Southern Rural Water
Managing Water. Serving Communities.

Department of Environment, Land, Water & Planning

Local Government Authority Dam Safety Program

South Gippsland Shire – Inspection Report

March 2018

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1. Introduction

1.1 Purpose of this report

The Department of Environment, Land, Water and Planning (DELWP) has a regulatory role for the safety of dams under the Water Act 1989 and is the control agency for dam related emergencies under the Emergency Management Manual of Victoria.

Local Government in Victoria is divided up between 79 Local Government Authorities (LGAs), each responsible for administering local infrastructure and community services such as roads, drainage, parks etc. Records provided to DELWP indicate that a number of the LGAs own or manage dams and retarding basins. Many of these assets, which include a mix of old water supply dams, ornamental lakes and retarding basins, have been accumulated by LGAs over many years as a result of asset transfers and conversions, land development projects, flood mitigation programs and opportunistic acquisition by the transfer of land.

DELWP has engaged Southern Rural Water (SRW) to assist and provide advice to the LGAs to significantly improve and update knowledge on LGA dams and retarding basins. The objective of this project is to ascertain where the State's LGA dams and retarding basins are located, what risks they might pose to communities and infrastructure, what to consider during emergency management planning and response, and whether the owners have the essential management tools and procedures in place to effectively manage these assets.

The outcome of this project is to support LGAs to improve management of their dams and retarding basins. It aims to do this by assisting LGAs with the development of basic dam safety programs that will enable LGAs to more effectively manage their portfolios of dams and retarding basins in terms of ongoing maintenance, dam surveillance and emergency planning and response, and demonstrate due care.

This Report has been prepared as part of the 2017/18 LGA Dam Safety Program on behalf of DELWP. Specifically, this Report presents a review of performance of dams under the control of South Gippsland Shire in accordance with the 2003 ANCOLD Guidelines on Dam Safety Management.

This Report is based on observations made during site inspections of South Gippsland Shire owned dams carried out in August 2017, combined with a desktop review of information provided by South Gippsland Shire and DELWP.

Throughout the Report, a number of abbreviations have been used. Descriptions for these abbreviations are provided in Appendix E.

1.2 Australian National Committee on Large Dams (ANCOLD)

The Australian National Committee on Large Dams Incorporated (ANCOLD Inc.) is an incorporated voluntary association of organisations and individual professionals with an interest in dams in Australia. ANCOLD was formed in 1937 as the Australian national committee of the International Commission on Large Dams (ICOLD), a non-government organisation established in 1928, and is one of 95 member countries.

ANCOLD's mission is to be the industry body, representing its Members and Associates, disseminating knowledge, developing capability and providing guidance in achieving excellence for all aspects of dam engineering, management and associated issues.

ANCOLD has developed a set of guidelines (ANCOLD Guidelines) that are applicable for water or tailings dams with the potential to cause loss of life or significant environmental or physical damage through operation or failure. Although prepared for dams which would normally be at least 10 to 15 m high, the ANCOLD Guidelines can also be used to assist with decisions on smaller dams, particularly where a dam or series of dams creates the potential for loss of life or significant damage.

In Victoria, under the Water Act 1989 and common law, responsibility for the safety of a dam rests with the dam owner. Dam owners are liable for loss and damage caused by the failure of a dam or the escape of water from a dam. Consequently, dam owners need to be committed to dam safety and have an effective dam safety management program. ANCOLD Guidelines are widely accepted in Australia to be best practice for implementing an effective dam safety management program.

Relevant ANCOLD Guidelines have been referenced throughout this Report. The work carried out as part of this project has been carried out in accordance with ANCOLD Guidelines and industry practice.

Further information about ANCOLD can be found via their website www.ancold.org.au.

1.3 Scope and limitations

This Report has been prepared by SRW for South Gippsland Shire on behalf of DELWP and may only be used and relied upon by South Gippsland Shire and DELWP for the purpose agreed between SRW and DELWP as set out in Section 1.1 of this Report.

SRW otherwise disclaims responsibility to any person other than South Gippsland Shire and DELWP arising in connection with this Report. SRW also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by SRW in connection with preparing this Report were limited to those specifically detailed in the Report and are subject to the scope limitations set out in the Report. The opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. SRW has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by SRW described in this Report, which are based on limited information presented in available data, past reports and drawings (supplied by DELWP or South Gippsland Shire as listed in this Report), reporting by Council staff on the performance of the dam and associated operating equipment, and visual observations made during the inspection. There may be conditions existing at the dam that cannot be visually detected. SRW disclaims liability arising from any of the assumptions being incorrect.

1.4 Council reservoirs and reference details

Information provided to SRW by DELWP and South Gippsland Shire indicates that South Gippsland Shire has responsibility for eight dams. An initial review of the assets was carried out by SRW, which included the following steps:

- Confirmation of the location of each asset using aerial imagery, topographic data and watercourse information, as well as via correspondence with South Gippsland Shire.
- Identification of the height of each embankment (data either provided by DELWP, South Gippsland Shire or estimated from survey or topographic data).
- For all dams that had a known or estimated height greater than 1.0 m, an indicative flood line and inundation zone was assumed using survey, topographic and watercourse data along with aerial imagery to identify expected Population at Risk (PAR) and other impacts (e.g. infrastructure) within the expected inundation zone.
- For all dams with a height greater than 1m and an expected PAR, review any documentation provided by DELWP or South Gippsland Shire to identify what work has previously been carried out at the site.

Based on this initial preliminary review, four sites were shortlisted for an 'intermediate' level inspection in August 2017. **Table 1** provides a summary of this desktop review.

Table 1: Site list

Site Name	Inspection Status	Summary of Desktop Review Outcomes
Foleys Road Yanakie	Yes, intermediate level inspection.	Likely that dambreak flood wave would discharge into ocean. However, site topography required confirmation to ascertain whether nearby caravan park would be impacted.
Walkerville Retarding Basin	Yes, intermediate level inspection.	Site visit required to confirm topography between RB and township and whether there is PAR.
Hannah Rise Crescent Korumburra	Yes, intermediate level inspection	Flood retarding basin with likely PAR immediately downstream of embankment, although low embankment height.
Shellcot Road Korumburra	Yes, intermediate level inspection.	Flood retarding basin with likely PAR and risk to road infrastructure based on defined drainage line. Ayrlie Park Crescent road forms the embankment.
Koonwarra Inverloch Road Leongatha South	Not formally inspected.	No PAR. Discharges into Black Spur Creek via farmland.
Johnson Street Leongatha	Not formally inspected.	Discharges away from residential area into creek via farmland. No PAR.
Coal Creek Museum	Not formally inspected.	Dam discharges into Coal Creek. No PAR.
Follett Drive Nyora	Not formally inspected.	Close to residences however discharge into nearby creek away from houses. No PAR.

2. Report layout

2.1 General

This Report includes a chapter for each site inspected as shown in **Table 1**. The chapter covers four key areas which includes:

- Site inspection observations and recommendations
- Consequence assessment
- Spillway capacity assessment
- Risk assessment

The layout and methodology for these four key components is discussed below.

2.2 Site Inspections

Site inspections were undertaken at an **"Intermediate Level" consistent with ANCOLD Guidelines on Dam Safety Management (2003)**.

The inspections included the identification of deficiencies by visual examination of the dam and review of recent surveillance data (if available) and then the development of recommendations for corrective action or further investigation. During the inspections, the team did not exercise any electrical or mechanical equipment and did not take any soil samples for testing purposes.

Observations made during the inspections are summarised in a checklist format. The following consistent terms have been used throughout this Report to describe the conditions of the various features or components of the dam, as observed during the inspections:

Satisfactory	Expected to fulfil its intended function
Fair	Expected to fulfil its intended function, but maintenance is recommended
Poor	May not fulfil its intended function; maintenance is necessary
Unsatisfactory	Not expected to fulfil its intended function; repair, replacement, or modification is necessary
Not applicable	Component/structure or item does not exit at this site

Recommendations in this report are made on the basis of visual observations during the site inspections and subsequent assessment. Recommendations provide preliminary guidance to the required actions, but have been based on limited information. Before any recommendation is adopted, it is further recommended that detailed advice is provided from an experienced dams engineer.

The recommendations have been separated with respect to the priority and classification according to the following urgency and importance ratings:

Urgency Rating

Immediate Action	Critical actions that need to be taken immediately to safeguard the integrity of the dam
Short Term Acton	Operation, maintenance, investigation or monitoring issues requiring detailed attention or action to be completed within the next twelve months, in addition to normal routine actions
Long Term Action	Lower priority, long-term operation, maintenance, investigation or monitoring issues that will require attention in the future; however, commencement may be deferred for twelve months, but require prudence during operation and routine inspections
Major Works	Items requiring capital works upgrades to address dam safety and/or business risks
Documentation	Items regarding documentation of the dam and its current condition. These items do not require physical works on site however are recommended as part of a comprehensive dam safety management programme
Consider	Further information is required to determine whether action should be carried out. For example, action may depend on further monitoring of the issue for signs of deterioration.

Importance Rating

High	These recommendations have been made regarding actions required to address observed deficiencies in the condition and management of the dam, in order to avoid a dam safety incident. Generally, only ‘immediate’ and ‘short-term’ actions would be considered High priority.
Medium	Operation, maintenance, investigation or monitoring issues requiring detailed attention or action to be completed within the next twelve months, in addition to normal routine actions
Low	Lower priority, long-term operation, maintenance, investigation or monitoring issues that will require attention in the future; however, commencement may be deferred for twelve months, but require prudence during operation and routine inspections

2.3 Consequence assessment

As outlined in the ANCOLD Guidelines on the Consequence Categories for Dams (2012), a consequence assessment is carried out to assign a dam a 'Consequence Category' by collecting information about the consequences of a potential dam-break and identifying the severity of these consequences. Consequence Categories provide a useful basis for determining dam safety management requirements, which include:

- Dam Safety surveillance
- Dam Safety inspections
- Operation and maintenance
- Dam safety emergency planning and management
- Remedial and upgrade works

The 'initial' level consequence assessment was carried out by mapping the downstream inundation extent using a GIS-based approach developed by GHD for SRW specifically for this project. The routine steps undertaken for each dam included:

1. From the embankment, project a line downstream starting at half the embankment height at a slope equal to the ground slope at the dam.
2. Buffer the line from point 1 above in a horizontal fashion in both directions until it intersects the ground surface.
3. Iteratively truncate the downstream extent created above to indicatively match the volume of the flood extent to the volume of the dam using inundation lengths specified for dam volumes in ANCOLD (2012).

This methodology produced a consistent and feasible result for the majority of the dams; however there were a small number of dams which needed to be reassessed. This method was generally judged to provide feasible results for the four dams assessed for South Gippsland Shire. However engineering judgement has been applied to the results in each case to ensure the extent of inundation, estimates of PAR and other impacts are logical.

The VicMap 10 metre and 20 metre digital terrain models (DTM) were adopted as the base terrain for this assessment. The inundation maps were used to estimate the PAR. The PAR estimates adopted include all those people who would be directly exposed to flood waters if they took no action to evacuate.

Assumptions

- The occupancy per dwelling adopted for the 'initial' level consequence assessment for the residential zones identified by the VicMap parcel layer was three people. This estimate is likely to be conservative, but was considered appropriate for this assessment.
- Where required this was refined using aerial imagery to more accurately identify the number of dwellings.
- Concurrent flow from the downstream catchment was not considered in the inundation mapping due to the 'initial' level mapping required of this project.
- Itinerants were not considered as part of the investigation, only people assumed to be inside structures.

The downstream inundation areas were observed by the inspection team as part of the site inspection process. This field observation took place prior to the mapping which helped the inspection team to refine and validate the modelled inundation extents and consequence categories adopted for each dam in this project.

Limitations

The results presented as part of this consequence assessment were limited by the availability of data. There was a lack of data for many sites, which led to the formulation of several key assumptions outlined in the 'Assumptions' section above. The results provided in this Report are thus indicative figures around the risk associated with the asset and should not be considered a definitive or absolute number.

2.4 Spillway capacity assessment

For this project a simplified assessment of spillway capacity was undertaken for dams inspected and where detail on spillway arrangement and dimensions were able to be taken.

The assessment methodology adopted well established hydrology and hydraulic computation techniques. Specifically this included:

1. Analysis of the regional (catchment) hydrology to determine the inflow flood frequency
2. Determining spillway discharge capacity (based on the spillway arrangement); and,
3. Determining the dam crest flood (DCF) AEP by comparing the spillway capacity to the flood frequency curve.

In the absence of a spillway (i.e. turkey's nest dams) a qualitative assessment approach was undertaken to assess flood capacity based on site characteristics and storage surface area. For South Gippsland Shire Council dams the spillway capacity assessment approach included the 3 steps listed above, except for Foley's Road dam in Yanakie which is of turkey's next construction and has no defined spillway.

2.5 Risk assessment

A Qualitative Risk Assessment (QRA) for each inspected dam was conducted using the 5 x 5 matrix shown below in **Table 2** as provided by DELWP for this project.

Table 2: DELWP qualitative risk matrix for dams and retarding basins

Likelihood/ Condition Rating	ANCOLD Consequence Category				
	Very Low (1)	Low (2)	Significant (3)	High A,B,C (4)	Extreme (5)
Most Likely (5)	Medium	Significant	Significant	High	High
Likely (4)	Medium	Medium	Significant	High	High
Possible (3)	Low	Medium	Medium	Significant	High
Unlikely (2)	Low	Low	Medium	Medium	Significant
Rare (1)	Low	Low	Low	Medium	Significant

Table 3 summarises a list of condition descriptors proposed by DELWP for rating the likelihood of dam failure due to (i) internal erosion and piping; (ii) scour erosion by flood overtop, or spillway failure; and (iii) deformation and instability of the dam embankment. For consistency, SRW also adopted GHD's extended version condition descriptors to aid assessment of the likelihood of failure due to the four major embankment failure modes, namely:

1. Internal erosion and piping
2. Flood overtopping
3. Embankment slope instability
4. Non-performance of spillway and/or floodway erosion

Assessment of the likelihood of dam failure was based on:

- Observed conditions of the dam
- Observed design features (or information provided by DELWP or the Council such as drawings if applicable); and,
- Our understanding of the dam safety surveillance and monitoring program in place based on discussions with the Council.

Table 3: Likelihood/condition descriptors proposed by DELWP

Likelihood	Condition descriptor
Most Likely (5)	Heavy woody vegetation, spillway filled or blocked, evidence of piping, sinkholes, severe settlement, upstream beaching erosion, severe cracking, heavily corroded outlet works
Likely (4)	Significant woody vegetation, spillway appears undersized or partially blocked, some surface erosion, settlement evident, moderate cracking
Possible (3)	Generally good grass cover with some woody vegetation, unlined clear spillway, minor settlement or cracking, may have zoned embankment, no filters, outlet works functional
Unlikely (2)	Good vegetation cover, some minor erosion and cracking, lined spillway with some defects, visual surveillance program, zoned embankment, may have filters
Rare (1)	Well maintained grass cover, full drainage and filters, lined spillway off embankment, monitoring instrumentation, surveillance program, outlet works fully operational

The following sections describe the various condition descriptors adopted by SRW (originally developed by GHD) for rating the likelihood of each of the four key failure modes, and how they would affect the safety of an earthen dam. A rating between one and five is assigned to each descriptor, with a rating of five representing the most unfavourable condition and a rating of one representing the most favourable condition. These ratings were then assessed together to assign

an overall rating of the likelihood of dam failure. The results of the assessment are provided in the section titled "Risk Considerations" for each site.

It should be noted that the results of the assessment does not necessarily indicate how close a dam is to failure but highlights the urgency for which improved dam safety practices and/or modifications to the dam are required.

2.5.1 Condition descriptors based on the observed condition of the dam

Vegetation

When trees and woody plants are allowed to grow on embankment dams, they can hinder safety inspections and can interfere with safe operation. Trees can damage the structure of an earthen dam and result in failure of dam in the following ways.

- Growth and penetration of tree roots into an embankment dam can open cracks through which piping erosion can take place.
- Fallen trees because of strong wind or when the trees die may result in big holes/depressions in the embankment dam which can lead to slope instability. It may shorten the seepage gradient and trigger piping erosion through the embankment.
- Fallen trees may result in local depressions along the embankment crest and increase the chance of flood overtop through the depressions.
- Roots of dead trees within the embankment will decay resulting in voids and preferential seepage paths along which piping erosion may occur.

On the contrary, a healthy, dense stand of low-growing grass on embankment dams is a desirable condition and should be encouraged. An embankment without grass cover may be subjected to gully erosion caused by surface runoff.

Therefore, a rating of 5 (most unfavourable) is to be assigned to situations when a lot of trees and woody plants grow within one metre of the embankment crest. A rating of 1 (most favourable) is to be assigned to embankments covered with dense, short growing grass.

Desiccation cracks

Cracks caused by desiccation in the top part of an embankment dam may form preferential seepage paths when the storage level rises above the tips of the cracks. Desiccation cracks usually occur in a random pattern. The cracks can be fine and very localised. The most unfavourable condition is when the cracks are wide and continuous in a transverse direction across the width of the embankment crest. When continuous transverse cracks are wider than 5 mm, the likelihood of seepage-induced erosion (i.e. piping erosion) initiating along the cracks are high.

A rating of 5 is to be assigned to embankments with wide (> 5 mm) desiccation cracks continuous through the width of the embankment crest, and a rating of 1 is to be assigned to embankments with no observable desiccation cracks.

Longitudinal/diagonal cracks

Longitudinal and diagonal cracks are indicators that part of the embankment is slipping or beginning to slip down the slope. A minor slip will leave a scarp along the top edge of the slip.

The most unfavourable condition, to be assigned a rating of 5, is when a longitudinal crack or scarp is observed on the upstream slope of the embankment. It may suggest that a relatively deep-seated slope failure is developing with the upper part of the slip surface daylighting on the upstream slope. When water level rises and drowns the longitudinal crack, water entering the crack may further destabilise the potential slipping mass.

A rating of 1 is to be assigned to embankments with no observable longitudinal cracks.

Signs of piping/internal erosion

Piping or internal erosion is a process where seepage occurs through the embankment or foundation and erodes material forming a “pipe” from the reservoir to the downstream face or toe. Over time this pipe may become larger as more and more material erodes. If this is allowed to continue, it could lead to the eventual collapse of the embankment.

Any signs of previous piping erosion in the embankment may suggest that piping erosion may be reactivated when the water level is high enough. Signs which suggest piping erosion might have occurred or is still progressing include but not limited to:

- Sinkholes. Most dangerous sinkholes are those found on the upstream slope which might be drowned when water level is high.
- Sand boils at the downstream toe. It is a sign of high groundwater pressure at the downstream toe, and the presence of some preferential seepage paths through the dam foundation.
- Areas of erosion or slips on the downstream face that may have been the exit point for the pipe. In many cases of piping, erosion starts at the downstream end of the pipe and works its way backwards.
- Leakage through the downstream slope or toe. This is an indication of flow through some relatively permeable zones or cracks within the embankment.
- Vortex observed in the reservoir. This is an indication of a major leak through the floor of the reservoir, and there is a chance that the leakage path might be through the embankment.

A rating of 5 should be assigned to the embankment if the above signs are observed. A rating of 1 should be applied if none of the above signs is observed.

Outlet works and conduits (if applicable)

There have been many reported incidents of piping along conduits through an embankment dam leading to dam failure. Piping along a conduit can occur due to the following reasons:

- Poor compaction around a conduit results in a preferential seepage path along which piping erosion can occur.
- Piping into a deteriorating conduit through opened pipe joints or cracks in the conduit.

- Leakage from a pressurised conduit resulting in erosion of earth materials along the conduit.
- Movement of the conduit or settlement/shrinkage of the embankment material may cause a separation between the embankment material and the conduit creating a pathway for seepage.

Due to the above reasons, a rating of 5 is to be assigned to an embankment with an embedded conduit which is inoperable, badly deteriorated, or might have partly broken within the embankment. A rating of 1 is to be assigned to an embankment with fully operational outlet works which do not pass through the embankment dam.

Movements

When reservoir level rises, overtopping of the dam will start at the lowest spot on the dam crest. Concentration of the flow through the low spot will result in a high flow velocity that may initiate a breach (notch) by scour erosion. Continuous flow through the initial breach will then quickly widen and deepen the notch as the breach progresses. Localised low spots possibly caused by settlement or surface erosion should, therefore, be avoided in an embankment dam to prevent concentration of flow through the low spots if overtopping occurs.

A rating of 5 is to be assigned to a dam with severe settlement observed on the crest and slopes. A rating of 1 is to be applied to a dam with uniform crest and slope surfaces having no obvious sign of settlement.

Surface erosion

When the embankment slopes are progressively undermined by wave and rainwater erosion, they become less stable. A rating of 5 is to be assigned to a dam whose upstream slope has been severely undermined by wave erosion, and severe gully erosion by surface runoff is observed in other parts of the dam. A rating of 1 is to be applied to a dam where there is no obvious surface erosion.

Spillway (if applicable)

The main function of a spillway is to release flood water from a reservoir to limit the rise in water level to avoid overtopping of the embankment dam. Therefore, a spillway should be maintained free from blockage so that its flood discharge capacity will not be hampered. A rating of 5 is to be assigned to dams whose spillway channel is severely blocked by heavy vegetation or debris. A rating of 1 is to be applied to dams whose spillway channel is clear of vegetation or debris.

2.5.2 Condition descriptors based on the design features of the dam

Slope gradient

Embankments with steep slopes are more likely to have slope instability problems. From experience, earth embankment slopes flatter than 3 (horizontal): 1 (vertical) usually have adequate safety margin against slope failure.

A rating of 5 is to be assigned to dams whose slope gradients are steeper than 1 (horizontal): 1 (vertical), and a rating of 1 is to be assigned to dams whose slope gradients are flatter than 4 (horizontal): 1 (vertical).

Embankment zoning and foundation

Embankments with full height chimney filters and complete foundation cut-off to bedrock level have good performance records in terms of their resistance against internal erosion and piping. On the contrary, homogeneous embankments constructed on permeable foundations with no seepage cut-off into the foundation are vulnerable to internal erosion and piping.

Therefore, a rating of 5 is to be assigned to homogeneous embankments without downstream filters, and which might have poorly compacted zones within the body of the embankment and permeable zones through the dam foundation. A rating of 1 is to be applied to zoned embankments with downstream filter constructed to the crest of the embankment and have complete seepage cut-off in the foundation constructed down to impermeable bedrock.

Crest width and protection

Applying a capping layer of fine gravels or bitumen-gravel to the crest of an embankment dam will protect the top part of the embankment from desiccation cracking. The capping layer will also add some resistance against scouring erosion in case the embankment is overtopped.

The width of the embankment crest will affect the likelihood of piping in the upper part of the embankment as the seepage gradient through cracks is lower if the embankment crest is wider. A wider crest also means that the likelihood of having continuous transverse cracks through the width of the crest will also be smaller.

When an embankment is overtopped, scouring erosion will initiate at the downstream edge of the embankment as the flow starts to accelerate down the slope. The scour erosion will work its way back towards the upstream edge of the dam crest to form an erosion channel and initiate a dam breach (notch). It will take longer time to form the initial breach if the embankment has a wide crest.

Therefore, a rating of 5 is to be assigned to embankments with a narrow crest (< 2 m) without paving to protect the crest materials against desiccation. A rating of 1 is to be applied to embankments with crest width wider than 3 m, with the crest sealed or covered with concrete pavement.

Flood capacity

The flood capacity is defined, in simple terms, as the storm event that will bring the water level to the dam crest level. The flood capacity of a dam, therefore, is a good indicator of the likelihood of flood overtopping.

A rating of 5 is to be assigned to dams whose flood capacity is less or equal to 1:50 AEP, and a rating of 1 is to be assigned to dams whose flood capacity is larger than the 1:10,000 AEP.

In the absence of a spillway (i.e. turkey's nest dams) a qualitative assessment approach was undertaken to assess flood capacity based on site characteristics and storage surface area.

Where no operational overflow is possible a 1 is to be assigned, and where a risk of embankment overtopping is considered possible based on site characteristics, a 5 is to be assigned.

Spillway lining (if applicable)

A spillway channel should have sufficient resistance against scour erosion when it operates, otherwise collapse of the channel side walls and backward scour erosion of the spillway channel may adversely affect the safety of the embankment dam. A properly designed spillway should have a stable channel floor and side walls which are resistant to scour erosion, otherwise the channel floor and the sides should be protected by lining.

A rating of 5 is to be assigned to a dam whose spillway is unlined, susceptible to scour erosion, has unstable side slopes and the potential to divert flows to the embankment toe causing damage to the embankment. A rating of 1 is to be assigned if the spillway is located far away from the embankment, or the chance of scour erosion of the spillway channel is negligible.

Spillway discharge (if applicable)

If a spillway discharges flood water at or close to the toe of the embankment dam, and there is no energy dissipater to reduce the flow velocity, there is a chance that the flood discharge will cause scour erosion at the downstream toe of the embankment. Scour erosion may also occur along the embankment toe if it is part of the floodway, or flood water discharged into the river course is backed up to the toe of the embankment.

A rating of 5 is to be assigned for situations when flood discharge through the spillway is likely to cause scour erosion at the downstream toe of the embankment. A rating of 1 is to be assigned if the spillway is located far away from the embankment and any flood discharge from the reservoir will not cause scour erosion at the downstream toe of the embankment.

Spillway training walls (if applicable)

The interface between a spillway training wall and the embankment dam is a vulnerable spot for piping erosion to initiate because of the following reasons:

- The soil porosity at the interface is higher than the porosity within the soil mass making the interface a preferential seepage path
- Deflection of the training wall may leave a gap between the buried face of the training wall and the backfill materials allowing water to seep through the gap
- Settlement of the embankment materials may cause a separation of the backfill materials from the training wall
- At some dams, the top of the training wall may be lower than the embankment crest level so that the upper part of the embankment above the top of the training wall may be subjected to scouring erosion when the water level is higher than the top of the training wall.

A rating of 5 is to be assigned when a gap is observed between the spillway training wall and the backfill due to deflection of the wall or lateral settlement of the embankment materials behind the wall, or when there are cracks and open lift joints in the training wall which allow water to seep

through the training wall and initiate piping erosion at the back of the wall. A rating of 1 is to be assigned if there is no spillway or the spillway is located away from the embankment dam.

2.5.3 Condition descriptors based on the dam safety inspection program in place

Surveillance and monitoring

A rating of 5 is assigned if no routine surveillance and monitoring program is applied to the dam. A rating of 1 is assigned if the dam has a surveillance and monitoring program in compliance with the requirements of ANCOLD (August 2003).

3. FOLEYS ROAD DAM YANAKIE

3.1 Reservoir details

3.1.1 Physical properties

This section provides information on the known parameters of the dam and its appurtenant structures (if applicable). The information is based on limited information presented in available reports and drawings provided by South Gippsland Council in combination with visual observations and discussions with South Gippsland staff during the inspections.

The data provided in **Table 4**, should be confirmed by the Council or with a feature survey. This information should not be relied upon for anything other than to gain a general appreciation of the site.

Table 4: Site details – Foleys Road

Type	Assessment
General site inspection details	
Site Name	Foley's Rd Dam
Locality	Yanakie
Map Reference (Coordinates)	Latitude = -38.816908 Latitude = 146.267568
Asset owner	South Gippsland
Describe access to site	Access from Foley's Road via a walking track through dense bush.
Photograph of site access	Damaged access gate. 

Type	Assessment
	Access track through scrub to dam. 
Storage level at time of inspection	2.0 m below FSL.
Spillway flowing	N/A – no spillway, turkeys nest construction.
Site data	
General purpose	Water supply dam for Caravan Park. Non potable supply.
Watercourse	N/A – Turkey's nest construction.
Original construction date (year)	Around 1973. No available records.
Subsequent upgrades or minor works	Unknown.
Historic incidents	Unknown.
Is there a current surveillance program?	No.
Historic surveillance reports reviewed? Details?	No.
Has an Emergency Plan or inundation map been provided?	No.
Catchment	
Description	Of turkey's nest construction, local runoff from road drainage to the west.

Type	Assessment
Determination from	Field inspection.
Downstream flood area	
Description	Eastward toward ocean. No PAR.
Determination from	Field inspection.
Dam Wall	
Construction type	Earthfill from site.
Upstream face type	Earthfill from site
Downstream face type	Earthfill from site (large boulders in d/s face).
Photograph of dam wall	Maximum section of dam looking south along crest.  Looking at d/s face from toe. Note non-homogeneous embankment material.

Type	Assessment
	
Crest length (m)	75.0 m
Crest width (m)	Varies 3.6 m – 4.5 m
Surface area at FSL (m^2)	1,100 m^2.
Storage Volume (ML)	~ 1.5 – 2.0 ML (estimated).
Upstream slope (V:H or %)	1V:2.5
Downstream slope (V:H or %)	1V:1H
Maximum height (m)	5.0 m at maximum section.
Inlet works	
Size	50.0 m L x 0.75 m W
Type	Drainage channel from road easement.
Inflow source	Road drainage

Type	Assessment
Photograph of inlet	 
Spillway	
Location	N/A – Turkey's nest construction.
Type	N/A
Structure details	N/A
Freeboard (m)	N/A
Photograph of outlet	N/A
Outlet works	
Size	1No. DN50

Type	Assessment
Detail	Petrol powered pump and poly pipe.
Discharge reason	Used for filling caravan park water tanks for non-potable purposes (i.e. showering, toilets, etc).
Photograph of outlet	

3.1.2 Aerial site view

Figure 1: Foleys Road - Aerial Site View

3.2 Site inspection

The dam was generally found to be in unsatisfactory condition with some principal areas of concern identified (mainly construction and design faults) that need further investigation and/or action. A summary of the inspection findings is provided in **Table 5**.

Table 5: Site Inspection Observations – Foleys Road

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Dam wall					
Upstream batter					
General condition	Fair	Firm above water level.	N/A		
Surface condition	Fair.	No beaching. However, the storage is well protected from wind and there is no sign of erosion.	N/A		
Other specific observations					
Vegetation	Unsatisfactory	Woody vegetation has taken root in u/s batter with > 200 mm trunk width.	After seeking advice from a dams engineer, remove vegetation including roots and re-compact embankment to acceptable engineering standard.	Long term action	Low
Embankment crest					
General condition	Unsatisfactory	Significant amount of woody vegetation has taken root in crest > 250 mm trunk width.	After seeking advice from a dams engineer, remove vegetation including roots and re-compact embankment to acceptable engineering standard.	Long term action	Low

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Surface condition	Unsatisfactory	Penetrable up to 300 mm with probe. Some residual gravel capping in spots. Overall unsatisfactory condition.	See above.		
Other specific observations					
Access	Unsatisfactory	Difficult to access the full embankment length for inspection purposes.	Removal of vegetation and improving access over full storage perimeter will aid maintenance and inspection tasks.	Long term action	Low
Downstream batter					
General condition	Unsatisfactory	Large amount of woody vegetation has taken root in d/s batter, some > 400 mm trunk width. Evidence of animal burrows in d/s face (possibly wombat). Large boulders present indicating non-homogenous embankment material. Downstream slope was much steeper than dam design guidelines recommend and combined with the vegetation and non-homogeneous fill, major works are required to meet modern standards.	Density of vegetation prohibited full inspection of the downstream batter. The entire downstream face of the dam embankment requires rebuilding to good engineering standard. There should be a minimum 10 metre buffer strip from the toe to any vegetation.	Long term action	Low
Surface condition	Unsatisfactory	Very steep and uneven d/s face.	Refer above		

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Downstream Toe Area					
General condition	Unsatisfactory	Difficult to assess due to vegetation density. Animal burrows and large boulders characterise embankment toe area.	Refer above		
Reservoir Surrounds					
General condition	Poor	Access to dam via foot only with inspection made difficult due to being overgrown with thick vegetation. Could not inspect entire toe due to vegetation density.	Create a buffer zone to trees to enable access to the structure for maintenance and inspection purposes.	Long term action	Low
Spillway					
General condition	N/A	No spillway or overflow structure.	Difficult to ascertain whether this structure has over topped during its life. Some form of overflow spillway is required	Long term action	Low
Outlet works					
Intake structure or approach channel					
General condition	N/A	Pumped to caravan park. Outlet only.	N/A		
Outlet conduit/ pipework					
General condition	N/A	No gravity outlet present.	N/A		

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Discharge point					
General condition	N/A	Petrol pump discharging water to caravan park non-potable water tanks.	N/A		
Inlet works					
General condition	Satisfactory	Road drainage channel from roadside into dam. Fit for purpose	N/A		
Instrumentation					
General condition	N/A	None observed.			
Other comments/ observations					
Population at Risk		There is no population at risk (PAR) if the dam was to fail. The above recommendations will not lower the PAR but will significantly improve the life of the asset. Council should satisfy itself that there are no cheaper options for the caravan park water supply before embarking on any major upgrade works.			

3.3 Risk considerations

3.3.1 Overview

This section presents the findings of the consequence, spillway capacity and risk assessments conducted in respect of the dam following the inspection. Assessments were conducted as per the ANCOLD Guidelines on the Consequence Categories for Dams (2012), and the DELWP qualitative risk matrix for dams and retarding basins, all in the context of the ANCOLD Guidelines on Dam Safety Management (2003) and Guidelines on Risk Assessment (2003).

3.3.2 Consequence Assessment

A consequence assessment for this dam has been carried out, in line with the methodology detailed in Section 2 of this Report. The results of this assessment are provided in **Table 6** below.

Table 6: Summary of Consequence Assessment – Foleys Road

Detail	Data
PAR Estimate (Range)	<1 Person
Severity of Damage and Loss Estimate	Minor
Assigned Consequence Category as per ANCOLD Guidelines on the Consequence Categories for Dams (2012)	Very Low

3.3.3 Spillway Capacity Assessment

No flood routing has been undertaken as part of the analysis. As mentioned in section 2.4, where there is no spillway a qualitative assessment approach was undertaken to assess flood capacity based on site characteristics and storage surface area.

Based on this approach, it is considered that the small storage capacity and area of catchment would make it likely that the dam would overtop in a prolonged event where the dam was at or close to full supply level (FSL) at the commencement of the event. However, the flow path would be straight into the ocean with no PAR.

The adopted consequence category for this dam is "**Very Low**", therefore utilising the fall-back position provided in "ANCOLD Guidelines on Selection of an Acceptable Flood Capacity (AFC) for Dams" (ANCOLD, March 2000), if the dam had a spillway it would be required to have a capacity to safely pass a flood with an AEP of 1:100 to 1:1,000.

The guideline suggests that the adopted flood capacity is selected within this range relative to consequences. As only a simplified consequence assessment has been completed for this project, the PAR has not been determined with sufficient accuracy to define the acceptable flood capacity (AFC) within that range. However, it is possible that the flood capacity does not meet the required standard.

3.3.4 Risk Assessment

The likelihood of the four main failure modes under consideration was assessed based on the inspection and the information available. Overall the dam is in reasonable condition but there are some uncertainties that led to higher scores than may otherwise have been the case for piping and flood capacity.

Using the risk matrix in **Table 2**, a likelihood of **Very Likely** and a consequence category of '**Very Low'** gives a risk of **Medium**

Table 7: Summary of Risk Assessment – Foleys Road

Risk Area	Likelihood	Score	Key issue
Potential for Piping	Very Likely	5	Significant tree growth on downstream face, large rocks within embankment and presence of animal burrows in the embankment indicate this was a hastily constructed storage with little QA. Potential for piping considered very likely.
Potential for slope instability	Likely	4	Downstream face slope does not meet good design criteria and is steeper than recommended. Furthermore, embankment is constructed from non-homogeneous material increasing the potential for slope instability. A score of likely is considered appropriate.
Potential for overtopping	Likely	4	No outlet capacity aside from small pump. No spillway present and overtopping is likely.
Spillway/floodway failure	Rare	1	No spillway.
Maximum Risk Rating	**Medium**		

3.3.5 Summary and Recommendations

The inspection found the dam to be in poor condition and it appears there is little regular maintenance carried out. The embankment was poorly constructed with non-homogeneous material and covered in large trees and shrubs making visual inspection difficult. There are a number of issues that need attention. These are:

1. Seek advice from a dams engineer and remove vegetation from upstream and downstream embankment faces and create a buffer zone to allow proper inspection. Long term action, Low importance.
2. Seek advice from a dams engineer and rebuild downstream face of embankment to a good engineering standard to improve embankment stability. Long term action, Low importance.
3. Seek advice from a dams engineer and design and construct spillway to reduce risk of embankment overtopping. Long term action, Low importance.

The dam was assigned an ANCOLD consequence category of **Very Low** and likelihood of failure of **Very Likely** giving a risk category of **Medium**.

4. WALKERVILLE RETARDING BASIN

4.1 Reservoir details

4.1.1 Physical properties

This section provides information on the known parameters of the dam and its appurtenant structures (if applicable). The information is based on information presented in available reports and drawings provided by South Gippsland Shire Council in combination with visual observations and discussions with South Gippsland staff during the inspections.

The data provided in **Table 8**, should be confirmed by the Council or with a feature survey. This information should not be relied upon for anything other than to gain a general appreciation of the site.

Table 8: Site details – Walkerville Retarding Basin

Type	Assessment
General site inspection details	
Site Name	Walkerville RB
Locality	Cnr Grevilla St & Panoramic Dr, Walkerville
Map Reference (Coordinates)	Latitude = -38.820639 Latitude = 145.997557
Asset owner	South Gippsland Shire
Describe site access	Retarding basin is accessed via Grevilla St.
Photograph of site access	
Storage level at time of inspection	At FSL.

Type	Assessment
Spillway flowing	Yes, approximately 30 L/min.
Site data	
General purpose	Retarding basin to attenuate storm flow.
Watercourse	N/A. Urban runoff catchment.
Original construction date (year)	1988
Subsequent upgrades or minor works	None known. Planned outlet structure raising (100 mm) October 2017 to increase capacity.
Historic incidents	Unknown.
Is there a current surveillance program?	No.
Historic surveillance reports reviewed? Details?	None provided.
Has an Emergency Plan or inundation map been provided?	No.
Catchment	
Description	Urban catchment ~0.38 km^2
Determination from	ArcGIS analysis. Indicative only.
Downstream flood area	
Description	PAR negligible. Breach on southern or eastern side toward dwellings but would attenuate before inundation occurred.
Determination from	ArcGIS analysis and field inspection.
Dam Wall (refer to drawings for more info)	
Construction type	Homogeneous earthfill.
Upstream face type	Homogeneous earthfill.
Downstream face type	Homogeneous earthfill.

Type	Assessment
Photograph of dam wall	 
Crest length (m)	Northern and southern crest lengths ~65.0 m Eastern and Western crest lengths ~150.0 m
Crest width (m)	Northern and southern crest width 4.2m Eastern and Western crest width 3.5m
Surface area at FSL (m^2)	~ 10,500 m^2
Upstream slope (V:H or %)	RB at FSL so couldn't be measured. According to drawings: 1V:2H.
Downstream slope (V:H or %)	25% or 1V:4H.
Height at maximum section (m)	3.50 m field altimeter test at southern embankment.

Type	Assessment
Inlet works (refer to drawings for more info)	
Size	1No. DN675 according to drawings (submerged during inspection).
Type	Grated mitred pipe with concrete headwall.
Inflow source	Prom Views Estate – Walkerville.
Photograph of inlet	Concrete headwall visible only (refer red outline) due to vegetation and storage level at time of inspection. 
Spillway (refer to outlet works)	
Location	N/A.
Type	N/A.
Structure details	N/A.
Freeboard (m)	N/A.
Photograph of outlet	N/A.
Outlet works	
Size	Riser pit with 1 No. DN375 outlet pipe.
Detail	**Urgent Investigation Required.** Riser outlet acting as side entry pit. Steel grate lid to prevent gross litter blocking outlet pipe when acting as glory hole spillway. No discharge through riser outlet as leakage around outlet emplacement and

Type	Assessment
	through embankment was occurring at time of inspection discharging via the outlet pipe (this indicates a break in the outlet pipe). Significant erosion around emplacement. Pipework exposed on u/s batter slope. Significant hole in crest offset ~0.5 m from outlet pipe alignment. Cause unknown but likely associated with leakage around outlet.
Discharge reason	Stormwater excess
Photograph of outlet	 

Type	Assessment
	
	

Additional comments

During the site inspection waypoints were taken with a GPS receiver of locations of interest at the dam site. These are shown below along with descriptions of each point.

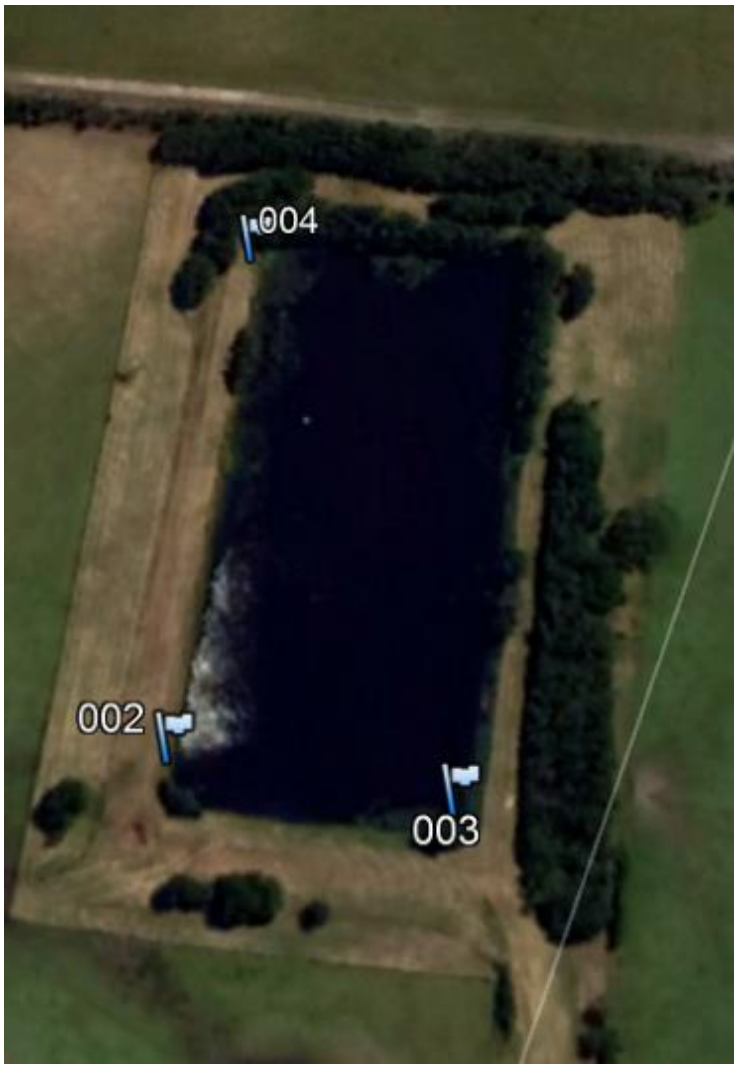


Figure 2: Walkerville Retarding Basin - Aerial view showing locations of interest

Key: 002 – Access stairway cut into upstream face of embankment, 003 – Inlet works, 004 – Outlet works.

4.1.2 Aerial Site View

Figure 3: Walkerville Retarding Basin - Aerial Site View

4.2 Site inspection

The dam was generally found to be in poor condition with a number of areas of concern identified that need further investigation and/or action. A summary of the inspection findings is provided in **Table 9**.

Table 9: Site Inspection Observations – Walkerville Retarding Basin

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Dam wall					
Upstream batter					
General condition	Poor	Significant tree growth in northern embankment and northern end of the eastern embankments.	Seek advice from a dams engineer and remove vegetation and clear around inlet and outlet structures.	Short Term Action	Medium
Embankment crest					
General condition	Poor	Erosion of embankment material at outlet structure. Possible piping failure in progress.	Dewater RB and inspect cause of erosion and possible pipe breakage. Seek advice from a dam design engineer and reinstate outlet structure to original design specification and reconstruct embankment to adequate compaction standard. Pipe should be concrete encased with a cross section shape to allow good compaction. Install appropriate filter around pipe to intercept any seepage.	Immediate Action Immediate Action Immediate Action Immediate Action	High High High High

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Surface condition	Poor	Grass too long to adequately inspect true condition. Felt uneven when trafficked in vehicle.	Seek advice from dams engineer and remove vegetation layer and cap crest with road base material (aggregates <20 mm). This will assist in identifying movement/ settlement in future.	Short Term Action	Medium
Downstream batter					
General condition	Poor	Significant tree growth on eastern side. Wombat hole on southeast corner of d/s batter. Soft in places indicating poor compaction.	Seek advice from a dams engineer and remove vegetation and burrows. If root and burrow penetration/ damage is significant reinstate embankment to adequate compaction standard.	Short Term Action	High
Surface condition	Poor	Significant tree growth in parts and grass too long to assess adequately.	Keep grass mown to short length.	Immediate Action	Low
Downstream Toe Area					
General condition	Poor	Ponding occurring at eastern embankment toe. Difficult to determine whether this is from seepage or recent rainfall. Drainage alignment along western and south western toe permanently wet. Soft in areas when tested with probe. Particularly at southern end.	Seek advice from a dams engineer and remove trees on eastern embankment toe and reinstate with drainage grade slope away from toe. Realign spoon drain channel away from western and southern toe. Consider excavating new spoon drain through adjacent property into drainage line.	Immediate Action	High

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
		Water gathering at southern toe. Appears to be due to flows from spillway/outlet. This is resulting in saturated and soft toe.			
Reservoir Surrounds					
General condition	Fair	Requires regular mowing and vegetation removal.	See above.		
Spillway					
General condition	N/A	No spillway.	Seek advice from a dams engineer to investigate spillway capacity and consider installing spillway in northern crest for above design condition flow. Spillway will reduce freeboard but mitigate overtopping risk. Or, consider additional discharge capacity when upgrading existing riser outlet.	Immediate Action	High
Outlet works					
Intake structure or approach channel					
General condition	Unsatisfactory	Concrete in good visual condition, however not operating at time of inspection due to leakage through embankment at interface with riser emplacement. Top grate and side entry pit prone	Seek advice from a dams engineer and review adequacy and configuration of outlet structure with a view to immediate upgrade due to existing preferential flow path	Immediate Action	High

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
		to blockage from gross litter and plant debris. Freeboard considered insufficient.	through embankment.		
Outlet conduit/ pipework					
General condition	Unsatisfactory	Evidence of break in pipe as flow bypassing outlet discharging through outlet pipe on d/s side.	As above.	As above.	As above.
Discharge point					
General condition	Fair	Discharge point and channel immediately below requires cleaning and regular maintenance.	Refer to recommendations under Spillway and Downstream Toe Area.		
Inlet works					
General condition	N/A	Not sighted due to storage level at time of inspection.	Seek advice from dams engineer and remove vegetation around inlet structure.	Short term action	High
Other comments/ observations					
Freeboard and outlet adequacy.		Large rainfall event could cause outlet pit trash screen to block and RB to overtop due to inadequate freeboard causing further damage to embankment and pipework where already compromised at outlet.	See above.		

4.3 Risk considerations

4.3.1 Overview

This section presents the findings of the consequence, spillway capacity and risk assessments conducted in respect of the dam following the inspection. Assessments were conducted as per the ANCOLD Guidelines on the Consequence Categories for Dams (2012), and the DELWP qualitative risk matrix for dams and retarding basins, all in the context of the ANCOLD Guidelines on Dam Safety Management (2003) and Guidelines on Risk Assessment (2003).

4.3.2 Consequence Assessment

A consequence assessment for this dam has been carried out, in line with the methodology detailed in Section 2 of this Report. The results of this assessment are provided in **Table 10** below.

Table 10: Summary of Consequence Assessment – Walkerville Retarding Basin

Detail	Data
PAR Estimate (Range)	<1 person
Severity of Damage and Loss Estimate	Minor
Assigned Consequence Category as per ANCOLD Guidelines on the Consequence Categories for Dams (2012)	Very Low

A consequence category of Very Low was assigned as part of this assessment. While the initial level inundation map in **Appendix B** – Walkerville Retarding Basin Initial level flood inundation mapshows four impacted dwellings, this is unlikely to occur if the eastern or southern embankments were to fail based on site topography. This demonstrates the limitations associated with the coarse topographic data used to generate the inundation extent. **Figure 4** shows the topography towards the impacted dwellings (as mapped) showing the rise in the natural surface which would limit this impact.

Figure 4: Walkerville RB – Looking south along access road toward CFA Station.

4.3.3 Spillway Capacity Assessment

No flood routing has been undertaken as part of the analysis. It has been assumed that there is no attenuation of flow through the reservoir and therefore flow in equals flow out.

Based on this approach, the spillway can safely pass a flood with a magnitude of about 0.1 m^3/s. This equates to an AEP of approximately 1 in 5.

The adopted consequence category for this dam is "**Very Low**", therefore utilising the fall-back position provided in "ANCOLD Guidelines on Selection of an Acceptable Flood Capacity (AFC) for Dams" (ANCOLD, March 2000), the spillway requires the capacity to safely pass a flood with an AEP of 1:100 to 1:1000.

The guideline suggests that the adopted flood capacity is selected within this range relative to consequences. As only a simplified consequence assessment has been completed for this project, the PAR has not been determined with sufficient accuracy to define the acceptable flood capacity (AFC) within that range. The spillway capacity appears to be inadequate based on the simple consequence assessment undertaken. A more rigorous assessment, including the determination of the incremental flood consequence category and an allowance for the attenuation provided by the reservoir will improve the accuracy of this initial level assessment. It does, however, indicate that further investigation of the spillway capacity is required as it may be significantly under the required capacity.

4.3.4 Risk Assessment

The likelihood of the four main failure modes under consideration were assessed based on the inspection and the information available. Overall the dam is in poor condition due to the possibility that piping is occurring. Using the risk matrix in **Table 2**, a likelihood of **Very Likely** and a consequence category of **Very Low** gives a risk of **Medium**.

Table 11: Summary of Risk Assessment – Walkerville Retarding Basin

Risk Area	Likelihood	Score	Key issue
Potential for Piping	Very Likely	5	Piping observed around outlet and top of embankment adjacent to outlet. Therefore highest likelihood score adopted.
Potential for slope instability	Likely	4	Wet spots observed in sections of downstream face which could lead to instability. Also, presence of woody vegetation on embankment has potential to pull out embankment material with root ball during high wind events. Animal burrows in embankment also increase potential for slope instability.
Potential for overtopping	Likely	4	Freeboard is insufficient and spillway capacity very low (1:5 AEP). However AEP of spillway capacity will become rarer once freeboard is taken into account.
Spillway/floodway failure	Likely	4	Outlet channel runs along toe of dam and flow is continuous in the winter months. Some energy dissipation provided by flow splitting blocks on d/s end of outlet pipe, however insufficient during high flow events.
Maximum Risk Rating	**Medium**		

4.3.5 Summary and Recommendations

The inspection found the dam to be in a poor condition with some serious issues identified. These are:

1. There is a large amount of vegetation on the embankment and at the toe, Seek advice from a dams engineer and remove vegetation from embankment. Short term action, High importance.
2. Seek advice from a dams engineer, dewater retarding basin and repair leakage path at outlet structure. Reinstate outlet pipe, including suitable filter material and compaction standard. Immediate term action, High importance.

3. Clear crest of vegetation and install road base material which will allow better visual indication of any movement and settlement. Medium term action, Low importance.
4. Investigate flood capacity in more detail and consider construction of a spillway for design flood to reduce risk of embankment overtopping as existing outlet is easily blocked. Ensure spillway channel diverts flow away from embankment toe as part of any new spillway design. Immediate term action, High importance.
5. Seek advice from a dams engineer and remove vegetation around inlet structure. Short term action, High importance.
6. Engage experienced dams engineer to review the adequacy and configuration of outlet structure with a view to immediate upgrade due to existing preferential flow path through embankment. Immediate term action, High importance.

The dam was assigned an ANCOLD consequence category of **Very Low** and likelihood of failure of **Very Likely** giving a risk category of **Medium**.

5. SHELLCOT ROAD RETARDING BASIN

5.1 Reservoir details

5.1.1 Physical properties

This section provides information on the known parameters of the dam and its appurtenant structures (if applicable). The information is based on limited information presented in available reports provided by South Gippsland Council in combination with visual observations and discussions with South Gippsland staff during the inspections.

The data provided in **Table 12**, should be confirmed by the Council or with a feature survey. This information should not be relied upon for anything other than to gain a general appreciation of the site.

Table 12: Site Details – Shellcot Road Retarding Basin

Type	Assessment
General site inspection details	
Site Name	Shellcot Road RB
Locality	Cnr Shellcot Rd & Ayrlie Park Crescent, Korumburra VIC 3950
Map Reference (Coordinates)	Latitude = -38.443613 Latitude = 145.82215
Asset owner	South Gippsland Shire
Describe access to site	Retarding basin is accessed via Shellcot Road. Cnr Shellcot Rd & Ayrlie Park Crescent.
Photograph of site access	Publically accessible via Shellcot Road.

Type	Assessment
	
Storage level at time of inspection	Empty.
Spillway flowing	N/A
Site data	
General purpose	Retarding basin to attenuate storm flow.
Watercourse	Ephemeral tributary of Coal Creek. Defined drainage path.
Original construction date (year)	Unknown
Subsequent upgrades or minor works	Unknown
Historic incidents	None reported
Is there a current surveillance program?	No
Historic surveillance reports reviewed? Details?	None provided
Has an Emergency Plan or inundation map been provided?	No
Catchment	
Description	Upland urban catchment (~0.28 km^2).
Determination from	ArcGIS analysis. Site inspection.
Downstream flood area	

Type	Assessment
Description	Flood path is to the south east of the RB into an existing drainage line. Discharges into stormwater drain and under Shellcot rd via a culvert into residential property adjacent to Shelloct Rd approx. 150 m d/s. Large events may cause road flooding and flooding of residence along natural drainage line.
Determination from	ArcGIS analysis and field inspection.
Dam Wall	
Construction type	Road embankment.
Upstream face type	Earthfill
Downstream face type	Earthfill
Photograph of dam wall	
Crest length (m)	65.0 m
Crest width (m)	8.0 m road embankment width
Surface area at FSL (m^2)	6,280 m^2
Upstream slope (V:H or %)	>1V:10H
Downstream slope (V:H or %)	1V:2H
Maximum height (m)	4.0 m at maximum section.
Inlet works	
Size	2 No. DN700 vertical entry inlet/ outlet pits.

Type	Assessment
Type	Direct entry pit.
Inflow source	Urban stormwater
Photograph of inlet	
Spillway	
Location	N/A
Type	N/A
Structure details	N/A
Freeboard (m)	N/A
Photograph of outlet	N/A
Outlet works	
Size	1No. DN700 RC Pipe.
Detail	Soft around headwall.
Discharge reason	Stormwater discharge.
Photograph of outlet	Outlet pit

Type	Assessment
	 Soft area beside outlet training wall (see probe penetration). 

Additional comments

N/A.

5.1.2 Aerial Site View

Figure 5: Shellcot Road Retarding Basin - Aerial Site View

5.2 Site inspection

The dam was generally found to be in satisfactory condition. A summary of the inspection findings are shown in **Table 13.**

Table 13: Site Inspection Observations – Shellcot Road Retarding Basin

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Dam wall					
Upstream batter					
General condition	Satisfactory	Firm, gentle slope. Some siltation in basin, but operating well.	N/A		
Surface condition	Satisfactory	Grass. Intermittently mown.	N/A		
Embankment crest					
General condition	Satisfactory	Bitumen road forms the crest (Ayrlie Park Crescent). Found to be in good condition. Low point near junction with Shellcot Road.	N/A		
Surface condition	Satisfactory	Bitumen road. Good condition. Low erodibility.	N/A		
Downstream batter					
General condition	Satisfactory	Soft around headwall of outlet, but generally good condition.	N/A		
Surface condition	Fair	Several large trees in embankment.	Seek advice from a dams engineer and	Long term action	Low

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
			consider removing large trees including roots within the embankment.		
Downstream Toe Area					
General condition	Satisfactory	Well maintained	N/A		
Reservoir Surrounds					
General condition	Satisfactory	Well maintained	N/A		
Spillway					
General condition	N/A	No spillway. Excess flow would overtop the embankment and flow down Shellcot Road.	Consider the history of flooding and PAR to determine whether a more controlled spill during floods would benefit the community.	Long term action	Low
Outlet works					
Intake structure or approach channel					
General condition	Fair	Grates require regular inspection and cleaning. There is potential for blockage from grass cuttings and blackberries.	Increase inspection visits in combination with an increased maintenance/weed control program.	Short term action	Low

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Outlet conduit/ pipework					
General condition	Satisfactory	Pits and pipes are in good condition.	N/A		
Discharge point					
General condition	Satisfactory	Concrete in good condition. No cracks in headwall. There was a soft spot in the fill beside the training wall.	Given the infrequent and temporary filling of the basin and low PAR it is considered that major works are unnecessary unless evidence of leakage is observed. It is recommended that more frequent inspections be implemented.	Documentation	Medium
Inlet works					
General condition	Satisfactory	Galvanised steel grates in good condition. Concrete in good condition.	N/A		
Instrumentation					
General condition	N/A				

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Other comments/ observations					
Storage basin	Satisfactory	Some siltation within basin. Vegetation within basin ranges b/w 50 mm – 500 mm.	Maintain a periodic inspection routine that will highlight any developing issues before they become too problematic.	Short term action	Medium

5.3 Risk considerations

5.3.1 Overview

This section presents the findings of the consequence, spillway capacity and risk assessments conducted in respect of the dam following the inspection. Assessments were conducted as per the ANCOLD Guidelines on the Consequence Categories for Dams (2012), and the DELWP qualitative risk matrix for dams and retarding basins, all in the context of the ANCOLD Guidelines on Dam Safety Management (2003) and Guidelines on Risk Assessment (2003).

5.3.2 Consequence Assessment

A consequence assessment for this dam has been carried out, in line with the methodology detailed in Section 2 of this Report. The results of this assessment are provided in **Table 14** below.

Table 14: Summary of Consequence Assessment – Shellcot Road Retarding Basin

Detail	Data
PAR Estimate (Range)	≥1 to < 10 people
Severity of Damage and Loss Estimate	Minor
Assigned Consequence Category as per ANCOLD Guidelines on the Consequence Categories for Dams (2012)	Low

5.3.3 Spillway Capacity Assessment

No flood routing has been undertaken as part of the analysis. It has been assumed that there is no attenuation of flow through the reservoir and therefore flow in equals flow out. As mentioned in section 2.4, where there is no spillway a qualitative assessment approach was undertaken to assess flood capacity based on site characteristics and storage surface area.

Based on this approach, it is considered that the small storage capacity and area of catchment would make it likely that the dam would overtop at the junction of Shellcot Road and Ayrlie Park Drive during significant rainfall events. The flow path would follow the small creek and any flood wave is likely to have attenuated before reaching the sole dwelling downstream.

The outlet works have a maximum discharge capacity of approximately, 1 m^3/s which equates to an AEP of about 1:2. This indicates that storms rarer than a 1:2 AEP would begin to overwhelm the outlet and increase the risk of embankment overtopping.

The adopted consequence category for this dam is "**Low**", therefore utilising the fall-back position provided in "ANCOLD Guidelines on Selection of an Acceptable Flood Capacity (AFC) for Dams" (ANCOLD, March 2000), the spillway requires capacity to safely pass a flood with an AEP of 1:100 to about 1:1,000.

The guideline suggests that the adopted flood capacity is selected within this range relative to consequences. As only a simplified consequence assessment has been completed for this project, the PAR has not been determined with sufficient accuracy to define the acceptable flood capacity (AFC) within that range. However, it is possible that the spillway capacity is inadequate based on the simple consequence assessment undertaken. A more rigorous assessment, including the determination of the incremental flood consequence category and an allowance for the attenuation provided by the reservoir will improve the accuracy of this initial level assessment. It does, however, indicate that further investigation of the spillway capacity is required as it may be under the required capacity.

5.3.4 Risk Assessment

The likelihood of the four main failure modes under consideration was assessed based on the inspection and the information available. Overall the dam is in satisfactory. Using the risk matrix in **Table 2**, a likelihood of **Possible** and a consequence category of **Low** give a risk of **Medium**.

Table 15: Summary of Risk Assessment – Shellcot Road Retarding Basin

Risk Area	Likelihood	Score	Key issue
Potential for Piping	Unlikely	2	Significant woody vegetation on downstream face of embankment. The embankment is a road and has been well compacted which when combined with the low frequency the basin holds water reduces the risk of piping.
Potential for slope instability	Unlikely	2	Engineered embankment appeared to be well constructed and compacted. Potential for slope instability unlikely.
Potential for overtopping	Possible	3	If the outlets block with debris it is possible the basin would overtop on the left hand side at the road junction.
Spillway/floodway failure	Unlikely	2	Embankment and spilling point are topped with road seal; failure considered unlikely.
Maximum Risk Rating	**Medium**		

5.3.5 Summary and Recommendations

The inspection found the dam to be in a reasonable condition with some issues identified. These are:

1. Seek advice from a dams engineer and consider removing the large trees including roots within the embankment. Long term action, Low importance.
2. Consider construction of a more formal spillway and discharge chute rather than uncontrolled discharge down Shellcot Road. Long term action, Low importance.
3. Commence a regular inspection program to monitor the condition of the retarding basin. Medium term action, Medium importance.

The dam was assigned an ANCOLD consequence category of **Low** and likelihood of failure of **Possible** giving a risk category of **Medium**.

6. HANNAH RISE RETARDING BASIN

6.1 Reservoir details

6.1.1 Physical properties

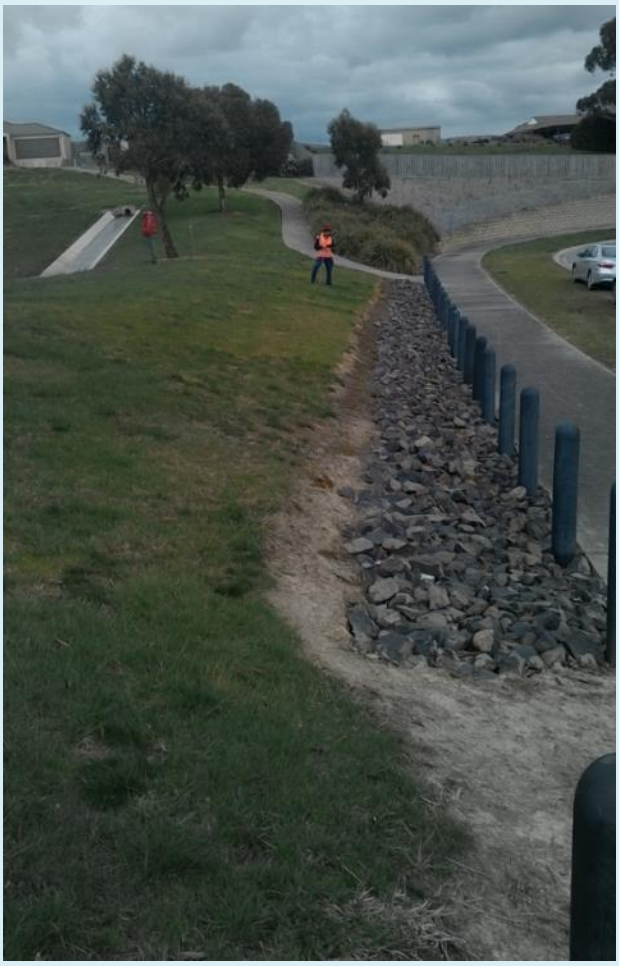
This section provides information on the known parameters of the dam and its appurtenant structures (if applicable). The information is based on limited information provided by South Gippsland Council in combination with visual observations and discussions with South Gippsland staff during the inspections.

The data provided in **Table 16**, should be confirmed by the Council or with a feature survey. This information should not be relied upon for anything other than to gain a general appreciation of the site.

Table 16: Site details – Hannah Rise Retarding Basin

Type	Assessment
General site inspection details	
Site Name	Hannah Rise Crescent RB
Locality	Korumburra
Map Reference (Coordinates)	Latitude = -38.440007 Latitude = 145.813432
Asset owner	South Gippsland Shire
Describe site access	Retarding basin is public open space recreation area. Accessible from all sides via Lauren Way and Hannah Rise Crescent.
Photograph of site access	
Storage level at time of inspection	N/A

Type	Assessment
Spillway flowing	N/A
Site data	
General purpose	Retarding basin to attenuate storm flow
Watercourse	N/A
Original construction date (year)	Pre - 2010
Subsequent upgrades or minor works	Unknown
Historic incidents	Evidence of recent overtopping. Although rock toe acts as energy dissipater and filter.
Is there a current surveillance program?	None supplied
Historic surveillance reports reviewed? Details?	None supplied
Has an Emergency Plan or inundation map been provided?	No
Catchment	
Description	Small upland urban catchment (~ 0.065 km^2).
Determination from	ArcGIS analysis and site inspection.
Downstream flood area	
Description	Flood path to the northwest of RB into residential area, ~5 dwellings d/s possibly impacted due to failure until floodwater reaches Jumbunna Rd.
Determination from	ArcGIS analysis and field inspection.
Dam Wall	
Construction type	Homogeneous earthfill
Upstream face type	Homogeneous earthfill
Downstream face type	Homogeneous earthfill with rock toe energy dissipation/ filtration strip.

Type	Assessment
Photograph of dam wall	
Crest length (m)	60.0 m
Crest width (m)	3.0 m
Surface area at FSL (m^2)	600 m^2 surface area.
Upstream slope (V:H or %)	<1V:10H
Downstream slope (V:H or %)	27% ~1V:4H
Maximum height (m)	2.0 m at maximum section.
Inlet works	
Size	1 No. DN375 inlet pipe (south western inlet) 1 No. DN500 inlet pipe (north western inlet)

Type	Assessment
Type	RC stormwater pipe.
Inflow source	Urban stormwater.
Photograph of inlet	DN375 inlet pipe (south western inlet)  DN500 inlet pipe (north western inlet) 

Type	Assessment
Spillway	
Location	Over crest length.
Type	Earth ogee with rock toe filtration strip (energy dissipation and possibly stormwater treatment).
Structure details	Refer above dimensions
Freeboard (m)	N/A
Photograph of outlet	Refer to photo two above.
Outlet works	
Size	Pit 1,200 mm x 900 mm Outlet pipe RC DN450 (assumed – couldn't visibly assess due to debris).
Detail	Pit with trash screen within low flow concrete channel.
Discharge reason	Stormwater discharge.
Photograph of outlet	Refer to photo directly above.

Additional comments

N/A

6.1.2 Aerial Site View

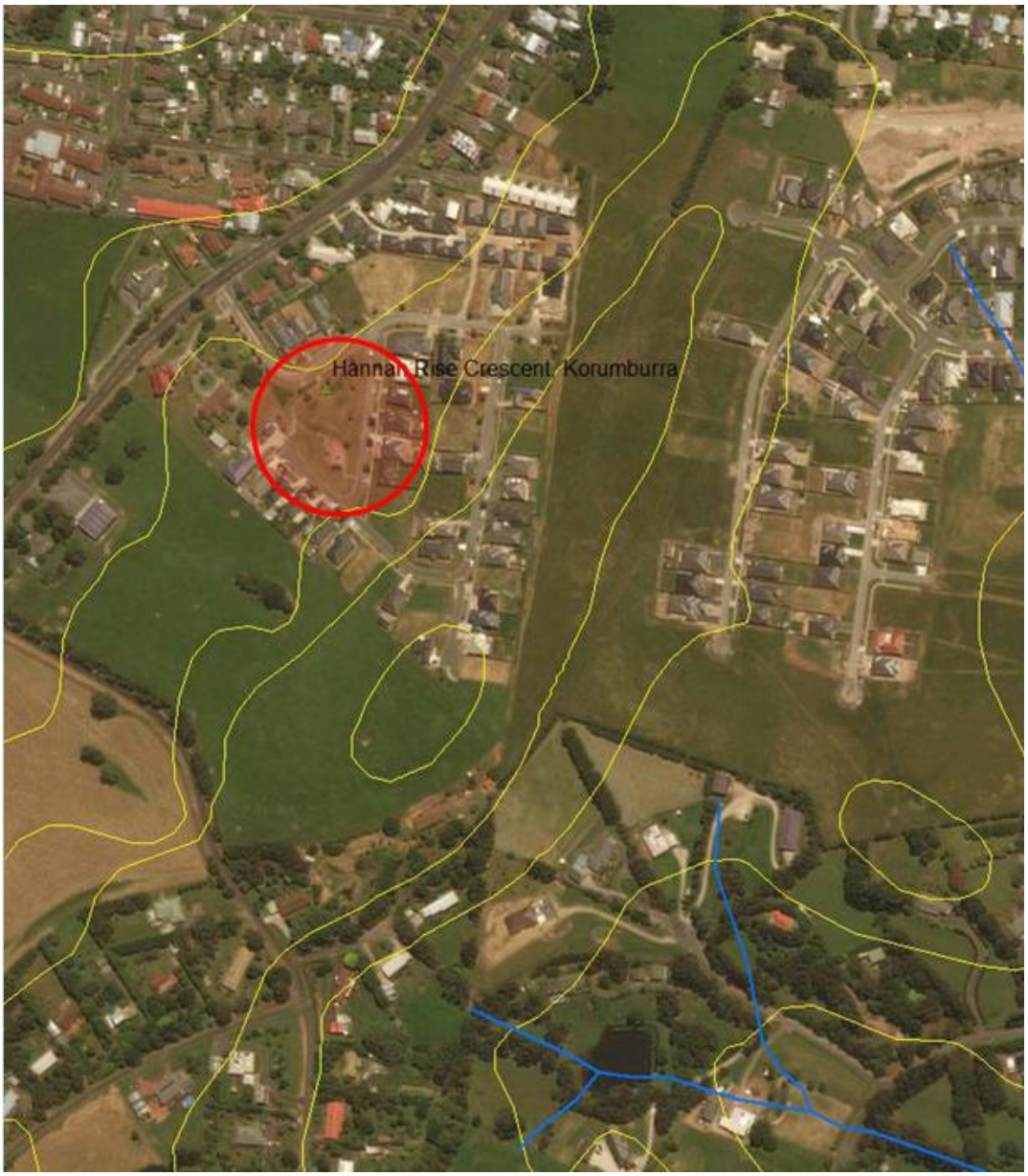


Figure 6: Hannah Rise Retarding Basin - Aerial Site View

6.2 Site inspection

The retarding basin was generally found to be in satisfactory condition with a number of areas for action identified. A summary of the inspection findings is provided in **Table 17**.

Table 17: Site Inspection Observations – Hannah Rise Retarding Basin

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Dam wall					
Upstream batter					
General condition	Satisfactory	Shallow slope and low height. Batter in very good condition.	N/A		
Surface condition	Satisfactory	Grassed and well maintained	N/A		
Embankment crest					
General condition	Fair	Trees within embankment.	Need to monitor. Good dam practice is to remove large vegetation from an embankment but given the infrequent and temporary nature of storage the aesthetics of retaining the trees may outweigh the very low risk of them causing issues. If trees are to be removed, seek advice from a dams engineer prior to carrying out.	Consider	Low
Surface condition	Satisfactory	Grassed and well maintained.	N/A		

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Downstream batter					
General condition	Satisfactory	Mown and firm when probed.	N/A		
Surface condition	Satisfactory	Grassed and well maintained.	N/A		
Downstream Toe Area					
General condition	Satisfactory	Looked to be operating well. Rockfill clear of debris and blockage.	N/A		
Reservoir Surrounds					
General condition	Satisfactory	Well maintained.	N/A		
Spillway					
General condition	Fair	Refer to comments on embankment crest.	Refer embankment crest comment above.		
Outlet works					
Intake structure or approach channel					
General condition	Poor	Grate blocked with debris from recent rain event.	Requires regular inspection and cleaning following rainfall.	Medium	High

Type	Assessment	Detail	Recommendation	Urgency Rating	Importance Rating
Outlet conduit/ pipework					
General condition	Not sighted.	Buried.	N/A		
Discharge point					
General condition	Not sighted.	Buried. Assumed to discharge into a larger stormwater drainage system.	N/A		
Inlet works					
General condition	Satisfactory	Concrete in good condition.	N/A		
Instrumentation					
General condition	N/A	None observed.			
Other comments/ observations					
Overtopping impacts	Poor	Up to five dwellings impacted if RB overtops.	Regular maintenance of the structure is required, particularly the outlet pit grate to ensure the structure operates to its full capacity during storms.	Short term action	High

6.3 Risk considerations

6.3.1 Overview

This section presents the findings of the consequence, spillway capacity and risk assessments conducted in respect of the dam following the inspection. Assessments were conducted as per the ANCOLD Guidelines on the Consequence Categories for Dams (2012), and the DELWP qualitative risk matrix for dams and retarding basins, all in the context of the ANCOLD Guidelines on Dam Safety Management (2003) and Guidelines on Risk Assessment (2003).

6.3.2 Consequence Assessment

A consequence assessment for this dam has been carried out, in line with the methodology detailed in Section 2 of this Report. The results of this assessment are provided in **Table 18** below.

Table 18: Summary of Consequence Assessment – Hannah Rise Retarding Basin

Detail	Data
PAR Estimate (Range)	≥ 1 to < 10
Severity of Damage and Loss Estimate	Minor
Assigned Consequence Category as per ANCOLD Guidelines on the Consequence Categories for Dams (2012)	Low

6.3.3 Spillway Capacity Assessment

No flood routing has been undertaken as part of the analysis. It has been assumed that there is no attenuation of flow through the basin and therefore flow in equals flow out.

Based on this approach, the spillway can pass a flood with a magnitude of about 1.5 m^3/s. This equates to an AEP of approximately 1 in 500. If this magnitude flood were to eventuate (i.e. entire length of ogee crest spilling), significant flooding of houses downstream should be expected.

The adopted consequence category for this dam is "**Low**", therefore utilising the fall-back position provided in "ANCOLD Guidelines on Selection of an Acceptable Flood Capacity (AFC) for Dams" (ANCOLD, March 2000), the spillway requires the capacity to safely pass a flood with an AEP of 1:100 to about 1:1,000.

The guideline suggests that the adopted flood capacity is selected within this range relative to consequences. As only a simplified consequence assessment has been completed for this project, the PAR has not been determined with sufficient accuracy to define the acceptable flood capacity (AFC) within that range. However, on the current assessment the flood capacity appears reasonable.

6.3.4 Risk Assessment

The likelihood of the four main failure modes under consideration were assessed based on the inspection and the information available. Using the risk matrix in **Table 2**, a likelihood of **Possible** and a consequence category of **Low** gives a risk of **Medium**.

Table 19: Summary of Risk Assessment – Hannah Rise Retarding Basin

Risk Area	Likelihood	Score	Key issue
Potential for Piping	Unlikely	2	Trees planted across embankment length could initiate piping, however trees currently immature.
Potential for slope instability	Rare	1	Low height, rare filling, good geometry, good compaction and no signs of cracking indicates slope instability very unlikely.
Potential for overtopping	Possible	3	Outlet screen was blocked at time of inspection which could lead to overtopping in large storm events.
Spillway/floodway failure	Rare	1	Spillway looked well constructed and contained adequate flow dissipation and embankment erosion protection.
Maximum Risk Rating	**Medium**		

6.3.5 Summary and Recommendations

The inspection found the retarding basin to be in good condition with only some minor issues identified. These include:

1. Consider removing trees from the embankment but given the infrequent operation this is not critical. Low importance.
2. Regular cleaning of outlet grate to lessen the risk of the embankment overtopping. Short term action, high importance.
3. Regular periodic inspections should be commenced to monitor the condition of the retarding basin. Short term action, high importance

The dam was assigned an ANCOLD consequence category of **Low** and likelihood of failure of **Possible** giving a risk category of **Medium**.

7. Dam safety conclusions & recommendations

7.1 Overview

There were four dams inspected in the South Gippsland Shire region with a number of issues identified, some of them serious that require further investigation. Whilst this is a high level study and conservative in many ways, the inspections and follow up analysis have indicated some obvious deficiencies.

7.2 Conclusions

The condition of the dams inspected varied from reasonable to unsatisfactory. The consequence category of the dams was also identified. This was an initial level assessment and may change if a more comprehensive assessment is carried out.

The dams were assessed in accordance with the ANCOLD Guidelines as noted above in the Report. An 'initial' level consequence assessment was carried out for each site by mapping the downstream inundation extent using a GIS-based approach developed specifically for this project. This assessment estimated the PAR and Severity of Damage and Loss for a breach of the embankment to assign Consequence Category in accordance with the ANCOLD Guidelines on the Consequence Categories for Dams (2012). A summary of these results is provided below.

Site	PAR	Severity of Damage and Loss	Consequence Category
Foleys Road Dam	<1	Minor	Very Low
Walkerville RB	<1	Minor	Very Low
Shellcot Road RB	≥1 to < 10	Minor	Low
Hannah Rise RB	≥1 to < 10	Minor	Low

The spillway capacity for each dam was assessed using the approaches highlighted in **Section 2.4** of this report. Results were varied, however spillway capacities or arrangements were generally found to be inadequate.

A qualitative risk assessment was also carried out for each site to assign an overall risk rating based on (a) the Consequence Category and (b) the Likelihood Rating of the predominant failure mode. The results of this assessment are summarised in the table below.

Site	Potential for:				Overall risk rating
	Piping	Slope instability	Overtopping	Spillway failure	
Foleys Road Dam	5	4	4	1	Medium
Walkerville RB	5	4	4	4	Medium
Shellcot Road RB	2	2	3	2	Medium
Hannah Rise RB	2	1	3	1	Medium

7.3 Recommendations

There are a number of recommendations for further action. Many of them are considered immediate or short term actions and/or urgent and should be promptly reviewed and actioned by SGSC. Detailed recommendations are included in the Site Inspection Observation tables in **Sections 3.2**, **4.2**, **5.2** and **6.2**. More general recommendations are made below.

Site Inspections

- The profile of dam embankments was observed to be irregular at some sites, particularly at Foleys Road dam which had a non-homogeneous embankment, steep downstream slope and covered in large trees. Similarly, Walkerville retarding basin had numerous trees on the embankment and piping around the outlet pit and pipe. Measures to remediate or assess the full extent of these issues are included earlier in this report.
- Not having a formed spillway increases the risk of overtopping. At three sites (Foleys Road dam, Walkerville and Shellcot retarding basins), there was no spillway. Any overtopping at these sites will likely result in erosion damage to the embankments as well as Council infrastructure in some cases (e.g. Shellcot Road). Consideration should be given to having the sites reviewed by an experienced dams engineer with the view to incorporating a spillway within each of the above mentioned structures.
- Visual inspections of the embankments and appurtenant works is a critical part of an ongoing dam safety management program. As a result, it is important that long grass, debris (i.e. dead branches) and vegetation that would obscure visual inspections be slashed, sprayed or removed. Key areas where this was observed included the upstream face, crest, downstream face, downstream toe area, spillway and outlet works.
- Trees are not recommended to grow on or near a dam embankment. However, the removal of old, large trees is not recommended without prior assessment from experienced dams engineers and horticultural experts, as the root systems of large trees may be prevalent throughout the embankment. The removal of significant trees from the embankment should be considered and planned. As a minimum, low level branches should be cut back and these areas should be

regularly monitored for signs of instability and piping. No planting of the embankments should be undertaken and any new saplings should be sprayed or removed by hand before they establish into mature trees.

- An established grass cover should be encouraged and well maintained on dam embankments, particularly along the downstream face. Grass cover, if well maintained can provide some protection along a dam crest however gravel or bitumen cover is recommended. The upstream face of dam embankments should also be provided with rip rap (rock) protection if there are signs of deterioration from wave action and erosion.
- Implement the Surveillance and Maintenance Plans and Dam Safety Emergency Plans (DSEP) and carry out annual reviews of these documents.

Consequence Assessments

The consequence assessments undertaken for these storages were carried out at an 'initial level' in accordance with ANCOLD Guidelines on Consequence Categories (2012).

A more rigorous consequence assessment will be more accurate and there is a good chance that the adopted consequence categories may change if more sophisticated methods are adopted. Given the possible consequences of dam failure, it is recommended that a more detailed consequence assessment for all retarding basins (with the exception of Foley's Rd Dam in Yanakie) within the SGSC region be carried out to more accurately identify:

- The dambreak flood inundation zone; and,
- The Population at Risk and potential loss of life due to dam failure.

This will better inform the level of management and surveillance required for each dam and the ANCOLD design standards that apply.

Spillway Capacity Assessment

The spillway assessments were conducted at a screening level that were appropriate for this study. They have identified that all dams have relatively low flood capacities. In particular those for Foleys Road dam, Walkerville and Shellcot retarding basins are of immediate concern and should be followed up with more detailed studies that include more sophisticated hydrologic and hydraulic modelling techniques.

Risk Assessment

The study has indicated that all the four SGSC dams that were inspected have a Medium risk rating.

Whilst these assessment outcomes may be refined following a more rigorous assessment, this report demonstrates that there are several areas requiring action for dams/ retarding basins within the SGSC region.

8. Appendices

8.1 Appendix A – Foleys Road Dam Initial level flood inundation map

Legend

Dam — Indicative Dam Break Flow Path — Major Roads

Method

The flood inundation mapping technique adopted for this project is consistent with the Initial Level Flood Assessment methodology prescribed in the Guidelines on the Consequence Categories for Dams (ANCOLD, 2012) (i.e. a flood height equal to half the height of the dam embankment is projected downstream with attenuation distance a function of storage volume). This assessment approach is conservative and is likely to overestimate actual consequences due to dam failure. Where indicative flood extents determined by the model were deemed unrealistic, engineering judgement was used to manually edit the extent.

GIS techniques, including the development of D8 flow and flow accumulation diagrams, were used to generate the inundation zones, based on digital elevation model (DEM) data provided by VICMAP.

Whilst experience and judgement has been put into developing and reviewing the flood inundation zone, this map should only be considered as an indication of the real extent. Decisions involving upgrades to the dam should be based on a more comprehensive assessment.

0 40 80 120 Metres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid GDA 1994 VICGRID94

N

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Department of Environment, Land, Water and Planning

Foley Road Dam

Yanakie VIC 3960

Date: 2 March 2018 Revision: A

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Data source: DELWP, LGA Dams, 02/2017; DELWP, VicMap Aerial overview, 2010.

8.2 Appendix B – Walkerville Retarding Basin Initial level flood inundation map

Legend

Indicative Flood Inundation Retarding Basin Major Roads

Method

The flood inundation mapping technique adopted for this project is consistent with the Initial Level Flood Assessment methodology prescribed in the Guidelines on the Consequence Categories for Dams (ANCOLD, 2012) (i.e. a flood height equal to half the height of the dam embankment is projected downstream with attenuation distance a function of storage volume). This assessment approach is conservative and is likely to overestimate actual consequences due to dam failure. Where indicative flood extents determined by the model were deemed unrealistic, engineering judgement was used to manually edit the extent.

GIS techniques, including the development of D8 flow and flow accumulation diagrams, were used to generate the inundation zones, based on digital elevation model (DEM) data provided by VICMAP.

Whilst experience and judgement has been put into developing and reviewing the flood inundation zone, this map should only be considered as an indication of the real extent. Decisions involving upgrades to the dam should be based on a more comprehensive assessment.

0 125 250 375 Metres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid GDA 1994 VICGRID94

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Walkerville Retarding Basin

Walkervillle VIC 3956

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Data source: DELWP, LGA Dams, 02/2017; DELWP, VicMap Aerial overview, 2010.

8.3 Appendix C – Shellcot Road Retarding Basin Initial level flood inundation map

Legend

Indicative Flood Inundation | Retarding Basin | Major Roads

Method

The flood inundation mapping technique adopted for this project is consistent with the Initial Level Flood Assessment methodology prescribed in the Guidelines on the Consequence Categories for Dams (ANCOLD, 2012) (i.e. a flood height equal to half the height of the dam embankment is projected downstream with attenuation distance a function of storage volume). This assessment approach is conservative and is likely to overestimate actual consequences due to dam failure. Where indicative flood extents determined by the model were deemed unrealistic, engineering judgement was used to manually edit the extent.

GIS techniques, including the development of D8 flow and flow accumulation diagrams, were used to generate the inundation zones, based on digital elevation model (DEM) data provided by VICMAP.

Whilst experience and judgement has been put into developing and reviewing the flood inundation zone, this map should only be considered as an indication of the real extent. Decisions involving upgrades to the dam should be based on a more comprehensive assessment.

0 60 120 180 Metres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid GDA 1994 VICGRID94

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Shellcot Road
Korumburra VIC 3950

Date: 2 March 2018 Revision: A

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Data source: DELWP, LGA Dams, 02/2017; DELWP, VicMap Aerial overview, 2010.

8.4 Appendix D – Hannah Rise Retarding Basin Initial level flood inundation map

Legend

Indicative Flood Inundation Retarding Basin Major Roads

Method

The flood inundation mapping technique adopted for this project is consistent with the Initial Level Flood Assessment methodology prescribed in the Guidelines on the Consequence Categories for Dams (ANCOLD, 2012) (i.e. a flood height equal to half the height of the dam embankment is projected downstream with attenuation distance a function of storage volume). This assessment approach is conservative and is likely to overestimate actual consequences due to dam failure. Where indicative flood extents determined by the model were deemed unrealistic, engineering judgement was used to manually edit the extent.

GIS techniques, including the development of D8 flow and flow accumulation diagrams, were used to generate the inundation zones, based on digital elevation model (DEM) data provided by VICMAP.

Whilst experience and judgement has been put into developing and reviewing the flood inundation zone, this map should only be considered as an indication of the real extent. Decisions involving upgrades to the dam should be based on a more comprehensive assessment.

0 25 50 75 Metres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid GDA 1994 VICGRID94

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Hannah Rise Crescent
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Date: 2 March 2018 Revision: A

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Data source: DELWP, LGA Dams, 02/2017; DELWP, VicMap Aerial overview, 2010.

8.6 Appendix E - List of Abbreviations and glossary of terms

List of abbreviations

Abbreviation	Description
AEP	Annual Exceedance Probability
AFC	Acceptable Flood Capacity (ANCOLD March 2000)
AHD	Australian Height Datum
ANCOLD	Australian National Committee on Large Dams
DCF	Dam Crest Flood Day
DSEP	Dam Safety Emergency Plan
dia	Diameter
EL	Elevation Level
FSL	Full Supply Level
H	Horizontal
h	Hour
m	Metre
ML	Mega Litre
PAR	Population at Risk
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RL	Reduced Level
s	Second
V	Vertical
WL	Water Level
yr	Year

Glossary of terms

Term	Description
ALARP (As Low As Reasonably Practicable) Principle:	That principle which states that risks, lower than the limit of tolerability, are tolerable only if further risk reduction is impracticable, or if its cost is grossly disproportionate (depending on risk level) to the improvement gained.
Annual Exceedance Probability (AEP):	The probability of a specified magnitude of a natural event being exceeded in any year.
Abutment:	That part of the valley side against which the dam is constructed.
Appurtenant Works:	All ancillary structures of a dam including, but not limited to, spillways, inlet and outlet works, tunnels, pipelines, penstocks, power stations and diversions.
Base of Dam:	The general foundation area of the lowest portion of the main body of the dam.
Catchment:	The land surface area which drains to a specific point, such as a reservoir.
Collapse:	The physical deformation of a structure to the point where it no longer fulfils its intended purpose.
Consequence:	Effects of an action or event.
Controlled Document:	A document subject to managerial control over its content, distribution and storage. It may have legal or contractual implications.
Dam:	An artificial barrier, together with appurtenant works, constructed for storage, or control of water, other liquids, or other liquid-borne material (excluding concrete/steel ring tanks reliant on hoop stress for structural stability). This classification normally excludes canals and levees, but these guidelines may be used as a basis for developing safety management plans for these structures, if the need exists.
Dam Construction Engineer:	A professional engineer who is suitably qualified and recognised by the engineering profession as experienced in dams construction.
Dam Crest Flood:	The flood event which, when routed through the reservoir, results in a still water reservoir level at the lowest crest level of the dam.
Dam Designer:	Any person, organisation or entity undertaking the design of a dam.
Dam Owner:	Any person, organisation or entity legally deemed to be the owner of a dam.
Dam Safety Emergency Plan (DSEP):	A continually updated set of instructions and maps that deal with possible emergency situations or unusual occurrences at or related to a dam or reservoir.

Term	Description
Dams Engineer:	A professional engineer who is suitably qualified and recognised by the engineering profession as experienced in the engineering of dams and its various subfields.
Data Book/ Base:	An abbreviated convenient source of information summarising all pertinent history and records related to the safety of a dam that is required to assess the performance and safety of a dam.
Decommissioned Dam:	Decommissioned Dam: A dam which has been taken out of service and which has been rendered safe in the long term.
Designer Operating Criteria (DOC):	Comprehensive operating criteria which state the dam designer's intentions in the use and operation of equipment and structures in the interest of safe, proper and efficient use of the facilities.
Disaster Plan (Flood Plan):	A plan developed by emergency management agencies to provide community protection in the event of emergencies (e.g. floods).
Disused Dam:	A dam where the storage is no longer used.
Emergency:	An emergency in terms of dam operation is any condition which develops unexpectedly, endangers the integrity of the dam or downstream property and life and requires immediate action.
Failure:	The uncontrolled release of the contents of a dam through collapse of the dam or some part of it, or the inability of a dam to perform its design functions, such as water supply, or hazardous substance containment.
Flood Control Dam:	A dam which temporarily stores or controls flood runoff and includes dams used to form flood retarding basins.
Foundation:	The undisturbed material on which the dam structure is placed.
Free board:	The vertical distance between a stated water level and the lowest level of the non-overflow section of a dam.
Full Supply Level (FSL):	The maximum normal operating water surface level of a reservoir when not affected by floods.
Hazard:	The threat or condition which may result from an external cause (eg flood, earthquake) with the potential for creating adverse consequences.
Hazard (Consequence) Category:	The scale of adverse consequences subsequent to a dam failure (see ANCOLD Consequences Guidelines 2000a).
Height of Dam:	Normally the maximum height from the lowest point of the general foundation area to the top of the dam. (Some legislation takes the lowest point along the downstream toe.)

Term	Description
Incident:	An event which could deteriorate to a very serious situation or endanger the dam.
Inspection (Dam):	A careful and critical viewing and examination of all visible aspects of a dam.
Inspector (Dam Safety):	A technical person suitably trained to undertake dam safety inspections.
Maintenance:	The routine work required to maintain existing works and systems (civil, hydraulic, mechanical and electrical) in a safe and functional condition.
Monitoring:	The observing of measuring devices that provide data from which can be deduced the performance and behavioural trends of a dam and appurtenant structures, and the recording and review of such data.
Operator (Dam):	The person, organisation, or legal entity which is responsible for the control, operation and maintenance of the dam and/or reservoir and the appurtenant works.
Outlet Works:	The combination of intake structure, conduits, tunnels, flow controls and dissipation devices to allow the release of water from a dam.
PMP Design Flood:	The flood derived from the PMP using AEP neutral assumptions.
Population at Risk (PAR):	All persons directly exposed to floodwaters within the dam break affected zone if they took no action to evacuate.
Probability:	The likelihood of a specific event or outcome.
Probable Maximum Flood (PMF):	The flood resulting from PMP and, where applicable, snow melt, coupled with the worst flood-producing catchment conditions that can be realistically expected in the prevailing meteorological conditions.
Probable Maximum Precipitation (PMP):	The theoretical ~deepest depth of precipitation for a given duration that is physically possible over a particular catchment area, based on generalised methods.
Project Manager:	The person accountable for management of a project.
Recommended Design Flood (RDF):	The flood event which has, the recommended annual exceedance probability or proportion of PMF inflow and which produces the highest flood for the dam.
Regulator:	The person or organisation that administers the relevant Act that controls aspects of dam safety.

Term	Description
Remedial Action:	Any action required to rectify a deficiency to an adequate safety standard.
Reservoir:	An artificial lake, pond or basin for storage, regulation and control of water, silt, debris or other liquid or liquid-borne material.
Reservoir Capacity:	The total or gross storage capacity of the reservoir at FSL.
Retarding Basin:	A type of flood mitigation dam used to temporarily store some, or all, of the stormwater runoff from an urban catchment.
Risk:	A measure of the probability and severity of an adverse effect to life, health, property, the environment or business concerns.
Safety Review:	The assessment of dam safety by methodical examination of all design and surveillance records and reports, and by the investigation and analysis of matters not addressed previously or of items subject to new design criteria or possible deterioration.
Seepage (Leakage):	The unregulated escape of water through, under or around the dam.
Spillway:	A weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the reservoir normally under flood conditions or in anticipation of floods.
Spillway Crest:	The lowest portion of the spillway overflow section.
Surveillance:	The continuing examination of the condition of a dam and its appurtenant structures and the review of operation, maintenance and monitoring procedures and results in order to determine whether a deficient trend is developing or appears likely to develop.
Tailwater Level:	The level of water in the channel immediately downstream of a dam.
Toe of Dam:	The junction of the downstream (or upstream) face of dam with the ground surface (foundation). Sometimes "Heel" is used to define the upstream toe of a concrete gravity dam.
Top (Crest) of Dam:	The elevation of the uppermost surface of a dam proper, not taking into account any camber allowed for settlement, kerbs, parapets, crest walls, guardrails or other structures that are not a part of the main water retaining structure. This elevation may be a roadway, walkway or the non-overflow section of a dam.