SOUTHERN HIGHLANDS REGIONAL SHOOTING COMPLEX (SHRSC)

Sampling & Analysis Quality Plan

2021-22 Annual Operational Monitoring Program Report

SEPT 2022

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Prepared for

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Appendix 1: Laboratory results (attached as separate xls.)

Part A: Background to Monitoring Event and SAQP

1 Introduction

1.1 Background to Document

This report forms part of the annual monitoring program for the Southern Highlands Regional Shooting Complex (SHRSC) and support the performance of the Operational Monitoring Program as detailed within Section 5 of the SHRSC Water Cycle Management Plan.

The monitoring undertaken may also be modified on site depending on site observations or in response to recommendations made as part of previous sampling exercises.

1.2 Structure of Document

This Report has been written in general accordance with the Guidelines for Consultants reporting on Contaminated Sites (OEH 2011) and National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999 (Amended 2013) specifically Section 4, Section 7 and Schedule B5a Guideline on Ecological Risk Assessment.

This document is presented in two parts;

Part A – Background to Monitoring Event and SAQP

Part B – Monitoring Program Implementation and Report

2 Background information

2.1 Site Location

The Southern Highlands Regional Shooting Complex (SHRSC) is located in the Wingecarribee LGA on Wattle Ridge Road, approximately 5.5 km northwest of the centre of the village of Hill Top in the southern highlands of New South Wales. The catchment for the site is between the upper reaches of the Nepean River and other rivers such as the Wollondilly, Nattai, Bargo and Wingecarribee. These rivers flow into the Nepean River further to the north. See Figure 1 – Site Location.

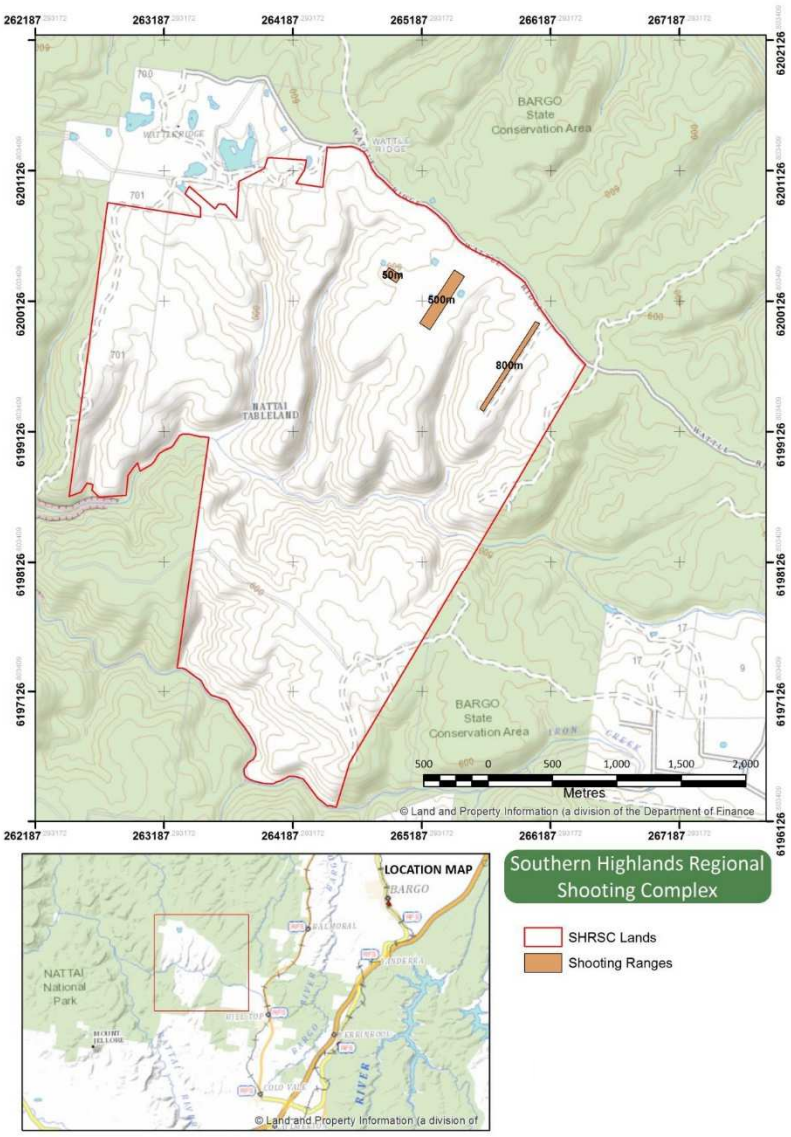

FIGURE 1: Site Location

1,036 hectares (ha) of land has been excised from the Bargo State Conservation Area by means of the National Parks and Wildlife (Adjustment of Areas) Act 2006. The SHRSC occupies an area of approximately 16 ha within this land. The remainder of the land on the site (approximately 1,000 ha) has been retained in its existing condition as a vegetation buffer zone. This area acts as a safety zone for the SHRSC.

2.2 Current Zoning

Figure 2 presents the current zoning of the SHRSC as SP1: Special Activities – Shooting Range referenced from the NSW Department of Planning SEPP 2005. For the purposes of this contamination assessment the area within the range will therefore be considered 'recreational and open space'.

The SP1 areas are bounded by a large parcel of land zoned E2: environmental conservation. This E2 land includes the receiving catchments of the shooting ranges from the Wattle Ridge Range to the nearest water course of Rocky Waterholes Creek. For the purposes of this SAQP the area outside the range is considered 'recreational and open space.

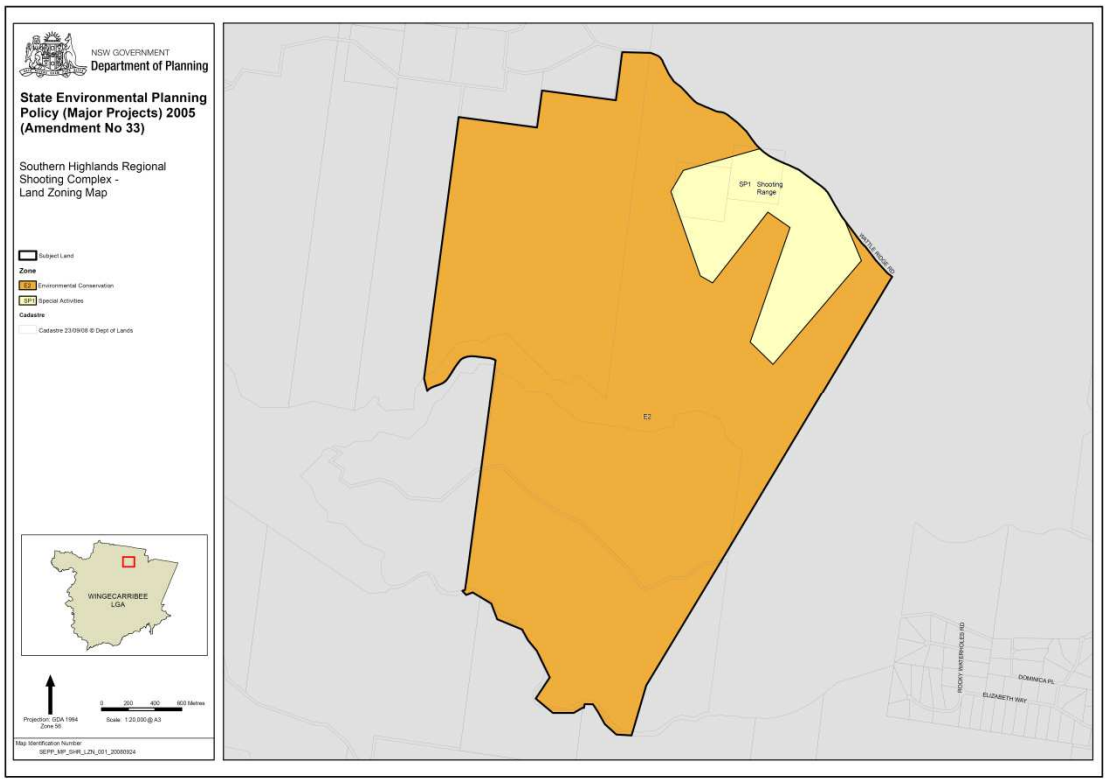

FIGURE 2: SHRSC Zoning Plan showing SP1 Special Activities and E2 Environmental Conservation

Table 1 below summarises the information relevant to the site.

TABLE 1 : SHRSC Information and Land Use

Site information	
Owner	Office of Sport
Operator	Office of Sport
Address	Wattle Ridge Rd
Lot and DP	100 DP1088254
County /Parish	Camden County, Cumbertine Parish
Local Government Area	WINGECARRIBEE
Zoning	SP1 Special Activities
Land Use (current)	Shooting range or proposed shooting range
Land Use (proposed)	Shooting range
Applicable LEP	Wingecarribee Local Environmental Plan 1989

2.3 Surrounding Land Use and Sensitive Receptors

The site is bounded by:

- Wattle Ridge – a grazing property/residence which adjoins the site to the northwest (located approximately 2.5 km north of the existing range);
- Bargo State Conservation Area to the southwest;
- A 330 kV cleared electricity easement (Transgrid) to the southeast; and
- Wattle Ridge Road to the northeast.

Bargo State Conservation Area is located further southwest, southeast and northeast. Nattai National Park is located further to the northwest, on the opposite site of the Wattle Ridge property. Nattai National Park is accessible from the end of Wattle Ridge Road approximately 3 km away.

Sensitive receptors include Rocky Waterholes Creek, located approximately 1.5 km south of the site. The creek is a tributary of the Nattai River. The Nattai River is located approximately 7.5 km west of the site.

2.4 Site Setting

The information in the sections below with respect to the physical setting at the site and the surrounding environment has been referenced from:

NSW Sport and Recreation *Southern Highlands Regional Shooting Complex Environmental Assessment (Volume 1****) GHD*** *February 2008*

2.4.1 Geology

The underlying geology of the site comprises the Hawkesbury Sandstone of the Mittagong Formation (Herbert and Helby: 1980: pp256). The site lies within an outcrop of the Narrabeen group, which comprises sandstone, claystone and siltstone. The Hawkesbury sandstone overlies a Triassic shale unit – the Wianamatta Group. Geologically, the site is transitional between the Cumberland Plain of the Sydney Basin and the southern uplands.

2.4.2 Soils

The three main groups of soils that occur within the regional environment are:

- Sandstone tableland soils;
- Valley soils (sandstone derived); and
- Soils associated with nutrient rich shales and igneous rocks.

Land surfaces on the site do not appear to have been significantly reworked cut or in-filled. Some grading has been undertaken at the ranges to construct the fairways and the Stop-butts. Deeper excavations and possible import of materials has occurred as part of the construction of the retention basins.

These soil landscape types are unstable when disturbed. They are highly susceptible to mass movement, such as slides and rock falls, as well as wind and water erosion (Hazelton and Tille: 1990).

2.4.3 Topography

The (SHRSC) is characterised by relatively flat topography and is situated on spur lines that trends to the north from the Wattle Ridge Range. The spur-line occupies a position between tributaries of the Rocky Waterholes Creek. All watercourses are upper tributaries of the Nattai River. Topographically the site is transitional between the Cumberland Plain of the Sydney Basin and the southern uplands.

2.4.4 Hydrology

Review of climate data for the region indicates that there is some variability in the rainfall with the maximum mean monthly rainfall of 93.8 mm in March, while the minimum mean monthly rainfall recorded is about 43.7 mm in September. The average annual rainfall is approximately 848 mm.

Rocky Waterholes Creek, which is immediately south of the proposal location, drains directly to the Nattai River approximately 6 km to the west of the existing Hill Top Rifle Range. The Nattai River drains north to Lake Burragorang.

The Hawkesbury Nepean Catchment Management Authority has classified 98% of the Nattai River as being 'Near Intact'.

The catchment of Rocky Waterholes Creek is approximately 23.5 km^2, whilst the catchment of the Nattai River upstream of the junction with Rocky Waterholes Creek is approximately 240 km^2. The total catchment area of the Nattai River upstream of Lake Burragorang is approximately 480 km^2.

Given the site location and the surrounding physical environment, the site is to be designed to the regulate / retain run off of the surface water and sediment from the stop butt and the range areas using site drainage measures that discharge to designated retention basins. The site design aims to minimise the net sediment load migrating off site under heavy rainfall conditions throughout the year.

2.4.5 Groundwater

The site is located within the Hawkesbury Sandstone – southeast groundwater flow system, which consists of layered aquifer system with yields ranging from less than one to 50 litres per second.

Basalt caps are expected to occur in some areas of the Mittagong Ranges, with groundwater from this horizon discharging into seeps, springs and rivers (Sydney Catchment Authority: 2006).

According to the Department of Natural Resources Groundwater Licence database, groundwater within the Hill Top area was found to be present at depths of approximately 20 metres in the sandstone aquifer.

The depth to groundwater within the aquifers is expected to be dependent on rainfall and therefore is likely to vary seasonally. However, groundwater is expected at depths greater

than 15 metres below ground level. Drilling undertaken on 12 and 13 July 2007 at the (SHRSC) location indicated no obvious groundwater table present within 50 metres below ground level. Based on the reported depth to groundwater on the site being greater than 50m below ground level, potential for surficial contaminants to impact ground water existing beneath the operational ranges is therefore considered to be of low likelihood. Groundwater assessment was therefore not considered to be necessary as part of this site assessment.

2.4.6 Surrounding Groundwater Use

The Bureau of Meteorology Australian Ground Water Explorer (http://www.bom.gov.au/water/groundwater/explorer/map.shtml) and the DPI Office of Water ground water data base was sued to search for bores within 800m of the site.

A number of monitoring bores were reported to be located within 2-5km of the site with no water quality data available. Two stock domestic bores were reported to be located within 5km.

- GW114443
  A 120m stock/domestic bore located in the Hilltop Village approximately 3.2km to the south east of the site.

- GW065725
  A 122m stock/domestic bore located around Wattleridge approximately 5k to the north of the site

Based on the results of the bore search and the reported local water quality the NEPM 1999 (amended 2013) ground water investigations levels (GILs) suitable for the protection of fresh water species should therefore be adopted as the assessment criteria for this SAQP.

3 SHRSC Description

The SHRSC is a regional recreational shooting complex incorporating the existing 800 metre Hill Top Rifle Range (HTRR) and separate newly constructed facilities located approximately 700m to the North West. The HTRR has been used since the 1980s by a local club for long rifles and pistol use.

It includes:

- A 800m range consisting of a of a single target area and stop butt with multiple firing points on raised mounds located at 100m intervals. In 2018-19 the 800m range was subject to major civil works to improve and rehabilitate the stop butt and surrounds.
- Club house and out buildings
- Informal parking

The newly constructed facilities include:

- A (500 metres by 100 metres) shooting range consisting of a single firing point and multiple target points set in front of intermediate mounds. A final large stop butt is provided at the end of the range;
- A (50 metres by 115 metres) shooting range consisting of 6 separated galleries each single firing point and large stop butt;
- Supporting facilities and infrastructure, including:
  - Range control and Toilet facilities;
  - Access roads (designed for two-wheel drive vehicle access) connecting to Wattle Ridge Road and between the ranges;
  - Diesel generator, solar panels, water supply tanks and septic system;
  - Informal parking for 160 cars; and
  - Basins to contain water for water quality control purposes.

- Future facilities include:
  - A (200 metres by 85 metres) shooting range;
  - A shotgun range;
  - An indoor air range (21 metres by 17 metres by 6.5 metres); and
  - A Clubhouse

Environmental controls are included in the design for the ranges at the SHRSC. These specific environmental controls are discussed following.

3.1 Water Quality Structures

A single pond or informal retention structure is located to the east of the 800m range primarily taking water from the access road adjacent to the range.

Four water quality structures/ retention basins have been constructed as part of the development of the of the 50m, 200m (yet to be built) and 500m ranges. A fifth Structure is proposed as part of a future shot gun range.

Additionally, works have been undertaken to modify an existing pond/structure located near the gate to the new ranges from Wattle Ridge Road. All structures above will be referred to in this Plan as “basins” including the informal ponds.

Figure 3 shows the layout at the SHRSC. Range and basin numbers are also indicated.

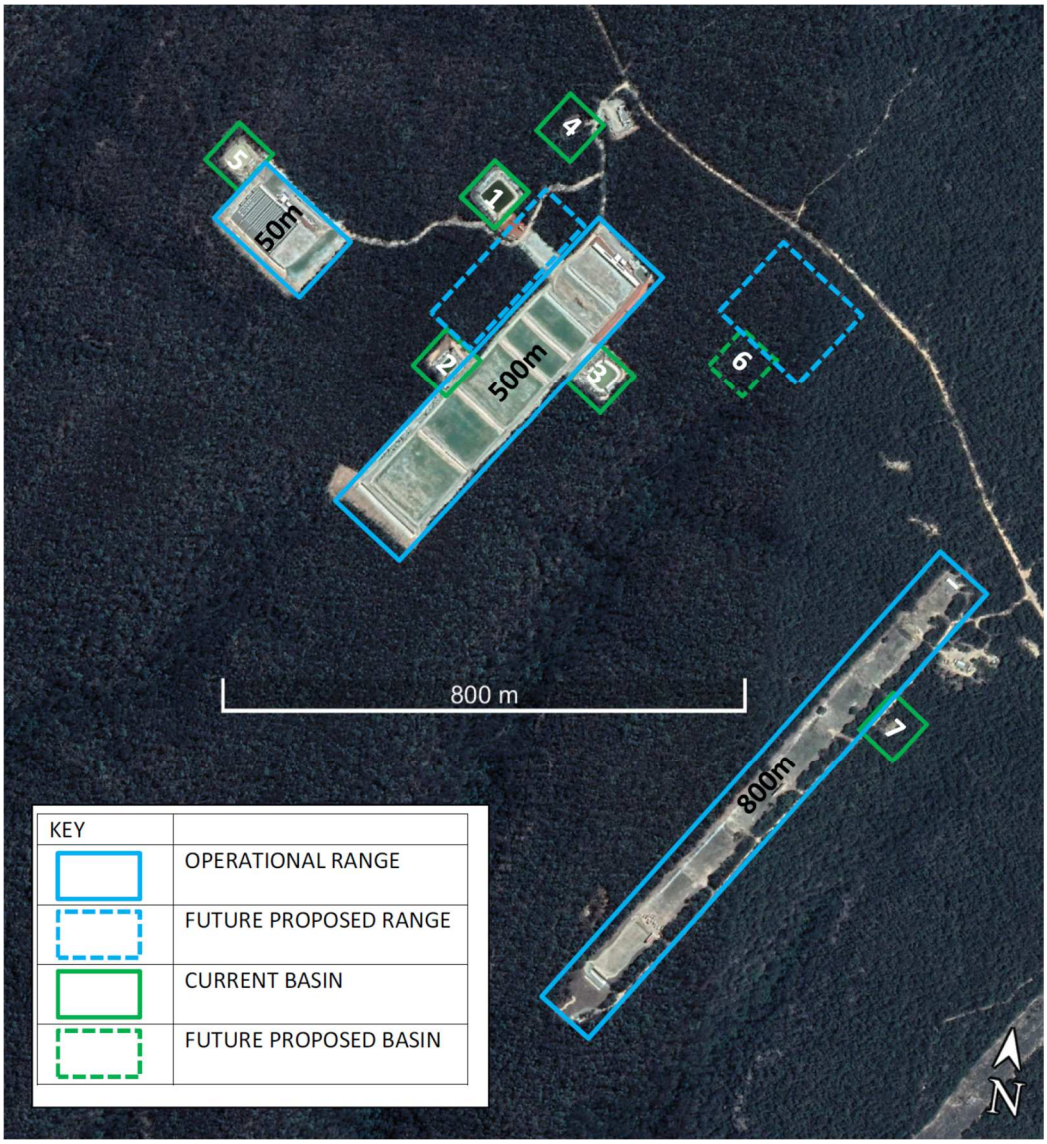

FIGURE 3: Site Layout of the SHRSC

3.2 Lime Treatment and Drainage

As part of the rehabilitation works to the 800m range and construction of the 500m and 50m ranges improved drainage measures were included. This drainage consists of a network of sub soil drainage trenches set down gradient of primary impact areas leading to lime treatment pits to raise pH and reduce the transport of heavy metals from the range areas. Stormwater lines from these treatment pits either lead to formal outlet measures or to new basins.

The 800m range has an additional pit to retain water/sediment for testing purposes as is the case for the basins at the 50 and 500 ranges. Lime pits and directional pits do not retain water.

Figure 4 provides schematic of the collection trenches, and the lime treatment pits

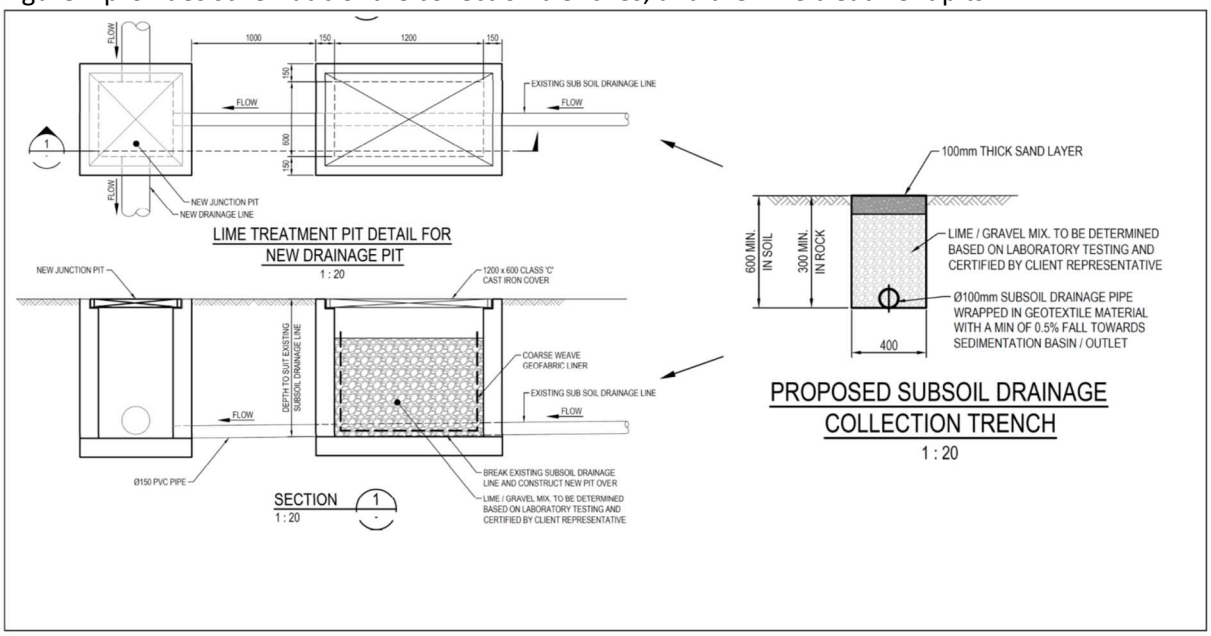

FIGURE 4: Lime treatment and Drainage Details.

3.3 Stopbutts and Bullet Catchers

As part of the rehabilitation works to the 800m range and construction of the 500m and 50m ranges specialised bullet catchers were included in the construction of the final stop butts for all the ranges. These bullet catchers consist of 300mm gravel layer enclosed in treated pine timber boxing and are designed to reduce potential for bullet skip or ricochet. The gravel also acts to allow free drainage to collection trenches and the lime treatment process reducing potential for leaching of contaminants to the sub surface.

Figure 5 provides an indicative bullet catcher and stop butt detail.

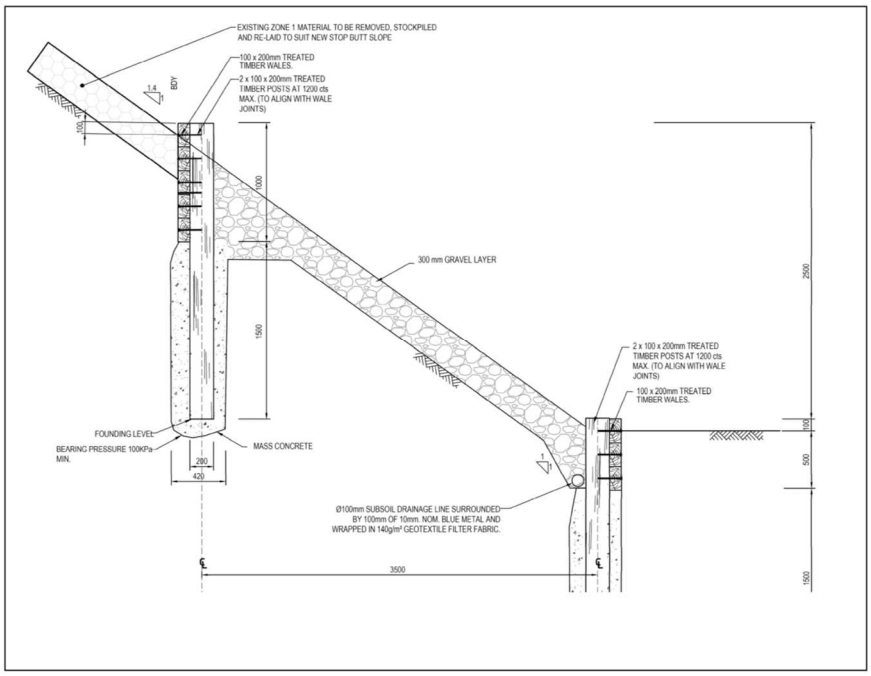

FIGURE 5: Bullet Catcher and Stop Butt Detail.

4 Quality Assurance and Data Control

4.1 Data Quality Objectives (DQO) Process

The DQO process is a seven (7) process applied to optimise the design of the sampling and analysis and to ensure that all objectives of the investigation are met.

DQOs have been developed to detail the type of data that is needed to meet the overall objectives of this project. The DQOs presented in this document have been developed consistent with the following published guidance;

- National Environment Protection Council (1999) National Environmental Protection Measure 1999 as amended 2013 – Assessment of Site Contamination. Schedule B(2) Guideline on Site Characterisation (NEPC 2013);
- NSW DECC (2007) Guidelines for the Assessment and Management of Groundwater Contamination;
- NSW DECC (2006) Guidelines for the NSW Site Auditor Scheme (2nd Edition);
- NSW EPA (1995) Sampling Design Guidelines;
- NSW EPA (2000) Guidelines for Consultants Reporting on Contaminated Sites;
- Australian/New Zealand Standard, AN/NZS 4360:2004, Risk Management – Principles and guidelines; and
- Australian/New Zealand Standard, AN/NZS 5667.11:1998, Water Quality – Sampling - Guidance on sampling of ground waters.

The seven (7) steps are outlined, as follows:

Step 1: State the Problem – concisely describe the problem to be studied. Review prior studies and existing information to gain a sufficient understanding to define the problem;
Previous assessments, range design and current usage indicate potential contamination issues associated with the stop butt and immediate surrounds, primary and secondary shot fall areas AND drainage pathways. Further investigation is needed to confirm the location, nature and extent of contamination (if present) and to determine what further action may be required.

Step 2: Identify the Decision – identify what questions the study will attempt to resolve, and what actions may result; ***The primary question(s) that this investigation will attempt to resolve are ….***
What are the characteristics of any contamination if present in the range and surrounds? Is further action e.g. a risk assessment or Remediation Action Plan (RAP) required to address any contamination issues? Are additional works required to respond to ongoing contamination and mitigate any risk to the surrounding environment?

Step 3: Identify the Inputs to the Decision – identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement;
The locations for sampling are presented in a Sampling Rationale Matrix for each range (see Sect 6). The contaminants of potential concern in soil/sediment/water have been selected based on the past and use as a shooting facility.

Contaminants of potential concern are presented in the list of Analytes within the SAQP Tables for each range (see Section 6.0)

Results will be assessed against the following guidelines
ANZECC 2000 Water Quality and Sediment Quality Guidelines and
NEPM 1999 (amended 2013) Health Investigation Levels (HILs) and Ecological Investigation Levels (EILs) for Soil.
(HILs) C. Parks, recreational open space and playing fields: includes secondary schools.
(HILs) D. Commercial/Industrial: includes premises such as shops and offices as well as factories and industrial sites.
NEPM (2013) HIL D criteria do not appear to be applicable on the site and have been referenced for information purposes only. The site is zoned SP1 Special Activities for the purposes of a shooting range under the State Environmental Planning Policy (State Significant Precincts) 2005. There are areas outside the ranges themselves within the SHRSC that are zoned E2 Environmental Conservation.

Specific investigation levels for the contaminants of potential concern are presented in Section 6 Site Assessment Criteria

Step 4: Define the Study Boundaries – specify the time periods and spatial area to which decisions will apply. Determine when and where data should be collected;

The investigation is confined to range areas including fairway, rear of stop butt and associated drainage as shown in Figure 3.

No investigation will be conducted outside of the site boundaries as the areas of concern are on top of a spur line/hill and contaminant migration has been limited vertically and horizontally by design layout and area usage.

Soil sampling will be conducted around the face of the stop butt plus from areas immediately down gradient from areas which receive bullet impacts.

Sampling will also be undertaken down gradient of the stop butt in overland/surface flow lines and within the area at the rear of the stop butt where surface water exits the site.

Samples will be collected surrounding bushland areas in close proximity to the ranges

Water and Sediments will be taken from basins within the SHRC in addition to adjacent creeks off the range but where these can be readily accessed below the outlet points of the basins.

Step 5: Develop a Decision Rule – define the statistical parameter of interest, specify the action level, and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions;

The proposed sampling density/frequency across the subject assessment area has not been strictly prepared to comply with the NSW EPA sampling density guidelines based on the assessment area.

The sampling strategy is based on previous assessments of site condition, range design, knowledge of site use and shot fall and the condition of the surrounding environment. The strategy is therefore considered sufficient to characterize contaminant impacts at the area in general accordance with the NSW EPA Sampling Design Guidelines.

The sampling frequency as acceptable for the purposes of site audit as it is in general accordance with the NSW EPA Sampling Design Guidelines.

Additional targeted sampling may be undertaken based on site observations during the site

inspection;
If the contaminants in the soil outside defined shot fall areas are identified above the adopted assessment criteria then the soil should be considered as potentially contaminated and then either subjected to further risk assessment AND/OR remediated AND/OR managed accordingly.

If concentration of contaminants in sediments or water samples is identified above the adopted assessment criteria then the sampled areas should be considered as potentially contaminated and then managed accordingly. Augmentation of drainage from the stop butt area should be considered.

Step 6: Specify Tolerable Limits on Decision Errors – define the decision maker's tolerable decision error based on a consideration of the consequences of making an incorrect decision.

Data generated during this project must be appropriate to allow decisions to be made with confidence.

The potential decision errors must be identified, the potential consequences evaluated and the severity of decision error consequences assessed, the null hypothesis must be defined and what level of false positive or false negative decision error will be acceptable for the site assessment must be specified.

Considering the current and ongoing use as a recreational shooting range it has been determined that the two decision errors for the contaminants of concern are:

Type I error – deciding that site soils are within the assessment criteria when they truly are not; and
Type II error – deciding that site soils exceed the assessment criteria when they truly do not.

The consequences of deciding that the soils exceed the assessment criteria when they truly do not, will be further human health and/or ecological risk assessment and/or active remediation/management of site soils.

The consequences of deciding that the soils do not exceed the remediation acceptance criteria when they truly do, will be that contaminated soils will be left unmanaged on the site and may potentially endanger human health or pose ongoing risks to the environment. Additionally, the owners of the site may be liable for future damages and environmental clean-up costs.

For site soils, sediments and water and for each respective contaminant of concern, the baseline condition or null hypothesis is “the soils/sediments/water levels exceed the assessment criteria”. The alternative hypothesis is “the soils/sediments/water levels are within the assessment criteria”.

It is noted that the past and ongoing use of the site is such that contamination is expected and that ongoing contamination of specific areas will be unavoidable. As such management of the site as a potentially contaminated area is the default approach.

Samples will be analysed at a National Association of Testing Authorities (NATA) Accredited Laboratory and as per the laboratory’s Quality Assurance targets.

Step 7: Optimise the Design – evaluate information from the previous steps and generate alternative data collection designs. Choose the most resource-effective design that meets all DQOs.

The proposed data collection design has been described in Section 6: SAQP and is expected to satisfy the DQOs.

Targeted sampling will be conducted to accurately define the lateral and vertical extent of contaminants expected at the site.

5 Conceptual Site Models (CSM)

5.1 800m Range: Conceptual Site Model (CSM)

The figure below provides a schematic CSM for the 800m range target area and surrounds. The CSM below aims to identify the following aspects relevant to the 800m range, they are:

- Areas of potential concern;
- Contaminants of potential concern;
- Potential contaminant expoure or migration pathways; and the
- Human and/or ecological receptors.

Additional elements of the CSM are discussed in the sections following.

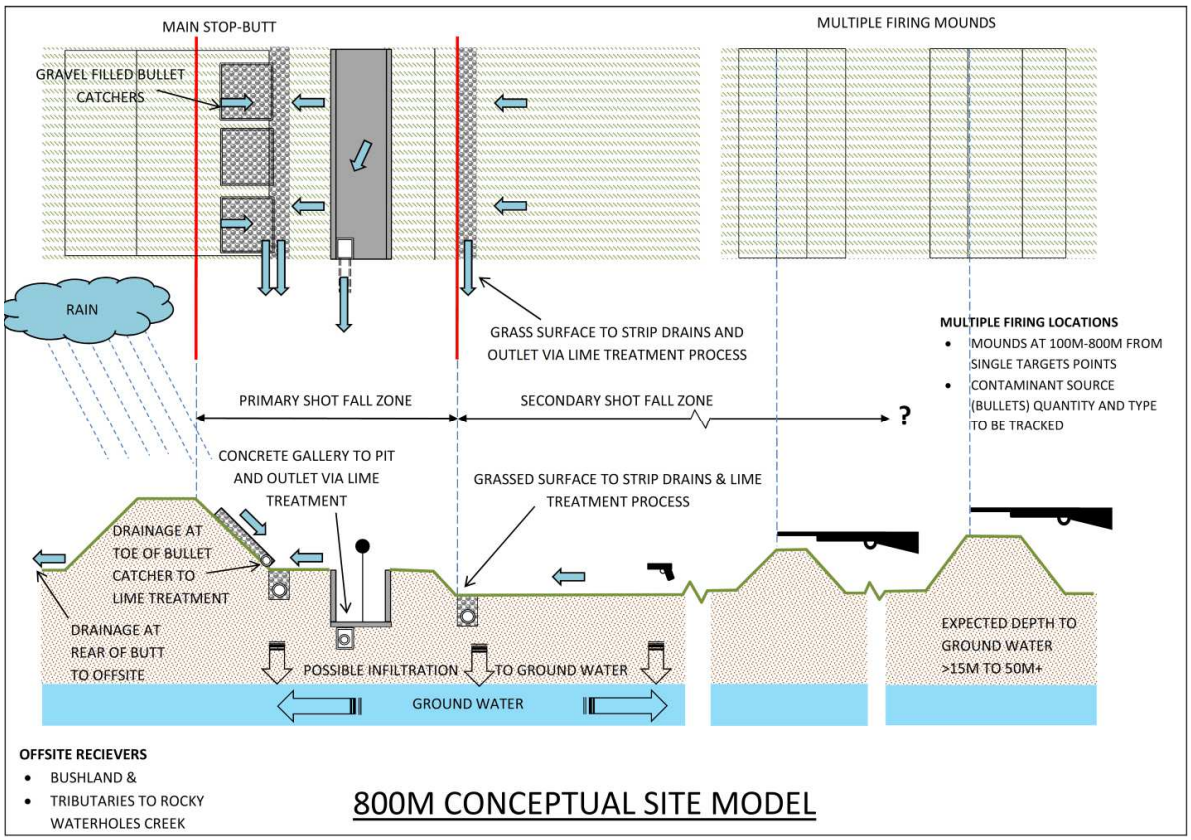

FIGURE 6: 800m Range: Conceptual Site Model (CSM)

5.1.1 Existing infrastructure and layout

Stop butt and target area

The primary potential area of concern identified at the 800m range is the target area, stop butt, bullet catcher, and surrounds.

The 800m range target area consists of target frames which are manually controlled from within a safe ~3m deep trench (or gallery). This gallery provides access to the stop butt for maintenance and is set below the line of fire.

In-front of the gallery there is a smaller mound or mantlet running the full length of the gallery and the target area. The purpose of this mantlet is to capture low projectiles and low ricochets, to protect the gallery from repeated strikes and protect the back side of the gallery by defining the firing line for targets so that it is backed by the stop butt.

At the rear of the gallery, a large earthen mound forms the stop butt. Directly behind the targets gravel filled boxes or bullet catchers are set on the face of the stop butt. These boxes act to capture bullet strikes after they have passed through the targets.

In addition, there are multiple firing mounds along the range spaced at 100m intervals set at 100-800m from the target area. A defined firing area used by pistol shooters is located on flat ground at approximately 25m from the targets.

A gallery area has been provided in-front of the stop butt face.

Formal and informal drainage system

A secondary area of potential concern identified at the 800m range is the new drainage system from the stop butt leading off site to the South East.

The rear area of the stop butt drains via a single channel to the south. This channel discharges over a flat area located 100-110m to the rear of the targets. Water then makes its way to natural drainage channels and upper tributaries of Rocky Waterholes Creek.

5.1.2 Sources of contamination and potential contaminants of concern

The OEMP for the SHRSC requires record keeping of the number of rounds /volume of bullets fired and the type of bullets fired so that annual estimates of shot fall can be calculated for each range for management purposes.

The 800m range is designed so that all bullets strike the mantlet face or the stop butt behind the target into the bullet catchers. These are the primary impact areas.
The material at the primary impact areas of the 800m range are able to be removed and sifted to remove bullet fragments or relocated for further treatment and/or removed from site as part of maintenance activities.

It is possible that some bullets may be fired over the stop butt entirely or similarly into the intermediate firing mounds along the range length prior to the target area (the secondary impact areas) however given this is a supervised range, this loss should be in very low volumes.

A broad suite of sample analytes was proposed within this SAQP given the potential variety of ammunition used at the range. However, the primary contaminant of concern at the 800m range is considered to be Lead (Pb). Lead is the predominant consitutent of ammunition shot used in most higher calibre rifles which have been used at the range.

The nominated suite of analytes for this site assessment is presented in Section 6.1 Tables 3A, B &C.

5.1.3 Identified contaminant migration pathways

The primary process for migration of contaminants from the stop butt and surrounds is identified to be via surface runoff and infiltration into the subsurface. Maintenance of stable ground cover over the surface acts to minimise potential for generation of dust from the area and also reduce potential for erosion and mobilisation of sediments. Maintenance may also include application of ameliorants to maintain a stable soil pH.

The CSM indicates the current pathways for surface water movement:

- The stop-butt benches and gallery drains as to the south east via new formal drainage infrastructure including subsoil drains, pits and open drains.
- Surface water runoff from the mantlet and the area immediately in front flows with other surface water from the range area to various points at the range perimeter.
- The area at the rear of the stop butt drains to the south via an open channel.
- Surface water at the side of the target area flows to the perimeter of the range.

The potential exists for leaching and vertical migration of contaminants into the subsurface from the primary and secondary shot fall areas. This potential is mitigated by the design of the gravel bullet catcher at the primary shot fall area which moves water more quickly to the formal drainage.
Depth to ground water is not known at the 800m range however based on the environmental assessment undertaken prior to construction of the SHRSC, groundwater is considered unlikely to be impacted by the contaminants of potential concern on the site. Therefore impacts on sources of potential water supply are not a consideration and as such Groundwater Investigations (GILs) for Fresh Waters will be used as the assessment level for management response.

5.1.4 Identified exposure routes

Three possible human exposure routes have been identified for the lead shot present at the range, they are:

- Direct contact by range users with lead impacted soils and shot
- Migration/infiltration of lead impacted surface water into retention ponds/basins and recreational water resources;
- Inhalation/ingestion of airborne lead impacted dust.

Direct contact

Two shot fall areas have been identified where direct contact (includes ingestion or absorbtion through the skin) with lead present in soil or shot by range users is possible where areas are not managed.
The primary impact areas where direct shot is received are the stop-butt face and the face of the mantlet. The secondary areas impact areas are the gallery and the areas in front of the mantlet. These areas in are shown on the CSM diagram.

Surface Water migration

Runoff and infiltration of rainwater that becomes impacted with lead could potentially have a low level impact on nearby downgradient surface water receptors however specific site drainage and water quality measures have been included in the design of the SHRSC to address and mitigate this potential.

Airborne dust ingestion/inhalation

Soil particles contaminated with lead around shot fall areas can become dry and be mobilized by wind events to either migrate off site or be ingested/inhaled by range users where areas are not managed.

5.1.5 Identified Receptors

The number of potential receptors identified are consistent between all the ranges at the SHRC:

- The SHRSC is situated within the Bargo State Conservation Area and is next to Nattai National Park which are known recreational areas and are home to local flora and fauna.
- The SHRSC is situated on a ridge line and drains to multiple drainage lines in the upper catchment. These are tributaries to Rocky Waterholes Creek which is a potential recreational water resource.
- SHRSC users and the general public visit the facility under supervised management protocols.

Receptor exposure will be managed under the OEMP which will take into account the specific shot fall patterns, ground cover requirements and direction of surface water movement at each range.

Site access restrictions and maintenance of suitable ground cover at the areas of potential concern will reduce the likelihood of direct human exposure to contaminants at the source.

5.2 50m: Conceptual Site Model (CSM)

The figure below provides a schematic CSM for the 50m range target area and surrounds. The CSM below aims to identify the following aspects relevant to the 50m range, they are:

- Areas of potential concern;
- Contaminants of potential concern;
- Potential contaminant expoure or migration pathways; and the
- Human and/or ecological receptors.

Additional elements of the CSM are discussed in the sections following.

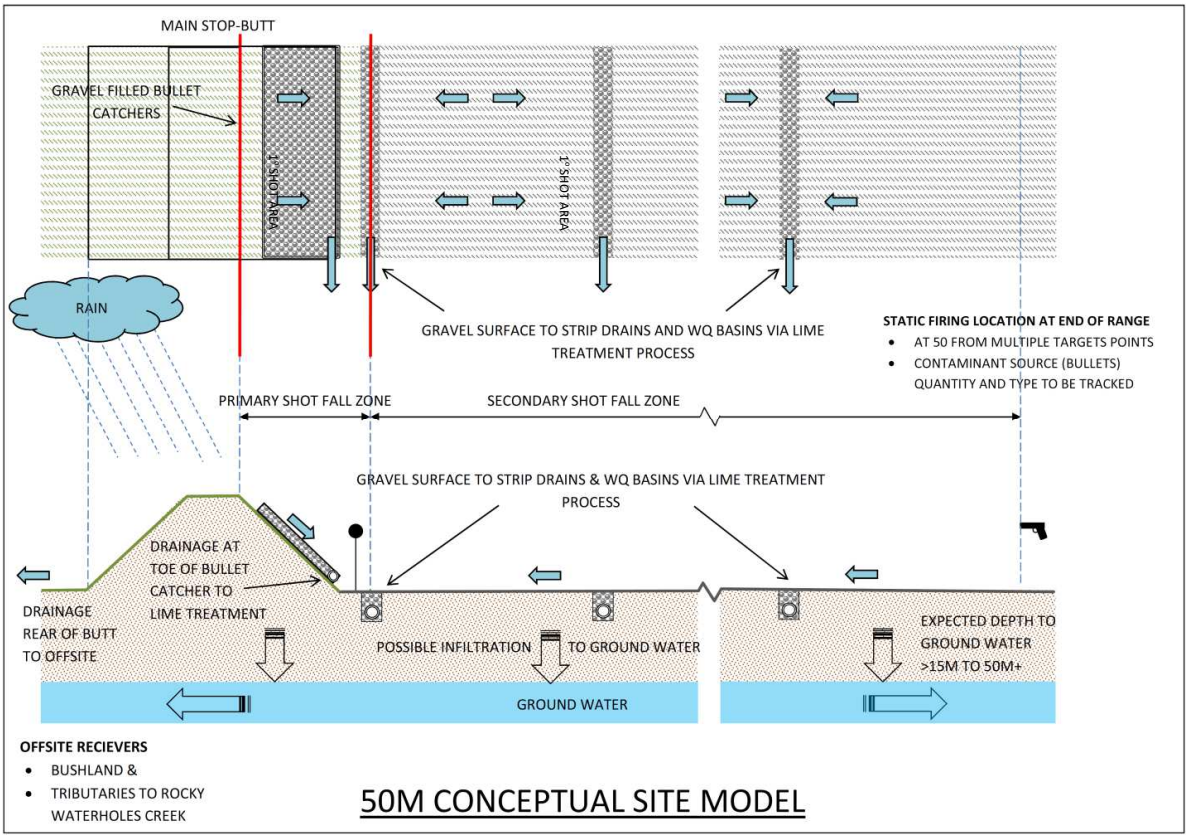

FIGURE 7 - 50m: Conceptual Site Model (CSM)

5.2.1 Existing infrastructure and layout

Stop butt and target area

The primary potential areas of concern identified at the 50m range are the target area, stop butt, bullet catcher, and surrounds.

The 50m Range consists of a five individual ranges separated by concrete dividing walls each with a single line of firing positions and a single stop butt behind the targets. The individual ranges are designed for varying uses; four are fully enclosed with gravel on the floor. The fifth range is more open with a grassed surface.

Behind the targets, a gravel filled bullet catcher is proved at the face of the stop butt.

Formal and informal drainage system

A secondary area of potential concern identified at the 50m range is the new drainage system from in front of the stop butt leading to Basin 5.

It is possible that some shot fall will occur within the floor area of the ranges.

Refer to Figure 8 for the current 50m Range layout.

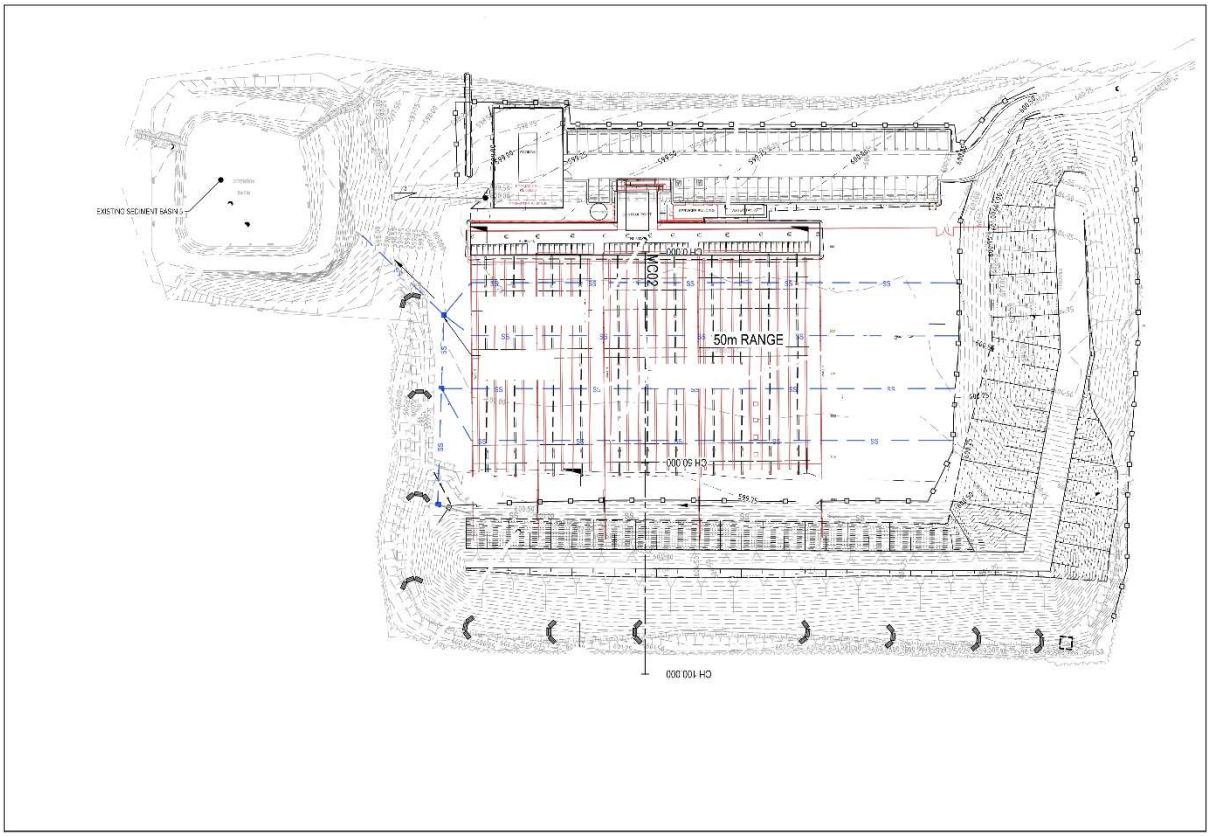

FIGURE 8 - 50m Range Layout

5.2.2 Sources of contamination and potential contaminants of concern

The 50 and 500m ranges are used by recreational and competitive shooters. The OEMP for the SHRSC requires record keeping of the number of rounds /volume of bullets fired and the type of bullets fired so that annual estimates of shot fall can be calculated for each range for management purposes.

The 50m range is designed so that all bullets strike the stop butt behind the target into the bullet catchers. These are the primary impact areas. Other areas within the range (e.g. the range floor) may receive bullet fall, ricochet or skip from the primary impact area. These are indicated as secondary impact areas on Figure 7.

The butt and bullet catcher at the 50m is designed to prevent the skipping of bullets or fragments to the rear of the butt. Ongoing sampling includes the rear of the stop-butt to confirm the effectiveness of design. It is possible that some bullets may be fired over the stop-butt entirely however, given this is a supervised range this loss should be in very low volumes.

The material at the primary impact areas of the 50m range are able to be removed and sifted to remove bullet fragments or relocated for further treatment and/or removed from site as part of maintenance or construction activities.

The type of bullets will be used to confirm the range of analytes for ongoing sampling. A broad suite of sample analytes is proposed within this SAQP given the potential variety of ammunition used at the range. However, the primary contaminant of concern at the range is considered to be Lead (Pb).

The suite of anolytes is presented in Section 6.2 Tables 5A, B & C

5.2.3 Identified contaminant migration pathways

The primary process for migration of contaminants from the primary and secondary impact areas and surrounds would be via surface runoff and potentially leaching to ground water. Maintenance of stable ground cover over the surface acts minimise potential for generation of dust from the area and also reduce potential for erosion and mobilisation of sediments. Maintenance may also include application of ameliorants to maintain a stable soil pH.

The CSM diagram indicates the pathways for surface water movement:

- A collection trench runs in-front of the stop butt of the 50m Range which directs surface water via a pipe to the lime treatment pit and then to the water quality basin
- No surface water from possible shot-fall areas (primary and secondary) is able to bypass the drainage to the Water Quality Basins.
- The new water quality basin has stable gabion spillways. The basins discharge to the natural catchment and then ultimately to the tributaries of Rocky Water Holes Creek.

The potential exists for leaching and vertical migration of contaminants into the subsurface from the primary and secondary shot fall areas. This potential is mitigated by the design of the gravel bullet catcher at the primary shot fall area which moves water more quickly to the formal drainage.

Environmental Assessment undertaken prior to the construction of the SHRSC presented that groundwater is expected at depths greater than 15m and likely greater than 50m (Refer to 2.4.5 Groundwater). Therefore impacts on sources of potential water supply are not a consideration and as such Groundwater Investigations (GILs) for Fresh Waters will be used as the assessment level for management response.

5.2.4 Identified exposure routes

Three possible human exposure routes have been identified for the lead shot present at the range, they are:

- Direct contact by range users with lead impacted soils and shot
- Migration/infiltration of lead impacted surface water into retention ponds/basins and recreational water resources;
- Inhalation/ingestion of airborne lead impacted dust

Direct contact

Two impact areas have been identified where direct contact (includes ingestion or absorbtion through the skin) with lead present in soil or shot by range users is possible where areas are not managed.

The primary impact areas where direct shot is received are the stop-butt face and the face of the mantlet.

The secondary areas impact areas are the floor of the range especially in front of the target area and potentially at the rear of the stop butt. These areas in are shown on the CSM diagram.

Surface Water migration

Runoff and infiltration of rainwater that becomes impacted with lead could potentially have a low-level impact on nearby downgradient surface water receptors however specific site drainage and water quality measures have been included in the design of the SHRSC to address and mitigate this potential.

Airborne dust ingestion/inhalation

Soil particles contaminated with lead around shot fall areas can become dry and be mobilized by wind events to either migrate off site or be ingested/inhaled by range users where areas are not managed.

5.2.5 Identified Receptors

The number of potential receptors identified are consistent between all the ranges at the SHRC:

- The SHRSC is situated within the Bargo State Conservation Area and is next to Nattai National Park which are known recreational areas and are home to local flora and fauna.
- The SHRSC is situated on a ridge line and drains to multiple drainage lines in the upper catchment. These are tributaries to Rocky Waterholes Creek which is a potential recreational water resource.
- SHRSC users and the general public visit the facility under supervised management protocols.

Receptor exposure will be managed under the OEMP which will take into account the specific shot fall patterns, ground cover requirements and direction of surface water movement at each range.

Site access restrictions and maintenance of suitable ground cover at the areas of potential concern will reduce the likelihood of direct human exposure to contaminants at the source.

5.3 500m Range: Conceptual Site Model (CSM)

The figure below provides a schematic CSM for the 500m range target area and surrounds. The CSM below aims to identify the following aspects relevant to the 50m range, they are:

- Areas of potential concern;
- Contaminants of potential concern;
- Potential contaminant expoure or migration pathways; and the
- Human and/or ecological receptors.

Additional elements of the CSM are discussed in the sections following.

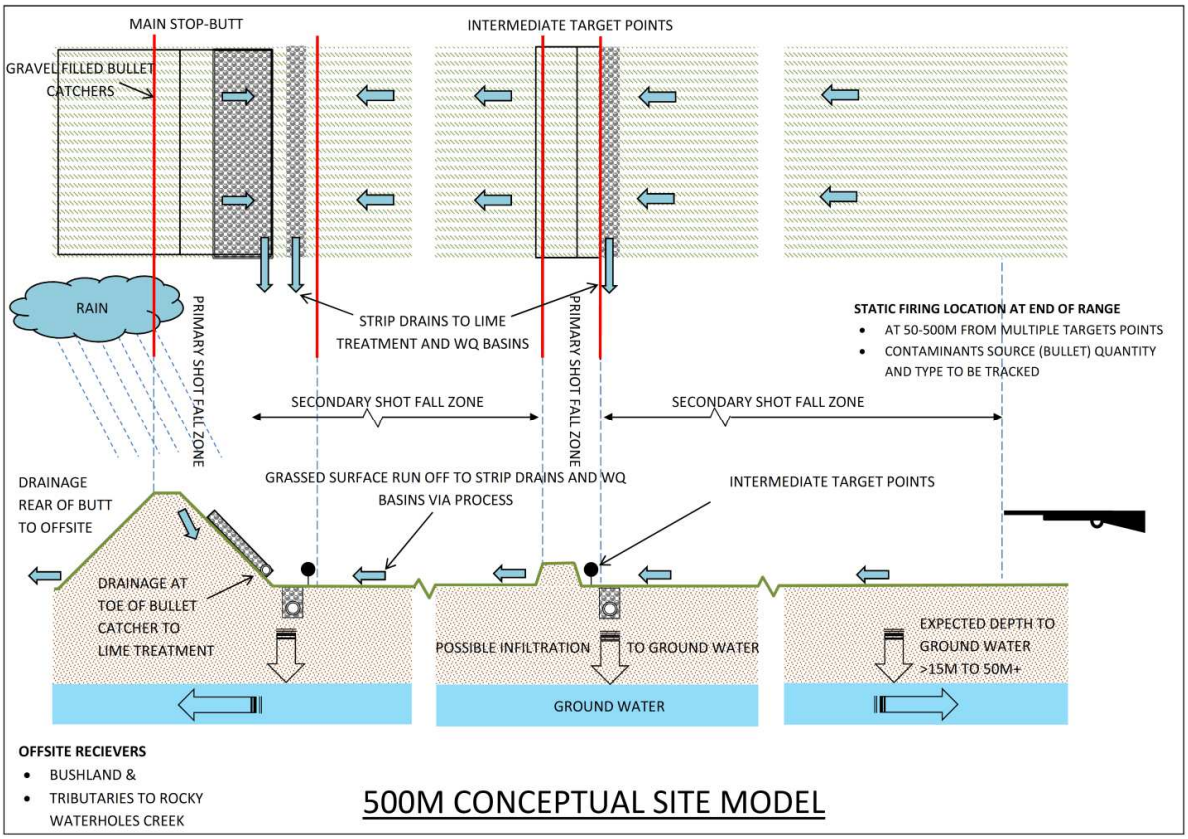

FIGURE 9 - 500m: Conceptual Site Model (CSM)

5.3.1 Existing infrastructure and layout

Stop butt and target area

The primary potential areas of concern identified at the 500m range are the target areas, stop butt & intermediate mound, bullet catcher and surrounds.

The 500m is a single range consists of a single firing point and multiple (x6) mounds and target points set along the range length with a 7th Primary stop butt at the end of the range.

A gravel filled bullet catcher is proved at the face of the stop butt.

It is expected that significant shot fall will occur within the floor area of the range and into the intermediate target mounds.

Formal and informal drainage system

A secondary area of potential concern identified at the 500m range is the new drainage

system from the stop butt and intermediate mound.

Surface water from the 500m range fairway flows to strip drains set at the rear of the intermediate target mounds and at the toe of the stopbutt face. These drains then are connected via pipes to either of the two water quality basins.

Refer to Figure 10 for the for the current 500m Range layout.

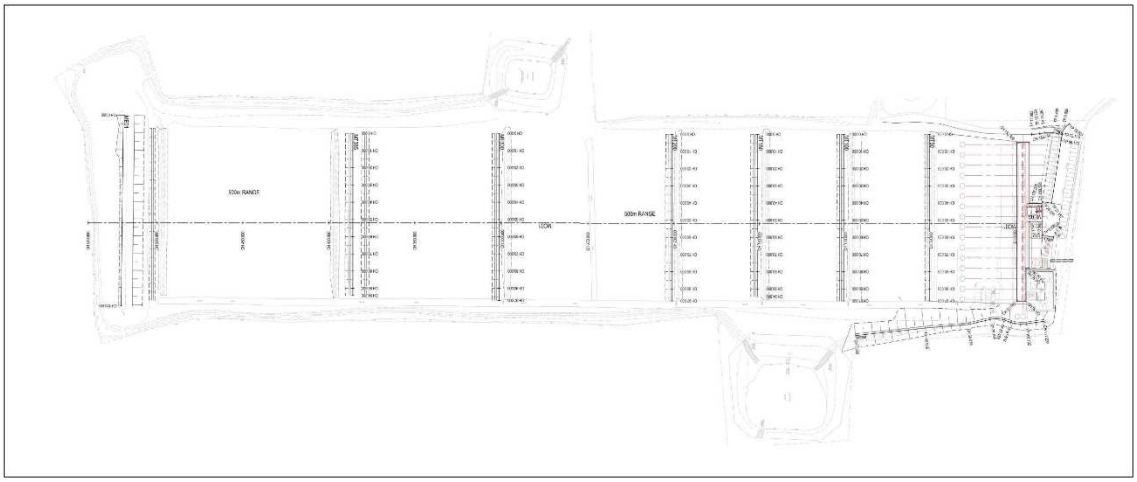

FIGURE 10 - 500m Range Layout

5.3.2 Sources of contamination and potential contaminants of concern

The 500m range is used by recreational and competitive shooters. The OEMP for the SHRSC requires record keeping of the number of rounds /volume of bullets fired and the type of bullets fired so that annual estimates of shot fall can be calculated for each range for management purposes.

The 500m range and its use are designed so that bullets strike the intermediate target mounds and the final stop butt at the end of the range. Significant shot fall is expected between the intermediate mounds and into the fairway. These are the primary impact areas.

It is possible that some bullets may be fired over the stop butt entirely or into adjacent off range areas. These are the secondary impact areas.

The butt at the 500m is designed to prevent the skipping of bullets or fragments to the rear of the butt. Ongoing sampling includes the rear of the stop-butt to confirm the effectiveness of design. It is possible that some bullets may be fired over the stop-butt entirely however, given this is a supervised range this loss should be in very low volumes.

The material at the bullet catcher at face of the stopbutt is able to be removed and sifted to remove bullet fragments or relocated for further treatment and/or removed from site as part of maintenance activities.

The type of bullets will be used to confirm the range of analytes for ongoing sampling. A broad suite of sample analytes is proposed within this SAQP given the potential variety of ammunition used at the range. However, the primary contaminant of concern at the range is considered to be Lead (Pb). The suite of anolytes is presented in Section 6.2 Tables 5A, B & C

5.3.3 Identified contaminant migration pathways

The primary process for migration of contaminants from the primary and secondary impact areas and surrounds would be via surface runoff and potentially leaching to ground water. Maintenance of stable ground cover over the surface acts minimise potential for generation of dust from the area and also reduce potential for erosion and mobilisation of sediments. Maintenance may also include application of ameliorants to maintain a stable soil pH.

The CSM diagram indicates the pathways for surface water movement:

- Strip drains in-front of the stop butt of the 500m Range which directs surface water via a pipe to the lime treatment pit and then to the water quality basin
- No surface water from possible shot-fall areas (primary and secondary) is able to bypass the drainage to the Water Quality Basins.
- The new water quality basins have stable gabion spillways. The basins discharge to the natural catchment and then ultimately to the tributaries of Rocky Water Holes Creek.

The potential exists for leaching and vertical migration of contaminants into the subsurface from the primary and secondary shot fall areas. This potential is mitigated by the design of the gravel bullet catcher at the stopbutt and at the drainage within the primary shot fall areas which moves water more quickly to the formal drainage.

Environmental Assessment undertaken prior to the construction of the SHRSC presented that groundwater is expected at depths greater than 15m and likely greater than 50m (Refer to 2.2.5 Groundwater). Therefore impacts on sources of potential water supply are not a consideration and as such Groundwater Investigations (GILs) for Fresh Waters will be used as the assessment level for management response.

5.3.4 Identified Receptors

The number of potential receptors identified are consistent between all the ranges at the SHRC:

- The SHRSC is situated within the Bargo State Conservation Area and is next to Nattai National Park which are known recreational areas and are home to local flora and fauna.

- The SHRSC is situated on a ridge line and drains to multiple drainage lines in the upper catchment. These are tributaries to Rocky Waterholes Creek which is a potential recreational water resource.

- SHRSC users and the general public visit the facility under supervised management protocols.

Receptor exposure will be managed under the OEMP which will take into account the specific shot fall patterns, ground cover requirements and direction of surface water movement at each range.

Site access restrictions and maintenance of suitable ground cover at the areas of potential concern will reduce the likelihood of direct human exposure to contaminants at the source.

6 Sampling Analysis and Quality Plans

The following sampling plans detail sampling exercises in accordance the Monitoring Program detailed within Section 5 of the SHRSC WCMP.

- Section 5.4 of the WCMP provides frequency of scheduled sampling activities;
- Section 5.4 of the WCMP provides the concentrations of analytes used in the assessment;
- Section 5.3 of the WCMP provides information on constraints and limitations for sampling surface waters off range; and
- Section 5.5 WCMP provides adopted assessment criteria and derivation method for EILs.

During the sampling activity any variations from the SAQP should be recorded for reference in the future annual review.

6.1 SAQP for the 800m Range

Table 2 provides the Sampling Rationale Matrix for the 800m range.

TABLE 2 – Sampling Rationale Matrix (800m Range)

Sample Location	Sample type	Context (in landscape) of Sample location	Rationale for selection
Bullet Catcher	Gravel (per Soil)	Primary Impact Zone	Confirm levels in area of expected contamination
Stop butt above bullet catcher	Soil	Face of stop- butt behind targets – impact area and adjacent to impact area	Confirm levels in area of expected contamination
Rear of stop butt	Soil	Possible shot fall area	Confirm no contamination
Bench in front of stop butt	Soil	Down gradient of stop butt impact area	Confirm levels in expected area of contamination. Identify contamination
Gallery	N/A	Shot fall area	Concrete area – record of cleaning to be made. Record visual inspection
Target Mound/Mantlet and associated drainage	Soil	Mound in front of galley – potential impact area	Confirm levels in expected area of contamination. Identify migration of contamination
Area in front of Mantlet	Soil	Outside drainage to impact areas	Identify migration of contamination
Over storeroom – west of gallery	Soil	Outside drainage to impact areas	Identify migration of contamination
New culvert East of Stopbutt	Soil	Down gradient of stop butt impact area	Confirm levels in expected area of contamination. Confirm/characterise migration of contamination
Mulched area behind stop butt	Soil	Down gradient of impact area– water quality area for stop butt	Confirm levels in expected area of contamination. Confirm migration of contamination

Outlet from mulched area	Soil, water, sediment	Discharge point for surface water	Assess for contamination from local catchment
Basin: East of 800m range	Surface, water sediment	Surface water from road and part range areas	Assess for contamination from local catchment
Pits – Lime treatment process	Water, Sediment if present	Possible water and sediment from primary impact area stop butt and surrounds	Monitor function of lime treatment process. Assess for failure of control and movement of sediment

Tables 3A -C provide the suite of analytes, planned location and numbers of samples at the 800m range as prepared for the SAQP.

Metals of concern included in the analysis suite are those to be common in the composition of bullets.

Depth of samples is generally 100mm as this is reflects the expectation of shot fall lying on or near to the surface and also the possible migration of contaminants primary via surface run off.

Additional samples may be taken in other locations due to site conditions and observations made at the time of sampling.

TABLE 3A: SOILS (INC GRAVELS) – (800m Range)		
Analytes/Suite	Locations	Number (SAQP)
PAH	Stop butt/bullet catcher (impact area behind targets)	2
Cadmium	Stop butt non-shot area – between bullet catchers	2
Arsenic	Stop butt directly under bullet catcher	2
Chromium	Gallery area- concrete	NIL-Visual
Mercury	Bench at front of butt/foot of stop butt	only
Nickel	Target mound/mantlet	3
Tin	In front of target mound/mantlet and associated	3
pH	drainage	3
Lead	Stop butt –rear	1
Copper	West of Gallery (grassed area over store room)	1
Zinc	Below outlet of culvert from stop butt drainage	2
Antimony	Exit channel from sump to offsite- to flow line over	
Iron	escarpment	2
CeC		
Clay Content	**Duplicate samples**	
TCLP	**Triplicate samples**	**2**
(for samples with elevated results only)		**2**
	Total	25

TABEL 3B: WATER (800m Range)		
Analytes/Suite	Locations	Number
Nickel	Basin adjacent to 800m range	1
Arsenic	Reservoir in lime treatment unit	1
Chromium	Channel at rear of 800m range (If available)	1

Total Phosphorus (TP) Total Nitrogen (TN) Ammonia (NH3) Dissolved Oxygen (DO) pH 1 Lead Copper Zinc Antimony Phosphate	Pit within Lime treatment process (if accessible and water present)	1
	Total	**4**

TABLE 3C: SEDIMENT (800m Range)		
Analytes/Suite	Locations	Number
PAH Cadmium Arsenic Chromium Mercury Nickel Tin Clay Content pH Lead Copper Zinc Antimony Iron CeC TCLP **(for samples with elevated results only)**	Basin adjacent to 800m range Pit within Lime treatment process (if accessible and sediment present**)**	1 1
	Total	2

6.2 SAQP for the 50m and 500m Range

Table 4 below gives the Sampling Rationale Matrix for the 50 and 500m Ranges.

TABLE 4: SAMPLING RATIONALE MATRIX: 50M & 500M RANGES			
Sample Location	**Sample Type**	**Context (in landscape) of Sample location**	**Rationale for selection**
On range (500m)	Soil	Main body of range / fairway/shot zone	Identify contamination – confirm no migration of contamination
On range (50m)	Soil or Gravel	Main body of range	Identify contamination – confirm no migration of contamination
Face of stop butt / bullet catcher	Gravel	Impact area of range	Confirm concentrations of expected contamination
Face of stop but above bullet catcher	Soil	Potential impact area of range	Confirm concentrations of expected contamination
Area immediately in front of toe of stop butt associated drainage	Soil	Outside drainage to impact area	Confirm no migration of contamination
Basins/basins	Water, sediment	Basins receive water from range areas	Confirm no migration of contamination Confirm water quality parameters
Rear of stop butt	Soil	Possible shot fall area	Confirm no contamination
Creek water off range (where available from Ephemeral creeks following rainfall or from natural pools)	Water, sediment	Separate from range run off	Confirm no migration of contamination. Confirm water quality parameters
Pits within the Lime treatment process (Note Lime and directional pits do not retain water)	Water, Sediment if present	Possible water and sediment from primary impact area stop butt and surrounds	Monitor function of lime treatment process. Assess for failure of control and movement of sediment

Tables 5A -C provide the suite of analytes, planned location and numbers of samples at the 50m and 500m ranges as prepared for the SAQP.

Metals of concern included in the analysis suite are those to be common in the composition of bullets.

Depth of samples is generally 100mm as this is reflects the expectation of shot fall lying on or near to the surface and also the possible migration of contaminants primary via surface run off.

Additional samples may be taken in other locations due to site conditions and observations made at the time of sampling.

TABLE 5A: SOILS			
Analytes/Suite	Range	Locations	Number
PAH Cadmium Arsenic Chromium Mercury Nickel Tin pH Lead Copper Zinc	500	On range – 1 from each target bay - plus random over all bays (max 2 per bay) Off range / bush land Face of stop main stop butt -plus 1 from each intermediate mound Within 10m in-front of toe of main Stop-butt and associated drainage -plus 1 from in front of each intermediate mound	7 3 5 3 6 3 6
Antimony Iron CEC Clay Content TCLP **(for samples with elevated results only)**	50	On range – gravel or soil range floor Off range / bushland Face of stop butt – bullet catcher Face of stop butt – from above bullet catcher Soil material below invert of bullet catcher Within 10m in-front of toe of Stop-butt and associated drainage	3 3 3 2 1 3
	50m/500m range	**Duplicate sample** **Triplicate sample**	1 1
	Total		50

TABLE 5B: WATER		
Analytes/Suite	Locations	Number
Nickel Arsenic Chromium Total Phosphorus (TP) Total Nitrogen (TN) Ammonia (NH3) Dissolved Oxygen (DO) pH 1 Lead Copper Zinc Antimony Phosphate Turbidity	Basin at car park (Basin 4)	1
	50m (Basin 5)	1
	500m East (Basin 3) 500m West (Basin 2)	1 1
	200m (Basin 1)	1
	Creek waters off range (where available from Ephemeral creeks following rainfall or from natural pools)	2
	Pits in Lime treatment process (if accessible/ present)	8
	Duplicate sample Triplicate sample	1 1
	Total	18

TABLE 5C: SEDIMENT		
Analytes/Suite	Locations	Number
PAH Cadmium Arsenic Chromium Mercury Nickel Tin Clay Content pH Lead Copper Zinc Antimony Iron CEC TCLP **(for samples with elevated**	Basin at car park (Basin 4)	1
	50m (Basin 5)	1
	500m East (Basin 3)	1
	500m West (Basin 2)	1
	200m (Basin 1)	1
	Creek waters off range (where available from Ephemeral creeks following rainfall or from natural pools)	2
	Pits within Lime treatment process (if present)	8
	Total	15

6.3 Visual Inspections

Section 5.4 of the SHRSC WCMP presents the items and frequency for visual inspections. These inspections are summarised following.

6.3.1 Water quality structures and surrounds

Inspect water quality basins for;

- evidence of scour from flows at inlet or outlet
- evidence of scour or failure at inside batters of structures
- evidence of scour, instability or failure of external batters of structure

6.3.2 Engineering controls – earthworks

Inspect Berms, drains channels, stock butts, access tracks and culverts for;

- evidence of scour from flows at inlet or outlet of culverts and channels or at invert of channels and drains.
- evidence of instability or erosion of track surfaces and associated drainage.
- evidence of scour, instability or failure of batters or formation of stopbutts.

6.3.3 Engineering controls – lime treatment process

Inspect accessible subsurface elements of lime treatment process / Engineering controls for;

- Evidence of fragments of bullets and other extraneous materials within pits or chambers of the treatment control.
- Evidence of sediment washed into pits or chambers of the treatment control.

6.3.4 Safety and signage

Inspect site safety and signage including fencing around sediment basins and drainage measures for;

- Visibility of signage
- Location per that in SHRSC OEMP
- Condition

6.3.5 Shot loss

Inspect Range perimeter, especially 800m and 500m ranges for;

- Evidence of loss and/or damage from stray projectiles

6.3.6 Vegetation health

Inspect vegetation heath of range floor and revegetated areas for;

- Percentage of ground cover -equivalent to C factor of 0.1 or lower (see WCMP)
- and vigour

6.4 Methodology

6.4.1 Soil sampling methodology

1. Soil Samples are to be collected in ~250ml glass sample jars provided by the Analytical Laboratory. Jars are to be labelled with;

    - Project title
    - Sample ID Number
    - Depth of Sample
    - Date of Sample
    - Identifier of Officer taking Sample

2. Samples will then be packed in a cooler with ice packs prior to being transported to the laboratory and tracked under chain of custody documentation.

3. Soil samples to be collected using a shallow auger or similar within the top 100mm of the soil surface where bullet or fragments was expected to be present (unless indicated otherwise).

4. Where soil material is too hard or soft for the auger, material was collected using a hand mattock/tool.

5. Where soils are observed to be excessively friable or where rocks/vegetation were present repeated samples are to be collected adjacent to each other to obtain an adequate sample volume.

6. Soil samples below 100mm if required are to be collected using a hand auger with extensions.

7. Vegetation/grass and rocks/gravel are to be screened from the samples collected.

8. Where shot fragments or projectiles are found in the sample these are to be removed and their presence recorded so that pure lead shot is not included in the sample submitted for analysis.

9. Between each sample collection the auger or hand tool is to be decontaminated by removing excess material from the face of the tool and washed down with distilled water.

10. Nitrile gloves are to be worn during sample collections and changed between locations to avoid cross contamination from the samplers hands.

6.4.2 Sediment sampling methodology

1. Sediment Samples are to be collected in ~250ml glass sample jars provided by the Analytical Laboratory. Jars are to be labelled with;

    - Project title
    - Sample ID Number
    - Depth of Sample

- Date of Sample
- Identifier of Officer taking Sample

2. Samples are then then packed in a cooler with ice packs prior to being transported to the laboratory and tracked under chain of custody documentation.

3. Sediment samples are to be collected within identified contaminant flow paths from ground level alluvium in surface water channels or from settled sediments at the sides of the water quality basins using a hand mattock or similar suitable collection tool.

4. The collection tool is to be decontaminated using distilled water prior to collection.

5. Nitrile gloves are to be worn during sample collections and changed between locations to avoid cross contamination from the samplers hands.

6.4.3 Water sampling methodology

1. Water samples are to be collected in a laboratory prepared and provided collection bottle. Bottles are to be labelled with;

   - Project title
   - Sample ID Number
   - Depth of Sample
   - Date of Sample

2. Samples will be collected from water quality basins using a sample bailer/pre-washed bottle attached to a sampling pole so samples could be collected from greater than 1.5m from the edge of the basin.

3. Samples collected from natural streams or pools within streams are to be collected from the middle of streams / pools.

4. Prior to collecting a sample the sample bailer bottle is rinsed with distilled water. And the rinsate is discarded well away from sample location.

5. Water samples were transferred to the collection bottles provided by the laboratory. Samples were then packed in a cooler with ice packs prior to being transported to the laboratory and tracked under chain of custody documentation and within the confirmed holding times for the various analytes.

   <u>Field Sampling</u>

   Field sampling of Soil pH or Water (pH or Turbidity) are to undertaken in accordance with the instrument guidelines.

   Field instruments are to be confirmed as calibrated per instrument guidelines and before every sampling exercise undertaken as part of the Monitoring Program within the SHRSC WCMP.

6.5 Laboratory QA QC

The following information has been provided by the laboratory selected for the analysis (Envirolab Services Chatswood NSW.)

NATA Accreditation
Envirolab is accredited by NATA to ISO 17025 under corporate accreditation number is 2901.
Quality Assurance
Envirolab is NATA accredited to AS ISO/IEC 17025. This includes all aspects of the analytical process including sample preservation, sample registration, methodology, instrument calibration and maintenance, data records, calculations and reporting of results.
The laboratory operates under a definitive plan which specifies the measures used to produce data of a known precision and bias. The quality assurance plan includes implementation of Quality Control and Quality Assessment Procedures.

Quality Control is a set of measures within a sample analysis methodology to assure that the process is in control.
Quality Control measures included:
- *Certification of operator competence*
- *Recovery of known additions*
- *Analysis of externally supplied standards*
- *Analysis of reagent blanks*
- *Calibration with standards*
- *Analysis of duplicates*
- *Control charts*

Quality Assessment is the procedure for determining the quality of laboratory measurements by use of data from internal and external quality control measures.
Quality Assessment measures included:
- *Laboratory inter-comparison trials*
- *Performance evaluation samples*
- *Performance audits*

Envirolab met or exceeded NEPM (2013) guidelines for QC for this assessment.
The Quality Control guidelines for this assessment were:
- *Duplicate: every 10 samples or per batch if <10*
- *Matrix Spike: every 20 samples or per batch if <20*
- *LCS: every 20 samples or per batch if <20*
- *Blank: every 20 samples or per batch if <20*

6.6 Laboratory Methods

Tables 6A and 6B below summarise the laboratory methods and NATA accreditation for each of the anolytes for Soil/Sediment and Waters. Details within this table have been taken from the laboratory's capability statement.

Table 6A :Soil /Sediment

Analysis suite	Technique	Reference method	PQL mg/L	NATA
Cadmium	020 ICP-AES	NIOSH 7301	0.4	Y
Arsenic			4	
Chromium			1	
Mercury			0.1	
Nickel			1	
Tin			1	
Lead			1	
Copper			1	
Zinc			1	
Antimony			7	
Iron			1	
PAH	Org-012 subset	USEPA 8270	+ve/-ve	Y
CEC	ICP	Aust. Lab Handbook 15B3	1meq/100g	
Clay Content	Hydrometer		1%	
pH	soil/water electrode	USEPA 9045	0.1 unit	Y

Table 6B: Water

Analysis suite	Technique	Reference method	PQL	NATA
pH	Electrode	APHA4500H+	0.1 unit	Y
Arsenic	Metals-022 ICP-MS	USEPA 200.8 USEPA 3005A (prep) USEPA 6020A	1 µg/L	Y
Chromium			1 µg/L	
Nickel			1 µg/L	
Lead			1 µg/L	
Copper			1 µg/L	
Zinc			1 µg/L	
Antimony			1 µg/L	
Phosphate	Colourmetric	EPA 365.1	0.005mg/L	Y
Ammonia	Paste	EPA 350.1	0.005mg/L	Y
Total Nitrogen	Colourmetric	APHA4500-Norg	0.1 mg/L	Y
Total Phosphorous	ICP-AES or Colourmetric	USEPA 200.7 or APHA 4500-P	0.05mg/L	Y
Dissolved Oxygen		Inorg-112	0.1	

7 Site Assessment Criteria

7.1 Rationale for Selection of Assessment Criteria

The following published assessment criteria have been referenced in the summary of results tables to characterise the contamination status of the site.

Comments are offered detailing why each criterion has been selected.

Section 6.1.1 presents the method for determination of EILs used for this assessment.

The data previously collected from non-operational areas of the SHRSC and surrounds has been used to determine Ambient Background Concentrations (ABC) as part of derivation of the EILs to be applied on the operational ranges.

Soil

NEPM
National Environment Protection (Assessment of Site contamination) Measure (2013) Health investigation level (HILs)

- C – Developed Open Space such as parks, playgrounds, playing fields
- D - Commercial/industrial includes premises such as shops, offices, factories and industrial sites.

The site is currently zoned as SP1: Special Activities – Shooting Range. The HIL C has been adopted as Tier 1 soil trigger values for management response. The HIL D have been presented for comparison and further discussion given that the shooting ranges are proposed to be managed and operated as a commercial facility.

NEPM
National Environment Protection (Assessment of Site contamination) Measure (2013) Ecological Investigation Levels (EILs)

Sediment

ANZECC
Water Quality Guidelines Chapter 3- Section 3.5.4 Table 3.5.1 Interim Sediment Quality Guidelines (LOW and HIGH triggers) (Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council, 2000)

Water

ANZECC PFWS
Protection of fresh water species - 95% level of protection trigger values (Australian and New Zealand Guidelines for Fresh and Marine Water Quality , Australian and New Zealand Environment and Conservation Council, 2000) (Note that the NEPM GILs for Freshwater have been adopted from the ANZECC 2000 guidelines.)
The ANZECC PFWS was selected due to the proximity to fresh water courses and fresh groundwater

ANZECC RWCG
Recreational Water Quality Guidelines (Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council, 2000)

NEPM
National Environment Protection (Assessment of Site contamination) Measure (2013) Ground Water Investigation Levels (GILs) for Freshwater.

GILs for Antimony (Sb), within the 2000 Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 2. Aquatic Ecosystems — Rationale and Background Information (Chapter 8) are not available due to insufficient data. As such a Low Reliability Trigger Value has been adopted.

7.1.1 Derivation of Ecological Investigation Levels (EILs)

This section presents the NEPM 1999 (amended 2013) method adopted by ErSed to derive the Ecological Investigation Levels (EILs) for this assessment.

Ecological Investigation Levels EILs (EILs) have been derived by summing the Ambient Background Concentration (ABC) and the Added Concentration Limit for the contaminants of concern i.e.

EIL= ABC + ACL

Derivation of ABC

Samples were collected from non-operational areas of the SHRSC and the heavy metal analytical results were used as a background sample data set. Data from samples collected from surface soils taken from drainage areas (sediments) was also used within the set.

Where sample results were below the limit of laboratory detection (i.e. <LOR) these were adjusted to the detection limit. The geometric mean of the data was used as the ABC to derive the EIL.

Derivation of ACL

Ambient Concentration Limits (ACLs) for metal analytes have been referenced from Tables 1(B) Schedule B1 (NEPM 2013).

Where required the geometric mean of pH and CEC have been used to calculate the ACL. The geometric mean for the clay content from samples taken from the 800m range has been used as a conservative value.

For the calculations of the EILs for lead (Pb) and copper the consultant has assumed that the criteria for public open space is the most relevant to the current site use.

7.1.2 Referenced NEPM 1999 (2013) Tier 1 Health Investigation Levels (HILs)

Published human health investigation criteria (HILs) have been sourced from table 1A Schedule B1 NEPM 1999 (Amended 2013).

As the site is currently zoned as SP1: Special Activities – Shooting Range, the HILs C – Recreational criteria will be applied.

Part B: Monitoring Program Implementation and Report

8 Monitoring Program – Implementation

Table 7 below summaries the required frequency operational monitoring detailed in Section 5.4 of the WCMP

Table 7: Annual Operational Monitoring Program

What to be monitored		Frequency
Soils	- Complete (Laboratory)	Annually
	- pH (Laboratory)	Six monthly
	- pH (Field with laboratory confirmation at 10% of samples)	Quarterly
Sediments	- Complete (Laboratory)	Annually
	- pH (Laboratory)	Quarterly
	- pH (Field with laboratory confirmation at 10% of samples)	Six monthly
Surface Waters	- Complete (Laboratory)	Six monthly
Visual	- Basins - Engineering controls - Gallery (800m Range) - Lime treatment process - Safety and signage	Annually
	- Range perimeter - Vegetation health	Six monthly

Table 8 below presents the annual monitoring program prepared to meet requirements detailed within section 5.4 the WCMP.

Table 8: Monitoring Program Schedule

Quarter	Activities
1	Field Sampling – pH in Primary and Secondary Impact Areas • Soils • Sediments Six Monthly Visual Inspections • WQ Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health
2	Six Monthly Monitoring - pH in Primary and Secondary Impact Areas • Soils • Sediments Six Monthly Monitoring • Surface Waters
3	Field Sampling – pH in Primary and Secondary Impact Areas • Soils • Sediments

	Six Monthly Visual Inspections • WQ Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health Annual Visual Inspection of Range perimeter for shot loss.
4	Annual Monitoring • Soil • Surface Waters • Sediments

Implementation of the Monitoring Program was heavily impacted during 2021-2022 by;

- travel restrictions for persons within Greater Sydney associated with COVID 19 through Quarter 1 and Quarter 2 (to December 2021) &
- Extreme rainfall in Quarter 3 (1100mm+ Rainfall during January to April 2022)

Accordingly, the annual monitoring program was implemented within a modified Q4 Program per the table 8.1 following

Quarter	**Activities**	**See Report Section**
4	Annual Monitoring • Soil • Surface Waters • Sediments	THIS REPORT
PLUS	Visual Inspections • WQ Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health • Range perimeter for shot loss.	
PLUS	Confirmation sampling of any results of concern returned.	

Summaries of the sampling event are provided in the following sections. Laboratory results for monitoring events are provided within Appendixes;

- **Appendix 1: Laboratory Results**

9 Monitoring Program – Modified Quarter 4

A samplings exercise was undertaken 19 & 20 MAY 22 in accordance with Section 8.
A follow up sampling event was undertaken 29 MAY 22.

A summary of the sampling event is given below.

Summary of sampling event

Table 9: Modified Quarter 4 Sampling Event

Aspect	**See Report Section**
Annual Monitoring • Soil • Surface Waters • Sediments PLUS Visual Inspections • WQ Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health • Range perimeter for shot loss. Results confirmation/ further sampling where required.	9.1

9.1 Annual Monitoring Soils & Sediment

Results for the annual monitoring for soils are given in the tables following;

- Table 10: 2022 Soil &Sediment Results 50m Range
- Table 11: 2022 Soil & Sediment Results 500m Range
- Table 12: 2022 Soil & Sediment Results 800m Range

Results are discussed at Section 9.3.1 following

9.2 Annual Monitoring Surface Waters

Results for the annual monitoring for surface waters are given in the table following;

- Table 13: 2022 Surface Water Results – All areas

TABLE 10: 2022 SOIL & SEDIMENT RESULTS 50m																	
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
101	Earth mound East of BAY 1	0.2	<0.5	<0.5	<4	<0.4	10	8	12	<0.1	2	14	<1	<7	17000	NT	7	NT
101	Earth mound East of BAY 1															NT	6.8	NT
102	Range Floor - BAY 5	<0.05	<0.5	<0.5	<4	<0.4	9	3	9	<0.1	3	14	<1	<7	7500	NT	7.5	NT
103	Range Floor - BAY 3	<0.05	<0.5	<0.5	<4	<0.4	3	1	3	<0.1	1	7	<1	<7	2700	NT	7.1	NT
104	Range Floor - BAY 2	<0.05	<0.5	<0.5	<4	<0.4	6	4	39	<0.1	3	12	<1	<7	6700	NT	7.4	NT
105	Bushland - South	<0.05	<0.5	<0.5	<4	<0.4	15	<1	16	<0.1	1	5	<1	<7	20000	NT	5.2	NT
105	Bushland - South	<0.05	<0.5	<0.5	<4	<0.4	11	<1	17	<0.1	1	5	<1	<7	14000	NT	-	NT
106	Bushland - West	<0.05	<0.5	<0.5	<4	<0.4	12	1	12	<0.1	1	5	<1	<7	14000	NT	5.5	NT
107	Bushland - North	<0.05	<0.5	<0.5	<4	<0.4	7	<1	11	<0.1	2	5	<1	<7	6800	NT	5.2	NT
108	Bullet catcher - BAY 2	<0.05	<0.5	<0.5	<4	<0.4	1	<1	11	<0.1	<1	4	<1	<7	1100	NT	8.3	NT
109	Bullet catcher - BAY 3	<0.05	<0.5	<0.5	<4	<0.4	<1	2	100	<0.1	<1	2	<1	<7	930	NT	9	NT
110	Bullet catcher - BAY 4	<0.05	<0.5	<0.5	<4	<0.4	<1	5	330	<0.1	<1	4	<1	<7	1000	NT	8.3	NT

TABLE 10: 2022 SOIL & SEDIMENT RESULTS 50m																		
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
111	Above Bullet catcher - BAY 1	<0.05	<0.5	<0.5	<4	<0.4	9	3	7	<0.1	2	8	<1	<7	24000	NT	8.9	NT
112	Above Bullet catcher - BAY 3	<0.05	<0.5	<0.5	12	<0.4	6	4	73	<0.1	<1	5	<1	<7	13000	NT	8.8	NT
113	10m Infront BC - BAY 2	<0.05	<0.5	<0.5	<4	<0.4	4	4	32	<0.1	1	7	<1	<7	2900	NT	7.9	NT
114	10m Infront BC - BAY 4	<0.05	<0.5	<0.5	<4	<0.4	5	3	320	<0.1	2	14	4	9	7200	NT	7.9	NT
115	10m Infront BC - BAY 5	<0.05	<0.5	<0.5	<4	<0.4	4	3	58	<0.1	2	12	<1	<7	4600	NT	9	NT
115	10m Infront BC - BAY 5	<0.05	<0.5	<0.5	<4	<0.4	7	3	100	<0.1	3	10	1	<7	4400	NT	-	NT
116	Sediment from Basin 5	<0.05	<0.5	<0.5	<4	<0.4	6	15	17	<0.1	5	33	<1	<7	5500	NT	6.4	NT
118	Mantlet/BC - BAY 2	<0.05	<0.5	<0.5	<4	<0.4	3	2	65	<0.1	<1	10	<1	<7	4700	NT	7.5	NT
119	Above Bullet catcher - BAY 4	<0.05	<0.5	<0.5	<4	<0.4	6	4	410	<0.1	2	12	2	10	11000	NT	8.7	NT
72	115 - [TRIPLICATE]				<4	<0.4	2	1	22	<0.1	1	8	<1	<7	2800	NT		NT

TABLE 11: 2022 SOIL & SEDIMENT RESULTS 500m																	
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
201	Range floor 385-500m	<0.05	<0.5	<0.5	<4	<0.4	11	5	37	<0.1	2	9	<1	<7	12000	NT	6.4	NT
201	Range floor 385-500m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NT	6.2	NT
202	Range floor 300-385m	<0.05	<0.5	<0.5	<4	<0.4	12	4	43	<0.1	2	6	<1	<7	13000	NT	6.4	NT
203	Range floor 200-300m	<0.05	<0.5	<0.5	<4	<0.4	12	9	55	<0.1	2	11	<1	<7	12000	NT	5.7	NT
203	Range floor 200-300m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NT	5.7	NT
204	Range floor 150-200m	<0.05	<0.5	<0.5	<4	<0.4	13	2	10	<0.1	2	5	<1	<7	13000	NT	6.4	NT
205	Range floor 100-150m	<0.05	<0.5	<0.5	7	<0.4	15	7	59	<0.1	1	7	<1	<7	15000	NT	5.8	NT
205	Range floor 100-150m	<0.05	<0.5	<0.5	<4	<0.4	11	3800	180	<0.1	2	240	<1	<7	13000	NT	-	NT
206	Range floor 50-100m	0.3	<0.5	<0.5	<4	<0.4	8	20	120	<0.1	4	54	2	<7	6400	NT	8.1	NT
207	Range floor 0-50m	<0.05	<0.5	<0.5	<4	<0.4	6	6	53	<0.1	2	10	<1	<7	9400	NT	6.9	NT
208	Additional RF 385-500m	<0.05	<0.5	<0.5	<4	<0.4	18	14	24	<0.1	3	27	<1	<7	18000	NT	6	NT
209	Additional RF 300-385m	<0.05	<0.5	<0.5	<4	<0.4	22	3	22	<0.1	3	7	<1	<7	23000	NT	6	NT
210	Additional RF ?	<0.05	<0.5	<0.5	<4	<0.4	11	31	72	<0.1	3	14	<1	<7	16000	NT	6.7	NT

TABLE 11: 2022 SOIL & SEDIMENT RESULTS 500m																	
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
211	500m Bushland - South	<0.05	<0.5	<0.5	<4	<0.4	9	2	14	<0.1	2	7	<1	<7	8800	NT	5.4	NT
212	500m Bushland - West 1	<0.05	<0.5	<0.5	<4	<0.4	12	1	12	<0.1	2	5	<1	<7	13000	NT	5.2	NT
213	500m Bushland - West 2	<0.05	<0.5	<0.5	<4	<0.4	15	<1	11	<0.1	2	3	<1	<7	18000	NT	4.9	NT
214	500m Bushland - East	<0.05	<0.5	<0.5	<4	<0.4	12	2	17	<0.1	2	7	<1	<7	13000	NT	5.3	NT
215	500m Bushland - North	<0.05	<0.5	<0.5	<4	<0.4	17	4	13	<0.1	4	9	<1	<7	14000	NT	5.5	NT
215	500m Bushland - North	<0.05	<0.5	<0.5	<4	<0.4	13	3	12	<0.1	3	8	<1	<7	11000	NT		NT
216	Main Butt - West	<0.05	<0.5	<0.5	<4	<0.4	1	<1	18	<0.1	<1	4	<1	<7	1700	NT	6.7	NT
217	Main Butt - Central	<0.05	<0.5	<0.5	<4	<0.4	<1	<1	51	<0.1	<1	<1	<1	<7	20	NT	7.6	NT
218	Main Butt - East	<0.05	<0.5	<0.5	<4	<0.4	<1	2	170	<0.1	<1	1	<1	<7	300	NT	7.3	NT
219	Intermediate Mound - 385m	<0.05	<0.5	<0.5	<4	<0.4	6	17	330	<0.1	2	11	<1	<7	10000	NT	6.5	NT
219	Intermediate Mound - 385m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NT	6.4	NT
220	Intermediate Mound - 300m	<0.05	<0.5	<0.5	4	<0.4	8	4	68	<0.1	2	8	<1	<7	13000	NT	8.5	NT

TABLE 11: 2022 SOIL & SEDIMENT RESULTS 500m																		
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
220	Intermediate Mound - 300m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NT	8.7	NT
221	Intermediate Mound - 50m	<0.05	<0.5	<0.5	<4	<0.4	7	4	10	<0.1	3	9	<1	<7	10000	NT	6.5	NT
222	Intermediate Mound - 200m	<0.05	<0.5	<0.5	4	<0.4	7	10	120	<0.1	2	12	<1	<7	11000	NT	8.4	NT
223	Intermediate Mound - 100m	<0.05	<0.5	<0.5	<4	<0.4	7	4	32	<0.1	2	9	<1	<7	12000	NT	8.2	NT
224	Intermediate Mound - 150m	<0.05	<0.5	<0.5	<4	<0.4	7	12	620	<0.1	2	9	<1	10	12000	NT	8.2	NT
225	10m Infront 500 Butt - West	<0.05	<0.5	<0.5	<4	<0.4	8	3	18	<0.1	2	10	<1	<7	14000	NT	6.4	NT
225	10m Infront 500 Butt - West	<0.05	<0.5	<0.5	<4	<0.4	9	4	41	<0.1	2	10	<1	<7	12000	NT		NT
226	10m Infront 500 Butt - Central	<0.05	<0.5	<0.5	<4	<0.4	10	9	430	<0.1	1	8	<1	<7	13000	NT	6.8	NT
226	10m Infront 500 Butt - Central	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NT	6.7	NT
227	10m Infront 500 Butt -	<0.05	<0.5	<0.5	<4	<0.4	4	3	89	<0.1	<1	4	<1	<7	5700	NT	6.9	NT

TABLE 11: 2022 SOIL & SEDIMENT RESULTS 500m																	
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
	East																	
228	10m Infront Int Mound - 385m	<0.05	<0.5	<0.5	<4	<0.4	14	11	87	<0.1	3	15	<1	<7	13000	NT	6.4	NT
229	10m Infront Int Mound - 300m	<0.05	<0.5	<0.5	<4	<0.4	16	2	23	<0.1	2	5	<1	<7	16000	NT	7	NT
230	10m Infront Int Mound - 200m	<0.05	<0.5	<0.5	<4	<0.4	14	13	18	<0.1	2	8	<1	<7	16000	NT	6	NT
231	10m Infront Int Mound - 150m	<0.05	<0.5	<0.5	<4	<0.4	12	34	890	<0.1	2	10	1	8	13000	NT	6.6	NT
232	10m Infront Int Mound - 50m	<0.05	<0.5	<0.5	4	<0.4	10	5	14	<0.1	5	26	<1	<7	15000	NT	6.3	NT
233	10m Infront Int Mound - 100m	<0.05	<0.5	<0.5	<4	<0.4	12	15	330	<0.1	2	11	<1	<7	13000	NT	6.3	NT
234	Container Area 500m west	<0.05	<0.5	<0.5	<4	<0.4	18	11	9	<0.1	7	25	<1	<7	14000	NT	8.3	NT
251	Sediment - Basin 4	<0.05	<0.5	<0.5	8	<0.4	16	7	12	0.1	1	10	<1	<7	28000	NT	6.1	NT
253	Sediment - Basin 1	<0.05	<0.5	<0.5	<4	<0.4	3	15	11	<0.1	3	15	<1	<7	2000	NT	6.9	NT
255	Sediment - Basin 3	<0.05	<0.5	<0.5	<4	<0.4	9	7	7	<0.1	4	17	<1	<7	9000	NT	7	NT

TABLE 11: 2022 SOIL & SEDIMENT RESULTS 500m																		
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
255	Sediment - Basin 3	-	-	-	-	-	-	-	-	-	-	-	-	--		NT	7	NT
257	Sediment - Basin 2	<0.05	<0.5	<0.5	<4	<0.4	8	33	9	<0.1	11	52	<1	<7	6500	NT	8.1	NT
259	Creek Sediment below Basin 1	<0.05	<0.5	<0.5	<4	<0.4	11	4	17	<0.1	4	20	<1	<7	13000	NT	5.8	NT
261	Creek Sediment below Basin 3	<0.05	<0.5	<0.5	<4	<0.4	8	5	14	<0.1	2	19	<1	<7	7700	NT	6.8	NT
261	Creek Sediment below Basin 3	<0.05	<0.5	<0.5	<4	<0.4	7	4	12	<0.1	2	17	<1	<7	6400	NT	-	NT
205	- [TRIPLICATE]	-	-	-	<4	<0.4	11	220	180	<0.1	2	44	<1	<7	12000	NT	-	NT
225	- [TRIPLICATE]	-	-	-	4	<0.4	13	6	250	<0.1	1	9	<1	<7	16000	NT	-	NT

TABLE 12: 2022 SOIL & SEDIMENT RESULTS 800m																		
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
001	800m Bullet Catcher 1	<0.05	<0.5	<0.5	<4	<0.4	<1	3	23	<0.1	<1	5	<1	<7	1300	NT	6.8	NT
001	800m Bullet Catcher 1	<0.05	<0.5	<0.5	<4	<0.4	1	2	24	<0.1	<1	8	<1	<7	2000	NT		NT
002	800m Bullet Catcher 4	<0.05	<0.5	<0.5	<4	<0.4	<1	3	1000	<0.1	<1	3	<1	<7	1700	NT	8.8	NT
003	Butt - above Bullet Catcher 5	1.2	<0.5	<0.5	10	<0.4	16	180	2100	<0.1	3	29	2	30	14000	NT	8.2	NT
003	Butt BTW Bullet Catcher 3-4															NT	8.2	NT
004	Butt BTW Bullet Catcher 3-4	<0.05	<0.5	<0.5	<4	<0.4	2	2	1100	<0.1	<1	6	<1	9	2900	NT	8.1	NT
005	Butt under Bullet Catcher 2	<0.05	<0.5	<0.5	<4	<0.4	<1	<1	5	<0.1	<1	3	<1	<7	1600	NT	8.5	NT
006	Butt under Bullet Catcher 6	<0.05	<0.5	<0.5	<4	<0.4	4	3	100	<0.1	2	7	<1	<7	2000	NT	7.9	NT
007	Mantlet West	<0.05	<0.5	<0.5	<4	<0.4	8	4	56	<0.1	<1	9	<1	<7	12000	NT	7	NT
008	Mantlet Central	<0.05	<0.5	<0.5	<4	<0.4	10	6	79	<0.1	1	5	<1	<7	13000	NT	6.3	NT

TABLE 12: 2022 SOIL & SEDIMENT RESULTS 800m																		
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
009	Mantlet East	<0.05	<0.5	<0.5	<4	<0.4	7	3	69	<0.1	<1	6	<1	<7	11000	NT	6.7	NT
010	Infront of Mantlet West	<0.05	<0.5	<0.5	<4	<0.4	12	38	390	<0.1	3	20	<1	<7	14000	NT	8.3	NT
011	Infront of Mantlet Central	<0.05	<0.5	<0.5	<4	<0.4	13	28	410	<0.1	2	15	1	<7	15000	NT	8.3	NT
011	Infront of Mantlet Central	<0.05	<0.5	<0.5	<4	<0.4	12	32	520	<0.1	2	16	1	<7	13000	NT		NT
012	Infront of Mantlet Central	<0.05	<0.5	<0.5	<4	<0.4	10	17	220	<0.1	2	13	<1	<7	12000	NT	8.1	NT
012	Infront of Mantlet Central															NT	8.1	NT
013	Bench in front of Butt West	<0.05	<0.5	<0.5	7	<0.4	9	39	660	<0.1	2	13	<1	10	7200	NT	8.2	NT
014	Bench in front of Butt Central	<0.05	<0.5	<0.5	60	<0.4	29	81	760	<0.1	3	20	1	10	11000	NT	8.1	NT
015	Bench in front of Butt East	<0.05	<0.5	<0.5	8	<0.4	13	39	430	<0.1	2	16	<1	10	10000	NT	8.3	NT
016	Rear of Butt	<0.05	<0.5	<0.5	<4	<0.4	12	6	57	<0.1	2	7	<1	<7	12000	NT	8	NT

TABLE 12: 2022 SOIL & SEDIMENT RESULTS 800m																		
Sample ID	Sample Location	PAH-Total	PAH-B(a) PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Anti-mony	Iron	CEC	pH	Clay in Soil <2µm
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	pH Units	% W/W
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**			**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400000**						
RANGE OF VALUES																	6.5 - 8.5	
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
017	Area over Storeroom	<0.05	<0.5	<0.5	<4	<0.4	12	20	210	<0.1	2	12	<1	<7	15000	NT	8	NT
018	Stormwater culvert upper	<0.05	<0.5	<0.5	5	<0.4	13	12	72	<0.1	3	20	<1	<7	9900	NT	7.4	NT
019	Stormwater culvert lower	<0.05	<0.5	<0.5	5	<0.4	8	6	50	<0.1	2	13	<1	<7	9500	NT	6.9	NT
020	Rear channel lower	<0.05	<0.5	<0.5	<4	<0.4	3	4	30	<0.1	<1	7	<1	<7	16000	NT	6.9	NT
021	Rear channel upper	<0.05	<0.5	<0.5	14	2	7	12	75	0.2	1	17	1	9	200000	NT	6.3	NT
021	Rear channel upper	<0.05	<0.5	<0.5	9	1	6	12	83	0.1	1	15	<1	<7	140000	NT		NT
023	Sediment at Pond 800m	<0.05	<0.5	<0.5	<4	<0.4	3	<1	9	<0.1	<1	3	<1	<7	2000	NT	5.5	NT
025	Sediment rear channel	<0.05	<0.5	<0.5	8	0.4	26	12	140	<0.1	4	16	<1	<7	36000	NT	5.6	NT
026	Sediment Galley	<0.5	<5	<5	9	0.6	21	8600	1600	<0.1	8	1200	6	8	28000	NT	7.6	NT
001 -	[TRIPLICATE]				<4	<0.4	3	2	23	<0.1	1	9	<1	<7	2200	NT		NT

TABLE 13: SURFACE WATERS – 50M, 500M, 800M & SURROUNDS															
Sample ID	LOCATION	pH	Turb-idity	Total N	Ammonia as N	DO	Phosphate as P	Phos-phorus	Nickel	Arsenic	Chromium	Lead	Copper	Zinc	Antimony
				OBS ONLY		OBS ONLY		OBS ONLY							
	ANZECC 2000 PFWS/NEPM 2013 GIL			0.25	0.9		0.015	0.2	11	13	3.3	3.4	1.4	8	9
	ANZECC 2000 RWQG			0.25	**10**				**100**	**50**	**50**	**50**	**1000**	**5000**	**-**
Units		pH Units	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Practical Quantitation Limit or Limit of Reporting Test (PQL)				0.1	0.005	0.1	0.005	0.05	1	1	1	1	1	1	1
22	Water: Rear Channel 800	3.3	[NT]	3	0.56	9.2	<0.005	0.1	9	16	35	2700	320	94	13
22	Water: Rear Channel 800	[NT]	[NT]	2.4	[NT]	[NT]	[NT]	0.2	8	15	31	2500	280	76	12
24	Water: Pond side of 800	6.1	20	0.3	0.022	8.5	<0.005	<0.05	<1	<1	<1	2	<1	12	<1
24	Water: Pond side of 800	6.2	[NT]	[NT]	[NT]	[NT]	[NT]		[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
117	Basin 5 – 50m	7.2	17	0.4	0.018	8.3	<0.005	<0.05	<1	1	1	3	2	2	7
120	Basin 5 – inlet pipe 50m	7	16	1	0.01	8.2	<0.005	<0.05	<1	<1	<1	1	1	2	2
120	Basin 5 – inlet pipe 50m	[NT]	16	1	0.011	[NT]	<0.005								
250	Basin 4 – Car Park 50/500	6.3	4.6	<0.1	<0.005	8.3	<0.005	<0.05	<1	<1	<1	1	2	14	<1
252	Basin 1- 200m	6.9	1.7	0.1	0.006	8	<0.005	<0.05	<1	<1	<1	<1	1	<1	<1
254	Basin 5 – 500m East	7.2	1.4	1	0.071	8	<0.005	<0.05	<1	<1	<1	2	3	<1	2
256	Basin 5 – 500m West	7.5	1.7	0.3	0.012	8	<0.005	<0.05	<1	1	<1	2	2	39	7
258	Creek waters below 200m	6.8	1.6	0.2	0.037	8.2	<0.005	<0.05	<1	<1	<1	2	2	4	<1
NIL	Creek below 500m East														

9.3 Visual Inspections

The observations from the QTR4 visual inspection are provided for each range following.

Results are discussed at Sections 9.3.1- 9.3.4 following.

9.3.1 50m range

Table 14: Visual Inspection, 50m Range and Surrounds

<table>
<tr><td colspan="2">Basins</td></tr>
<tr><td colspan="2">Basin 5 (at 50m range)</td></tr>
<tr><td>  </td><td>Basin full to trickle pipe invert
Note scour near entrance – this does not seem to have progressed- discussed further</td></tr>
<tr><td>  </td><td rowspan="2">Scour over batter at entrance to basin enclosure
Water directed by surface water swale to entrance track to basin
Scour leads down access track to spread at bench and then down batter at basin
This scour does not seem to have progressed and is now stable - no further action suggested
Outlet from basin is stable – no scour evident from sides or flanks of gabion scour protection.
Some plants are establishing within the gabion scour protection. These should be poisoned and removed before their growth disturbs the stability of the gabion structure.</td></tr>
<tr><td>  </td></tr>
<tr><td>No Photo</td><td>Water is flowing from the trickle pipe from the 50-metre range</td></tr>
<tr><td colspan="2">Vegetation Health/Surface cover</td></tr>
</table>

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<tr>
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  </td>
<td>

- Weeds generally across the 50m range are acceptable within the actual bay floor areas with only some ground covers establishing.
- On the face of the butt and above bullet catcher, weeds and vegetation generally is establishing more thickly especially in the lower portions of the butt immediately above the treated pine work.
- This is possibly due to moisture being most available at this location.
- In some areas woody species are establishing in the face of the butt. These larger woody species will need to be removed before they become a hazard for the shooting range and also their roots begin to undermine the stability of the stop butt.

</td>
</tr>
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  </td>
<td>

Noise mound to East of shoot Bay 1.

- Poor quality soil or subgrade material including blue metal gravel has been pushed over the surface of the eastern mound to bay 1.
- It appears as if some simple subsoil drainage has been installed under the base works to Bay 1.
- It is unknown where the subsoil drainage is connected.
- This new arrangement should be updated on plans within the SAQP and confirmed this drainage is connected to the stormwater leading to the main WQ basin.
- This batter to the noise mound should be stabilised however it is expected that importation of topsoil will be required with additional of fertiliser and or ameliorants.

</td>
</tr>
</table>

	**Top of Stop butt at 50m** • Erosion at face of but above bullet catcher is progressing and getting more severe and some areas particularly shooting base 4 and 3. • Occurs where water is pooling on top of butt formation and overflows over face • Evidence of erosion to approximately 30 cm deep. • Evidence of some dispersible material within the stop button material- Some evident of tunnelling • Localised scour is significant in some areas **Confirm previous recommendations to rework of top of the mound formation to prevent surface water passing over the batters of the stop butt.** **It is suggested that the material may require addition of gysum or lime to mitigate dispersive materials.** **Re surfacing of the top of butt / face of butt may be required**
	**Rear of main butt** • Vegetation at back of butt is patchy to bare, with cover mostly by small woody species. • Drainage swale at rear of butt is accumulating sediment but still functional. At eastern end the drainage swale is full and no longer functional. • To reduce ongoing sediment loss from this area it would be necessary to topsoil rear of butt or cover with a spray on soil blanket plus additional revegetation works.
	• Vegetation external to the 50m range is regenerating vigorously • Thick vegetation establishing across all areas

	•
Engineering controls: Lime treatment Process • The lime treatment process is a closed sealed unit. • Inspection of the unit is not possible This item has been removed from sampling program. Servicing or inspection by a qualified technician may be recommended by monitoring outcomes.	
Engineering controls: Road Infrastructure and Drainage • Road Infrastructure and Drainage for the 50m range is addressed within Section 8.2.2	
Safety and Signage • Safety and signage for the 50m range is addressed within Section 8.2.2	

9.3.2 500m range:

Table 15: Visual Inspection, 500m Range and Surrounds

Basins	
Basin 3 (500m east)	
	• The eastern Basin and surrounds show evidence of minor erosion to the batter is however all the sediment is captured within the basin. • The main Basin inlet is showing signs of scour through recent rain events, especially on the southern side. • It's expected that in time this Basin inlet will need to be reworked. • Other secondary inlets to the north stable. The outlet of the basin it's stable. The area below the outlet of the basin this table.

Basin 2 (500m west)

- The western basins and surrounds are stable.
- The inlet and outlet to the basin are stable.
- The water is clear.

Vegetation Health Surface Cover
General comment to vegetation on 500m range

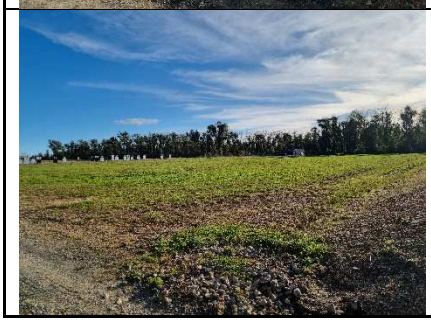
- No significant erosion evident
- Significant percentage of surface cover provided by moss and lichens and weeds
- Currently much of the cover is also clover – this is different to previous inspections

Shooting Point 0m to Intermediate mound 50m

- Grass cover is good approximately 100%
- Some bare areas in North-East corner.
- Cover is grass and clover

Intermediate mound 50m to intermediate mound 100m

- Grass cover is good 100% of grass and clover.
- Central area is saturated.



Intermediate mound 100m to intermediate mound 150m

- Grass cover is good approaching 100% comprising moss lichens and grass and clover.
- Water is ponding at the rear of the 100m intermediate mound.

	**Intermediate mound 150m to intermediate mound 200m** • Grass cover is good approaching 100% comprising moss lichens and grass and clover.
	**Intermediate mound 200m to intermediate mound 300m** • Grass cover is good approaching 100% comprising moss lichens and grass and clover. • Poor drainage at rear of target
No Photo	**Intermediate mound 300m to intermediate mound 385m** • Vegetation is good • Ground cover approaching 100% mostly lichen Moss and fresh growth of clover. • Water is ponding at the rear of the 200m stopbutt.
 	**Intermediate mound 385m to 500m Butt** • Vegetation cover is good • 80% + over most of range except for bare areas (less than 50% cover) in first 20m offset from main stop butt.
No Photo	**New lay-down area located to north of basin2** • Gravel surface is stable • 4 shipping containers placed to replace storage lost in fire

 	• Swale drains western side of 500– grassed up and stable
 	• Swale drain leading to southwest corner of 500m stop butt • Invert of drainage swales are bare with some scour/sediment loss evident • New rock check dams installed • rock size too large & no fabric installed causing water to be focused through with scour underneath **Recommend intermix smaller rock (75mm-150mm) into gaps of existing structures plus some smaller rock (diameter 25mm)**
	**Stormwater pit located at rear western corner of stop butt** • pit function reinstated following fire damage • surrounds of pit protected with rockwork

	**Rock inlet to stormwater pit located western corner at rear of butt** • Sediment from drainage swale accumulating in rock work
 	**Eastern side** • Eastern area drainage is good • Some erosion is evident however this is not severe. • Coir logs have been used to control erosion however these appear to be getting eaten by pigs. • The Central portion of the eastern table drain should be monitored and if erosion control is required. It is suggested that small check structures using 75 to 150mm graded ballast shaped into checks dams are recommended.
 	**Top of Stop butt at 500m** • Some riling at front of batter • Occurs where water is pooling on top of butt formation and overflows over face

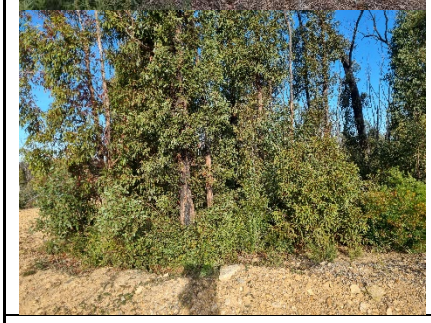
Access Tracks and Drainage – around 500m Range

- Access road on eastern side of 500m range
- Moderate scour extending through gravel of access track

Access roads on each side of 500m range are mostly stable. Minor scour is evident adjacent to the intermediate mounds where these have acted to direct water to the adjacent swales.

This scour should be monitored and repaired as required as part of regular ongoing maintenance.

Shot Loss 500m Range

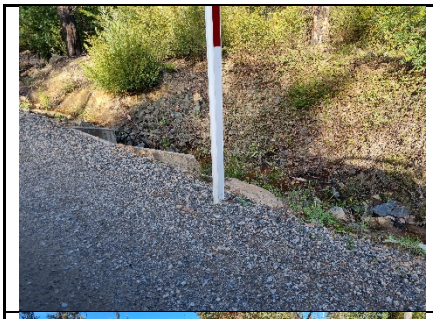


Shot loss assessment along the eastern and western side of the 500m rage.

No evidence of marks on trees from shot loss.

Engineering controls: Road Infrastructure and Drainage

- All road areas are stable
- Table drains and culverts and well maintained and stable

 	
Safety and signage	
No Photos	• Safety direction signage in place

9.3.3 Other Basins

Table 16: Visual Inspection, Other Basins

Basin 1 (at future 200m range)	
Basin 1 (Future 200m)	
 	• The basin is full and very clear. • Water is flying from the low flow outlet through the creek area below.

	• The inlet is stable however; • **woody vegetation growing within the inlet should be poisoned so it's growth does not undermine the structure of the inlet.**
 	• The Basin outlet is stable. • The surrounds of The Basin and access track a stable with no significant scour to be seen
Basin 4 (at car park)	
	• Basin inlet and outlet stable • Basin full of reeds

9.3.4 800m range

Table 17: Visual Inspection 800m Range and Surrounds

Basin 7 (800m Range)	
No Photo	**Basin 7/Bushland Pond** • Basin partially full of ponding water • Surrounds of basin are undisturbed /unchanged
Vegetation Health	
 	**Vegetative health 0-100m from target** • Improved grass cover from previous inspections • Some areas at sides of range slightly cover more • Rest of range grass cover good
	**Vegetative health first 6-10m from Mantlet** • 70% Plus cover with limited bare areas
	**Vegetative health – bench in-front of stop but and bullet catchers** • Good thick ground cover • Batter to gallery now covered with thick Kikuyu

	**Vegetative health rear of stop butt** • Vegetation establishing within channel • Mulched area still leaching water following rainfall • Organic sheen evident on surface of water
Concrete Galley	
	• Galley has been swept and is clear of small debris • Other general waste being removed at time of inspection as part of working bee
Engineering controls: Road Infrastructure and Drainage	
No Photos	**Roads and Access tracks** • Access track in fair condition • Some impact of heavy rainfall noted • Leaf litter and debris over surface
No Photos	**Safety and signage** • **Signage in place at entrance to 800m range**
Engineering controls: Lime treatment Process • The lime treatment process is a closed sealed unit. • Inspection of the unit is not possible This item has been removed from the sampling program. Servicing or inspection by a qualified technician may be recommended by monitoring outcomes.	
	Lime treatment process sealed and intact

9.4 Discussion of results – Soils and Sediments

9.4.1 Soils Sediments -pH

The following samples returned pH values outside the target range of pH 6.5 - 8.5;
Discussions of results is included following each observation.
Recommended actions are provided in bold.

Table 18: pH Discussion of Results – Soils and Sediments

Sample ID	Location	pH
50m Range		
105	Soil - Bushland off Range – South of main butt	5.2
106	Soil - Bushland off Range – West of main butt	5.5
107	Soil - Bushland off Range – West of main butt	5.2
• These samples are from a bushland area where a lower pH is to be expected • No action is recommended		
109	Bullet catcher - BAY 3 – Gravel Material	9.0
111	Above Bullet catcher - BAY 1 – Stabilised Natural Subgrade	8.9
112	Above Bullet catcher - BAY 3 Stabilised Natural Subgrade	8.8
115	Above Bullet catcher - BAY 3 Stabilised Natural Subgrade	9.0
• These samples are mildly alkaline & consistent with observations/ results from previous sampling exercises similar materials this sampling exercise • This elevated pH does not seem to have impacted on the pH of water within the receiving waters (Basin 5.) which has a pH of 7.2 • No action is recommended		
116	Sediment from Basin 5	6.4
• These samples are from natural clays within Basin 5 • the pH of waters within Basin 5 is within Range (pH 7.2) • No action is recommended		
500m Range		
212	500m Bushland - West 1	5.2
213	500m Bushland - West 2	4.9
214	500m Bushland - East	5.3
215	500m Bushland - North	5.5

Sample ID	Location	pH
• These samples are from bushland areas where a lower pH is to be expected • No action is recommended		
201	Range floor 385-500m	6.4/6.2
202	Range floor 300-385m	6.4
203	Range floor 200-300m	5.7/5.7
204	Range floor 150-200m	6.4
205	Range floor 100-150m	5.8
208	Additional RF 385-500m	6.0
209	Additional RF 300-385m	6.0
219	Intermediate Mound - 385m	6.4
228	10m Infront Int Mound - 385m	6.4
230	10m Infront Int Mound - 200m	6.0
231	10m Infront Int Mound - 50m	6.3
232	10m Infront Int Mound - 100m	6.3

• These samples are mildly acidic – moderately acidic
• These results are consistent with observations/ results from previous sampling exercises however the lower pH is now observed over a broader area.
• The observed pH could be attributed to;
  • Natural soil conditions
  • Effect of clover cover of range floor
  • Significant rainfall leaching Ca+ and Mg+ from soil upper horizons
• This elevated pH does not seem to have impacted on the pH of water within the receiving waters within the 500m Range (Basin 2 pH 7.2.& Basin 3 pH 7.5)
• This pH may have a limiting effect on the heath of vegetive cover
 	
Recommendations
• Samples taken from the range floor will be used to determine rates for application of agricultural lime or other ameliorants to correct the pH		

800m Range		
002	800m Bullet Catcher 4	8.8
• This sample is mildly alkaline & consistent with observations/ results from previous sampling exercises similar materials this sampling exercise • No action is recommended		
008	Mantlet central	6.3

Sample ID	Location	pH
• This sample is mildly acid. Adjacent samples are also mildly acidic but within the range of 6.5-8.5 • This area will be monitored in ongoing events. • No action is recommended		
021	Bushland/Outlet area from Rear Channel - Upper	5.3
• This sample is from bushland areas where a lower pH is to be expected • Samples 025 and 021 also received water passing from the mulched area at the rear of the 800m stop butt • No action is recommended		
021	Bushland/Outlet area from Rear Channel - Upper	5.3
025	Sediment from rear channel	5.5
• These samples are from bushland areas where a lower pH is to be expected • Samples 025 and 021 also received water passing from the mulched area at the rear of the 800m stop butt • **Issues associated with water from this mulched area is discussed in section 9.6**		
Other Areas		
251	Sediment – Basin 4 (Off Car park)	6.1
259	Creek Sediment below Basin 1 (Future 200m range)	5.8
• These samples are from a bushland areas or basins which do not receive runoff from Shot fall areas- where a lower pH is to be expected • No action is recommended		

9.4.2 Soils Sediments – Other Criteria

Table 19: Discussion of Results – Surface Waters - Other Criteria

Sample ID	Location	Analyte	Value
50m Range			
NIL			
500m Range			
205	Range floor 100-150m	Copper	3800 mg/kg
• Sample 205 is from a shot fall area within the 500m range • The level for copper is above the Ecological Investigation Level (EIL) from the WCMP but below the Health Intervention Levels for Development open space and Commercial industrial • This level does not present special health risks requiring management beyond that already employed by the SHRSC • This result is much higher than samples from similar shot fall areas. it is possible that bullet fragments were included in the sample collected • No further action is recommended			
205	Range floor 100-150m	Zinc	240 mg/kg
• Sample 205 is from a shot fall area within the 500m range • The level for Zinc is above the Ecological Investigation Level (EIL) from the WCMP but below the Health Intervention Levels for Development open space and Commercial industrial • This level does not present special health risks requiring management beyond that already employed by the SHRSC • This result is much higher than samples from similar shot fall areas. it is possible that bullet fragments were included in the sample collected • No further action is recommended			
224	Intermediate Mound - 150m	Lead	620 mg/kg
231	10m Infront Int Mound - 150m	Lead	890 mg/kg
• Samples 224 & 231 are from a shot fall area within the 500m range • The levels for lead are above the Health Investigation Level for developed Open Space (HIL (C)) but below the Health Intervention Level Commercial industrial (HIL (D)) and below the Ecological Investigation Level (EIL) from the WCMP • This level does not present special health risks requiring management beyond that already employed by the SHRSC • No further action is recommended			
800m Range			
002	800m Bullet Catcher 4	Lead	1000 mg/kg
013	Bench in front of Butt West	Lead	660 mg/kg
014	Bench in front of Butt Central	Lead	760 mg/kg

<table>
<tr><th>Sample ID</th><th>Location</th><th>Analyte</th><th>Value</th></tr>
<tr><td colspan="4">

These samples are from the Primary shot fall area within the 800m range
The levels for lead are above the Health Investigation Level for developed Open Space (HIL (C)) but below the Health Intervention Level Commercial industrial (HIL (D)) and below the Ecological Investigation Level (EIL) from the WCMP
These levels do not present special health risks requiring management beyond that already employed by the SHRSC

Given other lead levels observed in this area it is recommended that additional precautions be investigated and implemented for when undertaking activities in this area.
</td></tr>
<tr><td rowspan="2">003</td><td rowspan="2">Butt - above Bullet Catcher 5</td><td>Lead</td><td>2100 mg/kg</td></tr>
<tr><td>Copper</td><td>180 mg/kg</td></tr>
<tr><td colspan="4">

Sample 002 is from the Primary shot fall area within the 800m range
The levels for lead are above the Health Investigation Levels for developed Open Space (HIL (C)), Commercial industrial (HIL (D)) and Ecological Investigation Level (EIL) from the WCMP
The level for copper is above the Ecological Investigation Level (EIL) from the WCMP but below the Health Intervention Levels for Development open space and Commercial industrial
It may be that a bullet fragment was included within the sample collected

Given other lead levels observed in this area it is recommended that additional precautions be investigated and implemented for when undertaking activities in this area.
</td></tr>
<tr><td rowspan="2">026</td><td rowspan="2">Sediment accumulated in concrete drain within Galley</td><td>Copper</td><td>8600 mg/kg</td></tr>
<tr><td>Lead</td><td>1600 mg/kg</td></tr>
<tr><td colspan="4">

Sample 026 is from the Primary shot fall area within the 800m range
It is accumulated sediment from the primary shot fall area within the 800m range
The levels for lead are above the Health Investigation Levels for developed Open Space (HIL (C)), Commercial industrial (HIL (D)) and Ecological Investigation Level (EIL) from the WCMP
The level for copper is above the Ecological Investigation Level (EIL) from the WCMP but below the Health Intervention Levels for Development open space and Commercial industrial

It is recommended that additional precautions be investigated and implemented for when undertaking activities in this area especially associated with the regular sweeping and cleaning of this sediment.
</td></tr>
<tr><td colspan="2">Other Areas</td><td></td><td></td></tr>
<tr><td>NIL</td><td></td><td></td><td></td></tr>
</table>

9.5 Discussion of results – Surface Waters

9.5.1 pH Surface Waters

The following samples returned pH values outside the target range of pH 6.5-8.5;
Discussions of results is included following each observation.
Recommended actions are provided in bold.

Table 20: pH Discussion of Results – Surface Waters

Sample ID	Location	pH
50m Range		
NIL		
500m Range		
NIL		
800m Range		
022	Water: Rear Channel 800	3.3
• Sample 022 is water passing from the mulched area at the rear of the 800m stop butt • Decomposition of mulch is assumed to be generating organic acids which is lowering pH significantly • **Issues associated with water from this mulched area is discussed in section 9.6**		
024	Water: Pond side of 800	6.1/6.1
• This sample is from a bushland area & basin which do not receive runoff from Shot fall areas- where a lower pH is to be expected • No action is recommended		
Other Areas		
250	Basin 4 – Car Park 50/500	6.3
• This sample is from a bushland area & basin which do not receive runoff from Shot fall areas- where a lower pH is to be expected • No action is recommended		

9.5.2 Surface Waters – Other Criteria

Table 21: Discussion of Results – Surface Waters – Other Criteria

Sample ID	Location	Analyte	Value
50m Range			
117	Basin 5 – 50m	Total N	0.4 mg/L
120	Basin 5 – inlet pipe 50m	Total N	1 mg/L
• The values within the surface water management process for the 50m range returned for total Nitrogen are slightly higher than the adopted criteria • This may be consequent to the extreme rainfall received in over the recent period. In this instance it is expected that the levels of Total N would be expected to attenuate over time • Further sampling undertaken (Sample 117) 23/06/22 returned a value of 0.2 mg/L which is within the adopted criteria • No further action is recommended			
500m Range			
254	Basin 2 – 500m East	Total N	1 mg/L
256	Basin 3 – 500m West	Total N	0.3 mg/L
• The values within the surface water management process for the 500m range returned for total Nitrogen are slightly higher than the adopted criteria • This may be consequent to the extreme rainfall received in over the recent period. In this instance it is expected that the levels of Total N would be expected to attenuate over time • It may also be associated with the increased cover and growth of clover over the range floor and catchments to basins 2 and 3 • Further sampling undertaken (Sample 254) 23/06/22 returned a value of 0.2 mg/L which is within the adopted criteria • No further action is recommended			
800m Range			
022	Water: Rear Channel 800	Total N	3 & 2.4 mg/L
		Arsenic	16 & 15 µg/L
		Chromium	35 & 31 µg/L
		Lead	2700 & 2500 µg/L
		Copper	320 & 280 µg/L
		Zinc	94 & 76 µg/L
		Antimony	13 & 12 µg/L

Sample ID	Location	Analyte	Value
• Sample 022 is taken from water draining off and through the heavily mulched rear batter and surrounds of the 800m stop butt. • This water appears to be leaching through the mulched material resulting in a very low pH (pH 3.3) • This low pH is leading to Total N, Arsenic, Chromium, Copper, Zinc and Antimony higher than the adopted criteria – NEPM 2013 Ground water Investigation levels (GIL) but below the ANZECC 2000 Recreational Water Quality Guidelines • The returned value for Lead is higher than the adopted criteria – NEPM 2013 Ground water Investigation levels (GIL) AND the ANZECC 2000 Recreational Water Quality Guidelines. Action is required to manage and correct drainage from the rear of the stop butt. This may involve provision of a shallow water quality measure and addition of lime to raise pH.			
024	Water: Pond side of 800	Total N	0.3 mg/L
• The values within the pond adjacent to the 800m returned for total Nitrogen are slightly higher than the adopted criteria • This pond is within bushland and does not receive run off from any shot fall areas of the 800m range • This may be consequent to the extreme rainfall received in over the recent period. In this instance it is expected that the levels of Total N would be expected to attenuate over time. • No further action is recommended			
Other Areas			
250	Basin 4 – Car Park 50/500	Zinc	14
• The pond/basin adjacent to the entrance car park (50&500m ranges) returned a value for Zinc are slightly higher than the adopted criteria – NEPM 2013 Ground water Investigation levels (GIL) but below the ANZECC 2000 Recreational Water Quality Guidelines • This pond does not receive run off from any shot fall areas • It is noted that the pH for this pond is slightly lower (pH 6.3) which may lead to increased levels of zinc from natural soils • It is noted that burnt wire and fencing materials removed post the2019-20 bushfires has been stockpiled within the car park catchment to this pond. These fencing materials may have remnant degraded galvanised coatings which may be washed to this pond • The waste wire and fencing materials should be removed for appropriate disposal.			
256	Basin 3 – 500m West	Zinc	39
• Basin 3 returned a value for Zinc are slightly higher than the adopted criteria – NEPM 2013 Ground water Investigation levels (GIL) but below the ANZECC 2000 Recreational Water Quality Guidelines • It is noted that the pH for this basin is 7.5 • Zinc levels within Basin 3 are to be monitored in ongoing monitoring events.			

9.5.3 Visual Inspections: Water Quality Basins

The following table summarises observations and recommended actions from Section 9.2. Recommended actions are provided in bold.

Table 22: Discussion of Observations Water Quality Basins

Item	Location	Observation and Comment
1.	Basin 1	The inlet is stable however woody vegetation growing within the inlet should be poisoned so it's growth does not undermine the structure of the inlet.
2.	Outlet area below Basin 1	The Basin outlet is stable with no evidence of erosion post heavy rainfalls and loss of vegetation during fires.
3.	Basin 2 (500m west)	Inlets and outlet areas are stable.
4.	Basin 3 (500m east)	Significant rework has been undertaken at the main (Southern) inlet of the basin with placement of rock. Water is passing out the side of the inlet control and is Leading to scour adjacent to the inlet. **It is likely that rework of the inlet structure will be required. It is recommended that any rework include shaping of the inlet channel to create a defined inflow and is lined with geotextile.** **The rock used should consist of well graded angular material.**
5.	Basin 4 (car park)	Inlets and outlet areas are stable. No issues or required action is evident.
6.	Basin 5	Scour observed at entrance to enclosure does not seem to have progressed. The area now appears to have stabilised. **Some plants are establishing within the gabion scour protection. These should be poisoned and removed before their growth disturbs the stability of the gabion structure.**
7.	Basin 5 (50m)	Scour is evident over batter at entrance to basin enclosure. Water is directed by surface water swale towards entrance track to basin. Scour leads down access track to spread at bench and then down batter at basin leading to scour. **Suggest a formalise drain will be required in this location to arrest further scour – rock over fabric**
8.	Basin 6	This basin has not been constructed.
9.	Basin 7 (800m range)	Inlets and outlet areas are stable. No issues or required action is evident.

9.5.4 Visual Inspections: Lime treatment Process

Visual inspection of the lime treatment process was not possible as this infrastructure is sealed and not readily accessible. This item has been removed from the sampling program. Servicing or inspection by a qualified technician may be identified as required by future monitoring results.

9.5.5 Visual Inspections: Road Infrastructure and Drainage

The following table summarises observations and recommended actions from Section 9.2. Recommended actions are provided in bold.

Table 23: Discussion of Observations Road Infrastructure

Item	Location	Observation and Comment
1.	50/500m	Access roads on each side of 500m range are mostly stable. Minor scour is evident adjacent to the intermediate mounds where these have acted to direct water to the adjacent swales. This scour should be monitored and repaired as required as part of regular ongoing maintenance. All roads between the ranges and internal the SHRSC areas are stable Table drains and culverts and well maintained and stable
2.	800m	No issues or required action is evident.

9.5.6 Visual Inspections: Signage

Directional and safety signage was in place across all areas.
Signage was provided at basin enclosures indicating that the water is not suitable for firefighting purposes.

9.5.7 Visual Inspections: Vegetation health - Range areas

Grass cover is good approaching 100% over most of the 500m range comprising moss lichens and grass and clover.
An increased cover of clover has been observed during this sampling event
Localised ponding behind intermediate mounds is observed within the 500m range

No significant sediment loss was observed from Range areas or surrounds.
The existing surface soil material is generally poor however seems to be resistant to erosion.

The following table summarises observations and recommended actions from Section 9.2. Recommended actions are provided in bold.

Table 24: Discussion of Observations, Vegetation Health

Item	Location	Observation and Comment
1.	Range 1 – 50m range	Some minor weed growth within the gravels of the shooting bays. Woody plant growth in areas above the bullet catcher/main stop butt. These will need to be addressed as part of regular maintenance
2.	Various – 500m range	Localised pooling/poor drainage is occurring in several locations within the 500m range. This poor drainage will be monitored. Erosion is not evident over the surface

9.5.8 Visual Inspections: Other Engineering Controls and Structures

The following table summarises observations and recommended actions from Section 9.2. Recommended actions are provided in bold.

Table 25: Discussion of Observations, Other Engineering Controls and Structures

Item	Location	Observation and Comment
1.	New drainage – Shooting Bay 1 – 50m range	Confirm arrangement and connections of new subsoil drains within floor of the shooting range. **Confirm subsoil connects to the WQ treatment and drainage network for the shooting range.**
2.	Stop butt – 500m range	Riling at front of batter occurring where water is pooling on top of butt formation and overflows over face. This erosion is progressing and will require action. **Rework of top of the mound formation will be required to prevent surface water passing over the batters of the stop butt.** **Re surfacing of the face of the butt with a non-erodible cover should be investigated**
3.	Pit at Southeast corner of 50m stop butt	Pit is full of sediment and being bypassed. **Modification of this outlet area may be required depending on existing stormwater arrangement** **This may require replacement of the pit with a stable surface level outlet and spreader.**
4.	Drain at rear of 50m stop butt	The Drainage swale leading to the SE stormwater pit is bare. Sediment and litter is accumulating within the swale leading to the pit. **Further stabilization of the back of the mound will be required to reduce the sediment load to the drainage outlets.**
5.	Swale drain leading to southwest corner of 500m stop butt	The invert of drainage swales bare, with some scour/sediment loss evident. New rock check dams have been installed. It is noted that the rock size too large with no fabric installed causing water to be focused through with scour underneath **It is recommended intermix smaller rock (75mm-150mm) into gaps of existing structures plus some smaller rock (diameter 25mm).** **Works to revegetate the invert of the channels should be considered to reduce generation of sediment.**
6.	Western corner at rear of 500m butt	Sediment from drainage swale is accumulating in rock work at the inlet to the stormwater pit. **Revegetation / stabilisation works are required at the rear of the batter and invert of the swale to reduce sediment generation.**
7.	Face of stop butt at 500m	Some riling at front of batter occurring where water is pooling on top of butt formation and overflows over face. This does not seem to have progressed since previous inspections. Rework of the top of the mound may be considered if similar work is undertaken at the stop butt to the 50m range.

9.6 Recommendations

The following recommendations are made;

9.6.1 Management Actions

The following management actions are presented summarised from section 9.3;

1. Investigate works to re shape top of stop butt mounds at the 50 and 500m ranges
2. Investigate works to improve stabilisation/vegetation rear of the stop butt mounds at the 50 and 500m ranges and associated drainage
3. Replace check measures (as required) at the swale drains at the Eastern side of the 500m range. Coir logs placed within the swale appear to have been eaten by pigs.
4. Investigate works to maintain / improve drainage outlet at the southern corner at rear of 50m range.
5. Confirm rates of lime or similar ameliorants to correct pH across the range floor at the 500m Range.
6. Confirm connection of new subsoil drain to lime treatment pits and basin 5 at the 50m Range.
7. Investigate increased OHS and Hygiene measures for working within the Galley and surrounds of at the 800m range.
8. Investigate and implement works to address low pH drainage at rear of the 800m shooting range.
9. Remove waste burnt fencing materials from the car park at the entrance to the SHRSC 50/500m ranges.

9.6.2 Follow up Monitoring

No specific follow up monitoring is recommended.

9.6.3 Changes to Sampling Program

The following additional sampling items are recommended.

- Include 1 x sample to be taken from the mantlet within Bay 2 at the 50m range.
- Include 1 x sample to be taken from the eastern mound to Bay 1 at the 50m range
- Include 1 x sample of gravel from the container storage area located to the west of the 500m range

10 References

Southern Highlands Regional Shooting Complex, Water Cycle Management Plan (ErSed Sept 2018)

National Environment Protection (Assessment of Site Contamination) Measure (NEPM), National Environment Protection Council (2013).

National Environment Protection (Assessment of Site Contamination) Measure (NEPM), Schedule B1 Guideline on Investigation Levels for Soil and Groundwater, National Environment Protection Council (2011).

Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council (October 2000).

Guidelines for Consultants Reporting on Contaminated Sites, NSW Office of Environment and Heritage (2011).

Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd edition), NSW Department of Environment and Conservation (2006).

Best Management Practices for Lead at Outdoor Shooting Ranges, United States Environmental Protection Agency (2005).

Southern Highlands Regional Shooting Complex Civil Works Plans
Drawings C-SC-202-253 (Arcadis Australia Pacific Pty Limited, 2015)