Council, was as follows:

- Item 1 – Background review of precinct and desktop analysis of existing catchments;
- Item 2 – Information gathering and stakeholder consultation;
- Item 3 – Site assessment and catchment analysis;
- Item 4 – Analysis and master plan design; and
- Item 5 – Reporting.

2. Stormwater Management Plan

2.1 Overview

The stormwater management plan consists primarily of the following physical components:

- Retarding Basins;
- Wetlands systems (including GPTs and sediment basins at their inlets);
- Gross Pollutant Traps (GPTs);
- Open Channels;
- Culverts; and
- Third Pipe.

This section provides a summary of the details for each of the above components. The background, assessment and details for this Stormwater Management Plan are presented in a separate technical report (GHD, 2010).

2.2 Retarding Basins

Four retarding basins are proposed. Two retarding basins are located within the South Beach Road development (east and west), one is located within the Southern development and one is located within the Surf Coast Highway development. No retarding basins are proposed within the Horseshoe Bend Road development.

The objectives of the retarding basins would be to achieve no increase in the peak 100-year ARI flood flows from existing conditions at:

- Horseshoe Bend Road;
- The outlet from the northern catchment to the Sands Development; and
- At the outlet from the south east catchment to Deep Creek.

The South Beach Road development east and Southern development west retarding basins would be offline. The other two retarding basins would be online. Flows would enter the retarding basins from the local stormwater drainage network and overland flows from either open channels or roads. The local drainage within each sub-catchment would therefore need to be designed to pass through the retarding basins and roads would need to be graded to allow overlands flows to also be directed towards the retarding basins (see arrows provided on SMP for guidance).

Further details on the retarding basins are provided in Section 4.5 of the technical report.

2.3 Wetland Systems

Seven wetland systems are proposed as part of this SMP. Two are located within the Horseshoe Bend Road development, three within the South Beach Road development, one in the Southern development and one within the Surf Coast Highway development. All four proposed retarding basins would have wetlands within their footprints.

The wetlands have been designed to achieve the Best Practice Environmental Management Guideline objectives in the northern and Deep Creek catchments. Wetlands were not used in the separate catchment covering the east part of the Surf Coast Highway development, due to its size. Instead, GPTs were used (see Section 2.4) and the wetland within the west part of the Surf Coast Highway development was designed to partly compensate.

Each wetland systems would include a GPT and sediment basin at their inlet.

Further details on the wetlands are provided in Section 6 of the technical report.

2.4 Gross Pollutant Traps

Two Gross Pollutant Traps (GPTs) are proposed within the catchment covering the east part of the Surf Coast Shire Highway development. These are located at existing drainage connections into the local drainage network.

For the purpose of the water quality modelling for this SMP the following CDS unit was adopted:

- CDS P1015 unit for the two outlets to the existing Quay Development.

Further details on the GPTs are provided in Section 6 of the technical report.

2.5 Open Channels

An open channel has been shown along what are considered to be the main drainage paths through the northern and Deep Creek catchments.

In the Northern catchment, the open channel flows from the boundary of the Civic precinct, through the South Beach Road development west retarding basin (online), in between Beach Road development east retarding basin (offline) and Southern development retarding basin (offline), before flowing beneath Horseshoe Bend Road and through the Horseshoe Bend Road development towards the existing Sands development.

In the Deep Creek catchment, the open channel flows from the Civic Precinct south through the Surf Coast Highway development towards the catchment outlet to Deep Creek. It provides the formal drainage paths for the existing low points within the Civic Precinct and the Surf Coast Highway development.

The alignment of the open channels is indicative and within reason can be adjusted to fit within the eventual layout design of the future developments.

The open channels should be designed to convey the 100-year ARI flows.

2.6 Culverts

Culverts have been used within the SMP to pass flows from the open channels beneath known proposed roads. The number of culverts required therefore depends on the eventual layout design of the future developments.

The culverts should be designed to pass the 100-year ARI peak design flows.

2.7 Third Pipe

Opportunities to harvest stormwater and/or roofwater to meet household non-potable water demand are today a common component of stormwater master plans. It is understood that for the Torquay North precinct, the Surf Coast Shire Council have made a commitment to connect the precinct to a third pipe system, which will supply non-potable water from the Armstrong Creek catchment to each lot within the precinct. Based on the assumption that the supply of water from this third pipe system will be enough to meet future non-potable water demand within the precinct, the need for harvesting initiatives is negated. However, developers and/or individual lot owners could still choose to pursue separate harvesting initiatives if they desired.

Further discussion on stormwater harvesting is provided in Section 5 of the technical report.

3. Maintenance

3.1 Wetlands

A general maintenance schedule for the proposed wetlands is presented in Table 1. It covers the general maintenance requirements for each of the main components that would form a typical wetland system. These have been identified as follows:

- Course Sediment Trap;
- Diversion Structure;
- Wetland;
- Wetland Outlet;
- Wetland Overflow Channel;
- Landscape Areas;
- Internal Paths; and
- Landscape Furniture.

As part of this stormwater management plan, the wetlands have only been developed to a level appropriate for a plan. The schedule is therefore based on a typical wetland system and should be reviewed following the detailed design stage when this is undertaken for each wetland.

The frequency of maintenance presented is a guideline and additional maintenance may be required following individual flood events.

Table 1 Maintenance Schedule

Description	Assets	Maintenance Works	Description	Frequency of Maintenance Works
Coarse Sediment Trap	Sedimentation Pond	Removal of litter	Litter removal as required.	◗ 3-monthly ◗ Maintain as required
		Removal of sediment	Sediment removal required once accumulated to a maximum depth (to be confirmed during functional design).	Frequency of cleanout is typically low (i.e. 5-10 years) however this should be checked during each maintenance inspection as expected catchment conditions may vary.
		Weed control and nuisance management	Removal of vegetation and debris that reduce storage volume, and of nuisance species including algae and exotic fish.	◗ 3-monthly ◗ Maintain as required
	Overflow weir	Removal of litter	Litter removal as required	◗ 3-monthly ◗ Maintain as required

Description	Assets	Maintenance Works	Description	Frequency of Maintenance Works
	Low-flow bypass pipe	Clear	Clear blockages. Check that flow is conveyed below the weir.	◗ 3-monthly ◗ Maintain as required
Diversion Structure	Diversion Pit	Clear	Remove debris and litter from grate, remove sediment within the base and clear any obvious pipe blockages.	◗ 3-monthly ◗ Maintain as required
	Junction Pit	Remove sediment and debris	Remove sediment and clear any obvious pipe blockages.	◗ 3-monthly ◗ Maintain as required
	Outfall into Wetland	Stability check	Check for erosion, including pipe undercutting and rock beaching stability.	◗ 3-monthly ◗ Maintain as required
		Clear	Clear blockages, check flap gate operating.	◗ 3-monthly ◗ Maintain as required
Wetland	Wetland macrophyte zone	Removal of litter and debris	Remove litter and dead plant material and other debris as required	◗ 3-monthly ◗ Maintain as required
		Weed removal.	Removal of non-preferred vegetation, maintain plant diversity. Priority weed species attached (Annexure C)	◗ 3-monthly ◗ Maintain as required
		Macrophyte harvesting	Reduce macrophyte density where excessive and older growth occurs.	◗ 3-monthly ◗ Maintain as required
		Bank stability check and Erosion control	Check for erosion damage within batters, berms, and near inlet and outlet structures. Maintain and stabilise with increased scour protection, bank reinforcement and re-vegetation.	◗ 3-monthly ◗ Maintain as required
		Vegetation health	Check plant condition is good, where not seek advice, treat affected plants and revegetate where required.	◗ 3-monthly ◗ Maintain as required
		Revegetation	Infill areas where there is over 3 m^2 bare from plant growth. Use original planting palate unless a species is not successful.	◗ 3-monthly ◗ Maintain as required
Wetland Outlet	Wetland Outflow	Clear	Clear blockages and debris from PVC inlet, rock headwall and pipe.	◗ Inspect PVC inlet 6 monthly. ◗ Inspect integrity of pipe annually.

Description	Assets	Maintenance Works	Description	Frequency of Maintenance Works
	Drawdown Pit	Remove sediment and debris	Remove sediment and clear any obvious pipe blockages.	◗ Inspect PVC inlet 6 monthly. ◗ Inspect integrity of structure annually.
	Wetland Control Pit	Remove sediment and debris	Remove sediment in pit and clear any orifice blockages.	◗ Inspect PVC inlet 6 monthly. ◗ Inspect integrity of structure annually.
		Orifice plate function	Ensure that the seal between weir and the orifice plate maintained. Check the functioning of the weir and outlet plate mechanisms.	◗ Inspect PVC inlet 6 monthly. ◗ Inspect integrity of structure annually
Wetland Overflow Channel	Bluestone paving	Clear	Removal of litter and debris to provide clear flow path.	◗ 3-monthly ◗ Maintain as required
Landscaped areas	All terrestrial planted areas	Replacement of damaged and deceased plants	Infill areas where there is evidence of over 3 m^2 bare from plant growth. Use original planting palate unless a species is not successful.	Inspect minimum 6-monthly, plant during spring or autumn.
		Removal of litter	Litter to be removed during regular inspection	As required
		Broad leaf weed spray		As a minimum 3-monthly
Internal paths	Bitumen Paths	Repair of damaged / cracked sections.	Replace areas of bitumen paths where there is evidence of damaged, cracked or broken sections.	As required.
	Granitic Sand Paths	Replacement of surface material	Following annual inspection, surface material of sand paths may need to be replaced if there is evidence of scour, or wash out.	Inspect annually
		Broad leaf weed spray	Maintain internal pathways using broad leaf weed spray.	As required.
	Timber walkways	Repair of timber surface, galvanised frame and footings	Annual inspection to determine maintenance required on all timber surfaces including their galvanised frame and footings	Inspect annually.
		Repair hand-rails and ensure that they are free from damage	Annual inspection to determine maintenance required on all timber hand rails.	Inspect annually.

Description	Assets	Maintenance Works	Description	Frequency of Maintenance Works
Landscape Furniture	Signage	Repair of vandalised components	Clean or replace signage as required.	As required
	Entry Signage	Repair of vandalised components	Clean or replace entry signage as required.	As required

3.2 Gross Pollutant Traps

Rocla CDS units were adopted for the Gross Pollutant Traps (GPT) used in the water quality modelling undertaken as part of the technical assessment for this stormwater master plan. The CDS unit maintenance guidelines, provided by Rocla, have been included in Appendix B as a typical guide.

Alternative GPTs may be adopted by developers. However due to the variable levels of performance between different GPTs, the performance of an alternative GPT and the achievement of the water quality objectives by the catchment will need to be re-assessed.

Any GPT used by a developer should be accompanied by maintenance instructions, similar to those presented in Appendix B for the Rocla CDS unit, and these should be supplied to Council by the developer.

3.3 Retarding Basins

When retarding basins store water they act as dams, potentially storing significant volumes of stormwater. They therefore pose a risk to any development that may be located downstream. As a result, retarding basins must be designed in accordance with ANCOLD (Australian National Committee on Large Dams) guidelines (ANCOLD, 2000) and Australian Standards and by suitably qualified persons (i.e. dam engineers or urban drainage engineers with suitable experience).

Council will normally be responsible for the safe operation and maintenance of the retarding basins within the Torquay North Precinct. To determine maintenance requirements, each retarding basin should undergo a site specific risk assessment in accordance with the ANCOLD Guidelines (ANCOLD, 2003). The assessment will provide a hazard category for the basin, which is based on the severity of damage and loss resulting from retarding basin failure and population at risk. The hazard categories are shown in Appendix C1.

The hazard category determined in the risk assessment will determine the type and frequency of inspection as shown in Appendix C2. A description of the inspection types is presented in Appendix C3.

Further ANCOLD guidance on maintenance is provided in Appendix C4.

4. References

ANCOLD (2000) ‘Guidelines on assessment of the consequences of dam failure’ Australia.

ANCOLD (2003) ‘Guidelines on dam safety management’ Australia.

GHD (2010a), Report for Stormwater Master Plan – Torquay North, Technical Report, for Surf Coast Shire, November 2010.

GHD (2010b), Stormwater Master Plan for Torquay North, for Surf Coast Shire, November 2010.

Appendix A

Wetland Maintenance Checklist

Torquay North Wetlands – Typical Maintenance Checklist*

Wetland Maintenance Checklist - Inspection Frequency: 3 Months	
Location:	
Date of visit:	
Site visit by:	
Weather condition:	

Inspection Items	Action Required?		Details of Actions Required
	Yes	No	
Coarse Sediment Trap			
Litter accumulation at Outfall?			
Weeds/exotic vegetation within inlet zone/sedimentation pond?			
Litter or debris at low flow pipe through rock weir?			
Litter or debris on overflow weir?			
Sediment accumulation within inlet zone (record depth, remove if > 2/3 full)?			
Sediment accumulation at inflow points?			
Wetland Diversion Structure			
Litter or debris within inlet structure/diversion pit to wetland?			
Sediment accumulation within junction pit?			
Erosion present at outfall to wetland?			
Blockages of outfall to wetland?			
Wetland – Macrophyte Zone			
Litter or debris within Macrophyte zone?			
Presence of weeds/non-preferred vegetation in Macrophyte zone?			
Presence of erosion on batters, berms, inlet structures, outlet structures?			
Terrestrial vegetation condition satisfactory (density, weeds, disease, pest infection, stunted growth or dead plants?			
Aquatic vegetation condition satisfactory (density, weeds, disease, pest infection, stunted growth or dead plants?			
Replanting required?			

Wetland – Outflow and Control Structures			
Overflow structures integrity satisfactory?			
Wetland outlet structure free of debris?			
Drawdown pit free of debris/sediment?			
Maintenance drain operational?			
Orifice plate functioning correctly?			
Wetland – Overflow Channel			
Bluestone paving free of debris / litter?			
Landscaped Areas			
Litter or debris in terrestrial planted areas?			
Evidence of damage or vandalism?			
Internal Paths			
Evidence of cracking or broken sections?			
Evidence of erosion or loss of sand or gravel?			
Evidence of damage or vandalism?			
Presence of weeds?			
General			
Evidence of damage or vandalism?			
Evidence of dumping building waste, oils, etc.?			
Evidence of algal scums?			
Evidence of odours?			

* Adapted from Constructed Wetlands Guidelines

Torquay North Wetlands - Maintenance Checklist*
Further comments on inspection
Actions required
1.
2.
3.
4.
5.
6.

* Adapted from Constructed Wetlands Guidelines

Appendix B

GPT Maintenance Guidelines

Rocla – CDS units

Source:
www.rocla.com.au/Drawings/CDS_Unit_Tech_Summary_8p_brochure.pdf

CDS® UNITS MAINTENANCE

Whilst the frequency of cleaning will be dependant upon the pollutant loads of each catchment, there are three alternative methods of removing the collected waste from CDS® Units.

The following methods of cleaning can be used individually on any CDS® Unit, even well after installation.

This is a very significant feature that allows asset owners to choose the cheapest option available for ongoing maintenance given the required cleaning frequency and the respective cleaning services and resources available.

The three maintenance options available are described following:

1. MECHANICAL GRAB CLEANING

Cleaning by grab can be carried out without dewatering the unit and is a single person operation in most locations.

This results in a cleaning technique which is generally faster, cheaper and safer. It also allows a visible inspection of the pollution that was captured, as opposed to suction that doesn't. No physical entry is required.

2. BASKET REMOVAL CLEANING

If a waste removal basket is fitted, it can be lifted at any time, without the need for dewatering. Also it provides a safe and cost effective method of cleaning. The cost benefit of this option depends on the CDS® Unit design and on waste disposal requirements. No physical entry is required.

3. SUCTION CLEANING

Due to the dewatering time, costs and disposal of the water, suction cleaning is generally the most expensive cleaning option. However by taking advantage of the large sump volumes available in CDS® Units, it may still be a very cost effective maintenance option.

Suction cleaning is used for most proprietary GPT's. Even if a more cost effective method is used at shorter intervals, suction cleaning is recommended for CDS® Units at one to two year intervals so that a thorough inspection of the screen and lower chambers can be carried out. Physical entry may or may not be required.

Normally a CDS® Unit would be sized with an appropriate sump volume to allow cleaning 3 or 4 times per year. These maintenance cleans would be carried out either by using a basket or a grab, with a single comprehensive clean per year completed by suction.

The best option for any particular unit will depend on tidal or backwater impact, pollution load and cleaning frequency as well as access and disposal costs for pump-down water.

CDS® Units may sometimes be required to use penstocks to isolate the unit during maintenance operations. This would be essential where a unit is affected by backwater and/or high levels of tidal inundation.

The main benefit of removable baskets is their speed and ease of cleaning, particularly in tidal zones. But the storage basket must be smaller than the screen to allow its removal. As such, the volume in a basket will be less than that of a large sump CDS® Unit volume.

Consequently, whilst it may be cheaper, cleaning removable baskets might also be required 4 or 5 times more often.

For larger CDS® Units, the grab truck cleaning option offers the removal of 80 – 90% of the pollution stored in a sump and is subjected to similar constraints as the removable basket option.

When considering GPT maintenance costs and procedures, the three maintenance options of CDS® Units offer greater operational flexibility and low life-cycle cost considerations.

More general GPT maintenance decision methodology information is available in the CDS® Unit Operation and Maintenance manuals or upon request.

Appendix C

ANCOLD Guidelines

Appendix C1: Hazard Categories (Source: Guidelines on assessment of the consequences of dam failure, ANCOLD, May 2000, Table 3, page 13)

Population at Risk	Severity of Damage and Loss			
	Negligible	**Minor**	**Medium**	**Major**
0	**Very Low**	**Very Low**	**Low**	**Significant**
1 to 10	**Low** Notes 1 and 4	**Low** Notes 4 and 5	**Significant** Note 5	**High C** Note 6
11 to 100	Note 1	**Significant** Notes 2 and 5	**High C** Note 6	**High B** Note 6
101 to 1000		Note 2	**High A** Note 6	**High A** Notes 6
>1000			Note 3	**Extreme** Note 6

Note 1: With a PAR of 5 or more people, it is unlikely that the severity of damage and loss will be "Negligible".

Note 2: "Minor" damage and loss would be unlikely when the PAR exceeds 10.

Note 3 "Medium" damage and loss would be unlikely when the PAR exceeds 1000.

Note 4: Change to *Significant* where the potential for one life being lost is recognised.

Note 5 Change to *High* where there is the potential for one or more lives being lost

Note 6 See Section 2.7 and 1.6 for explanation of the range of High Hazard Categories

Appendix C2: Hazard Categories (Source: Guidelines on dam safety management, ANCOLD, August 2003, Table 5.2, page 24)

Hazard Category	Inspection Type			
	Comprehensive	Intermediate	Routine Visual	Special
Extreme	On first filling then 5 yearly	Annual	Daily [1]	As required
High A,B,C	On first filling then 5 yearly	Annual	Daily to[1]Tri-Weekly	As required
Significant	On first filling then 5 yearly	Annual to 2-Yearly	Twice Weekly to Weekly [1]	As required
Low		On first filling, then 5 yearly	Monthly	As required
Very Low		Dam Owner's Responsibility[2]	Dam Owner's Responsibility[2]	As required

Note 1: Dam owners may undertake a review to determine if a reduced or increased frequency of inspection is acceptable. The review should be carried out by a dams engineer and take into account such matters as Regulator requirements, dam hazard and risk, type and size of dam, dam failure modes and monitoring arrangements (refer Pattle et al).

Note 2: Monthly routine visual inspections, and 5 yearly intermediate inspections with test operation of equipment and review of hazard category, are suggested.

Appendix C3: Dam/RB Safety Inspections (Source: Guidelines on dam safety management, ANCOLD, August 2003, Table 5.1, page 23)

Type of Inspection	Personnel	Purpose
Comprehensive	Dams Engineer and Specialists[1] (where relevant)	The identification of deficiencies by a thorough onsite inspection; by evaluating surveillance data; and by applying current criteria and prevailing knowledge. Equipment should be test operated to identify deficiencies. For a Safety Review consider: • Draining of outlet works for internal inspection. • Diver inspection of submerged structures.
Intermediate	Dams Engineer	The identification of deficiencies by visual examination of the dam and review of recent surveillance data, with recommendations for corrective actions. Equipment is inspected and, preferably, test operated.
Routine Visual	Operations Personnel	The identification and reporting of deficiencies by visual observation of the dam by operating personnel as part of their duties at the dam.
Special / Emergency	Dams Engineer and Specialists[1]	The examination of a particular feature of a dam for some special reason (eg. after earthquakes, heavy floods, rapid drawdown, emergency situation) to determine the need for pre-emptive or corrective actions.

(Note1: Examples of specialists include mechanical and electrical engineers, to inspect outlet works, spillway gates and automated systems, and corrosion engineers.)

Appendix C4: Maintenance Instructions (Source: Guidelines on dam safety management, ANCOLD, August 2003, Appendix A9 to A14)

Public safety is also of paramount importance at all dams and reservoirs. Specifically, public safety on the reservoir near the dam, in areas adjacent to the reservoir, and below the dam should be considered. Safety measures could include identification of high watermarks to indicate past or probable reservoir levels and stream flows, posting of safety instructions at highly visible and key locations, and providing audible safety warnings upstream of and below outlets as appropriate.

Communications should be maintained among affected government bodies and with the public to enhance the safety aspects of the operation of the dam. Communication alternatives include written communications, radio, telephone, television and newspapers.

A.4 MAINTENANCE INSTRUCTIONS

A.4.1 Maintenance Priorities

Maintenance is a task that should never be neglected. If it is, the consequences and costs could multiply. Maintenance could be prioritised as follows:

a. Corrective Maintenance, which may require immediate remedial action (see Section 7) and even prior emergency action, such as evacuation, if warranted. These relate to the most critical of conditions at a dam, which call for immediate attention. These conditions may include, but are not limited to:

- *A dam being over-topped or about to be over-topped;*
- *A dam about to be breached by erosion, slope failure or other circumstances;*
- *A dam showing signs of piping and/or internal erosion;*
- *A blocked or otherwise inoperable spillway at a dam; or*
- *A dam showing signs of excessive seepage.*

b. Preventive Maintenance - This can be further broken down into routine or condition-based maintenance.

(i) Condition-Based Maintenance - This may be relatively urgent. It should be scheduled bearing in mind the dam owner's resource constraints, the risks involved with not doing the maintenance and the owners priorities on the dam and within his dam portfolio. These may include, but are not limited to:

- *Clearing undergrowth and trees from embankments, sealing any consequent piping / erosion areas, and establishing a good grass cover;*
- *Regrading and reseeding eroded areas and gullies;*
- *Repairing defective but still operational spillways, gates, valves and other appurtenant features;*
- *Repairing deteriorated concrete, metal or jointing compounds; and*
- *Maintenance and repair of cracks and joints in concrete structures.*

(ii) Routine Maintenance - Routine scheduled maintenance tasks at a dam. These could include:

- *Mowing and general minor repairs;*
- *Maintenance of electrical and mechanical equipment and systems (eg. servicing stand by generator, gantry crane, spillway gates);*
- *Operation of electrical and mechanical equipment and systems (eg. exercising valves, exercising gates);*
- *Operation of scours and outlets to keep them clear of silt;*
- *Maintenance of monitoring equipment;*
- *Testing monitoring equipment and alarms;*
- *Testing security equipment;*
- *Testing communication equipment;*
- *Inspections (discussed elsewhere in these guidelines); and*
- *Monitoring upstream and downstream developments, which could have an impact on the dam or its hazard category.*

A.4.2 Details

Specialists should prepare maintenance checklists and schedules indicating the maintenance procedures, frequencies and protective measures for each structure and for each piece of operating, communications, and power equipment, including monitoring systems. Special attention should be given to known problem areas.

Special instructions should be provided for checking operating facilities following floods, earthquakes, and other natural phenomena.

Maintenance procedures include preventative measures such as painting and lubrication as well as repairs to keep equipment in intended operating condition, and minor structural repairs such as maintaining drainage systems and correcting minor deterioration of concrete and embankment surfaces. The design staff should be advised of any significant maintenance work.

Maintenance of retarding basins is essential to ensure their ongoing performance. Outlets should be maintained clear and tree growth in overflow sections removed to maximise performance during floods. Grass cover should be maintained to prevent scour and erosion during flood events.

A list of tasks included in the maintenance instructions may comprise but is not restricted to the following:

- *removing brush and trees;*
- *removing debris, including silt upstream of outlets;*
- *regrading the crest and/or access roads;*
- *removing harmful fauna;*

- *operating and lubricating gates;*
- *adding rip-rap when needed;*
- *sealing joints in concrete facings;*
- *clearing seepage measuring weirs, surface drainage channels and pits;*
- *maintaining monitoring points;*
- *maintaining security of operating equipment;*
- *repairing damaged or deteriorating concrete;*
- *cleaning uplift pressure and other drains;*
- *maintaining all associated electrical and mechanical equipment;*
- *reporting any abnormalities observed during the course of maintenance (eg higher than normal seepage or new seepage locations);*
- *removing floating debris from the reservoir;*
- *maintaining spillway protection floating booms;*
- *painting of metal and timber surfaces;*
- *maintaining road bridge bearings and expansion joints across spillways;*
- *maintenance of coating and protection from impact for steel conduits outlet works;*
- *maintaining outlet works tunnels;*
- *maintaining valves; and*
- *maintaining safety signs and barriers.*

A.5 SAMPLE DUTY SCHEDULE FOR OPERATING PERSONNEL

The following checklist should be used as a guide in preparing a duty schedule for operating personnel. The frequencies of these duties should be varied according to circumstances (eg the condition of the equipment). In particular, safety monitoring should accord with Table 5.3 of these Guidelines. All activities, or lack of activities with reasons, should be recorded in the dam logbook.

DAILY

- Visual inspection of dam
  - Crest of dam
  - Upstream and downstream faces
  - Visible portions of foundation and abutment contacts
  - Galleries
- Record water surface elevation
- Record reservoir inflow and spillway discharges
- Record releases
- Record seepage
- Complete logbook which should include the above information

MONTHLY

Check condition of:

Dam and Reservoir

- Spillway stilling basin
- Outlet works stilling basin
- Critical landslide areas
- Reservoir area
- Drainage systems, toe drains
- Measuring devices and alarm levels
- Fauna problems
- Security and safety devices
- Communication devices
- Vegetation growth (there may be too much or too little)

Electrical System

- Standby generator
  - Run for minimum of 1 hour
  - Keep battery charged
  - Check fuel supply
- Replace light globes

THREE MONTHLY

Outlet Works

- Operating instructions - up to date and legible
- Check gate air vents on downstream face
- Clean gate control switchboxes
- Check security and safety devices
- Read weather gauges and record data
- Make required changes in gates and valves
- Check log or safety boom
- Check spillway outflow channel for debris
- Check instrumentation schedule
- Record pertinent information in Operating Log
- Check seepage weir condition
- Grease hydraulic gate hanger

- Check
  - Signs that warn public of hazards
  - Trashrack of intake structure
  - Outlet works stilling basin
  - Valve house

Spillway

- Check for debris in inlet channels
- Check operation of gates
- Check fence condition and caution signs
- Check and clear bridge drains
- Clean inside of motor control cabinet

SIX MONTHLY

Outlet Works

- Check hydraulic oil lines
- Check oil reservoir level in hydraulic system
- Lubricate gate rollers
- Check rubber seals and seal clamp bar
- Check hoist cables - lubricate

Electrical System and Equipment

- Change oil in standby generator
- Check exposed electrical wiring
  - Outlet works, valve house
  - Spillway bridge
  - Gate hoists

ANNUALLY

Outlet Works

- Paint
  - Metalwork
  - Colour-coded valves
  - Woodwork and trim
- Exercise gates and valves

Spillway

- Exercise equipment

FIVE YEARLY

Examine intake structure, trash racks and stilling basin, which normally are underwater; less frequent if experience indicates. This should coincide with the Comprehensive Inspection and may need to be done by divers.

Dam and Reservoir

Review the Operation and Maintenance Procedures.

Mechanical

- Check and re-paint metal work on gates, bridges, pipes, fences, etc.
- Check hoists cables - lubricate
- Check mechanical hoist bearings and flexible coupling bearings
- Check gear cases
  - Hoist gear case, replace grease
  - Spur gear units and gear motors

Electrical

- Check electrical conduits, pull-boxes and switches
- Outlet works valve house
- Gate hoists
- Spillway
- Galleries

Outlet

- Check condition of interior and exterior of outlet conduit.

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