SOUTHERN HIGHLANDS REGIONAL SHOOTING COMPLEX (SHRSC)

Sampling and Analysis Quality Plan &

2020 Annual Operational Monitoring Program Report

SEPT 2020

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Prepared for

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The information contained herein has been collated and prepared for the stated project or use. This information may not be applicable to other projects or for other uses and should not be used for any other purpose.

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1 Introduction

1.1 Background to Document

The SAQP forms part of the Operational Environmental Management for the Southern Highlands Regional Shooting Complex (SHRSC).

It provides information, plans, methods and justification to support the performance of the Operational Monitoring Program as detailed within Section 5 of the SHRSC Water Cycle Management Plan.

The SAQP is intended to be reviewed annually and modified or confirmed in response to any changes in conditions or management at the site or changes in accepted best practice for contaminated site assessment.

The Annual Operational Monitoring Program report provides the results from the implementation of the SAQP.

1.2 Structure of Document

This SAQP 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.

The Annual Operational Monitoring Program Report has been prepared in accordance with the requirements of the SAQP.

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.

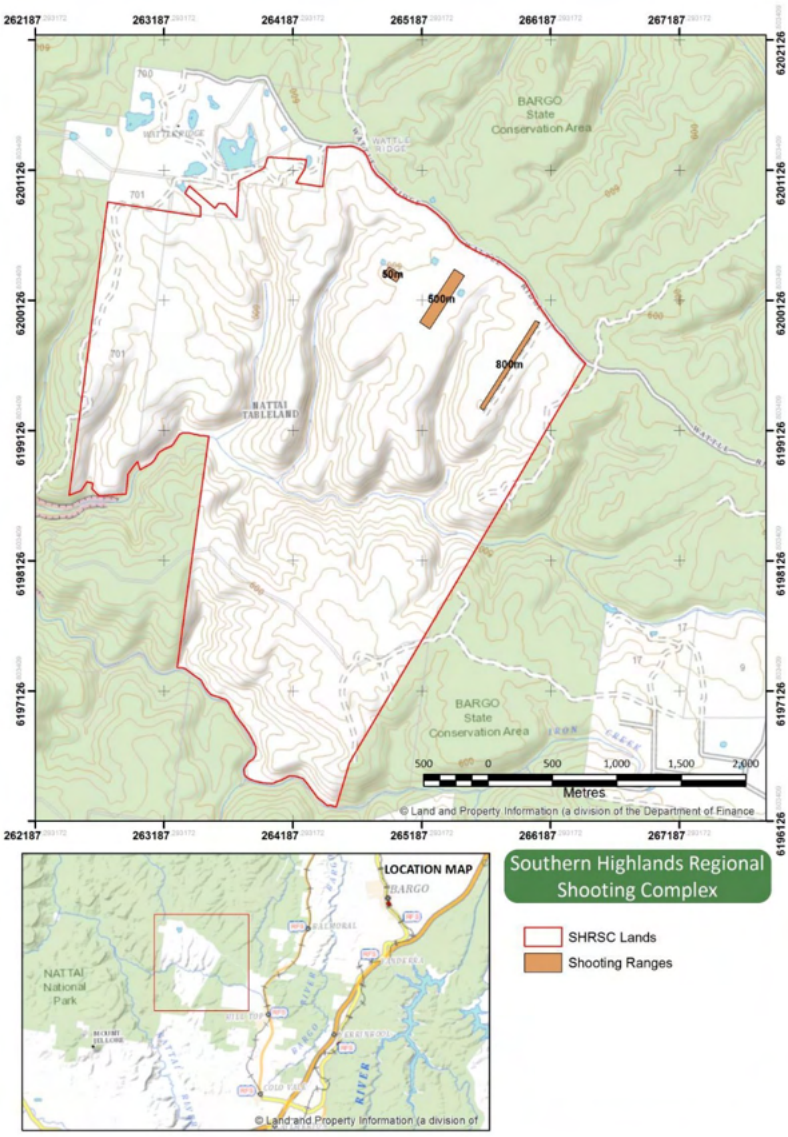

FIGURE 1: Site Location

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.

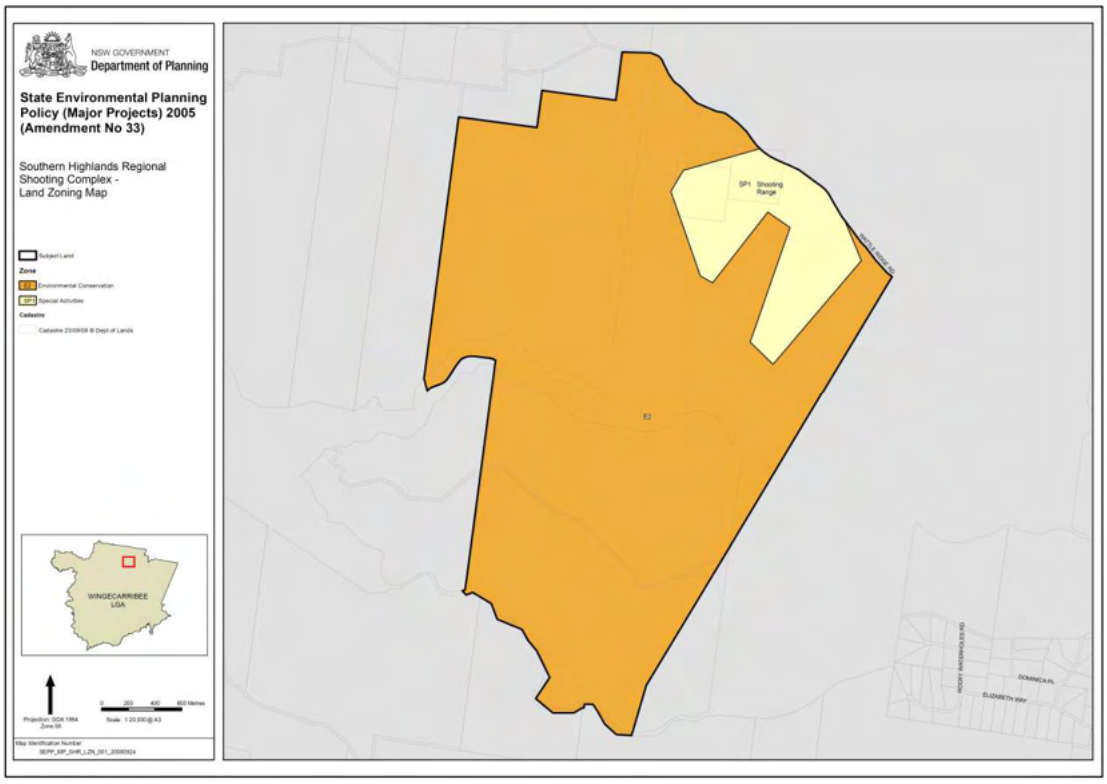

FIGURE 2: SHRSC Zoning Plan showing SP1 Special Activities and E2 Environmental Conservation

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 but and surrounding areas
- 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.

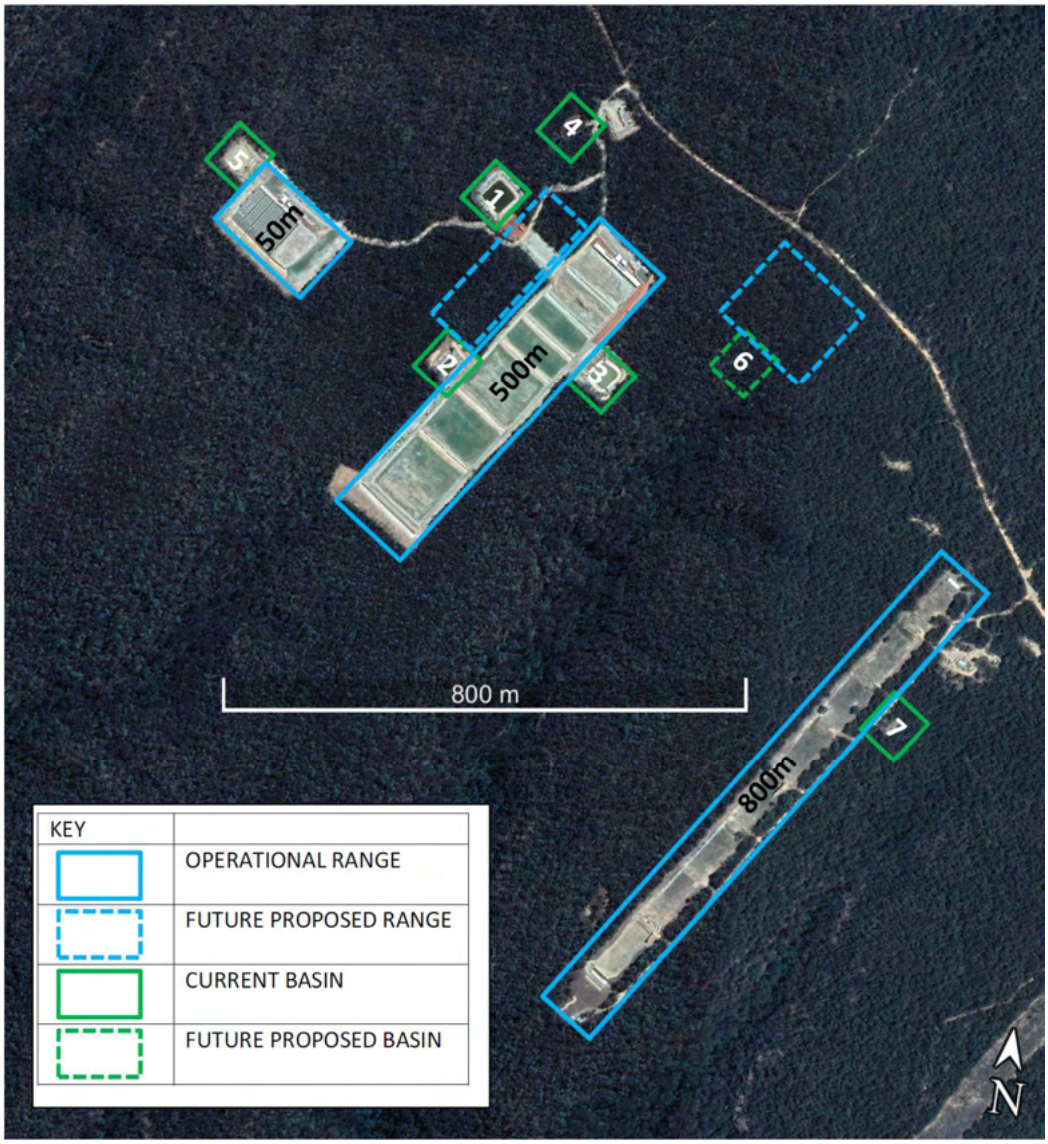

FIGURE 3: Site Layout of the SHRSC

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

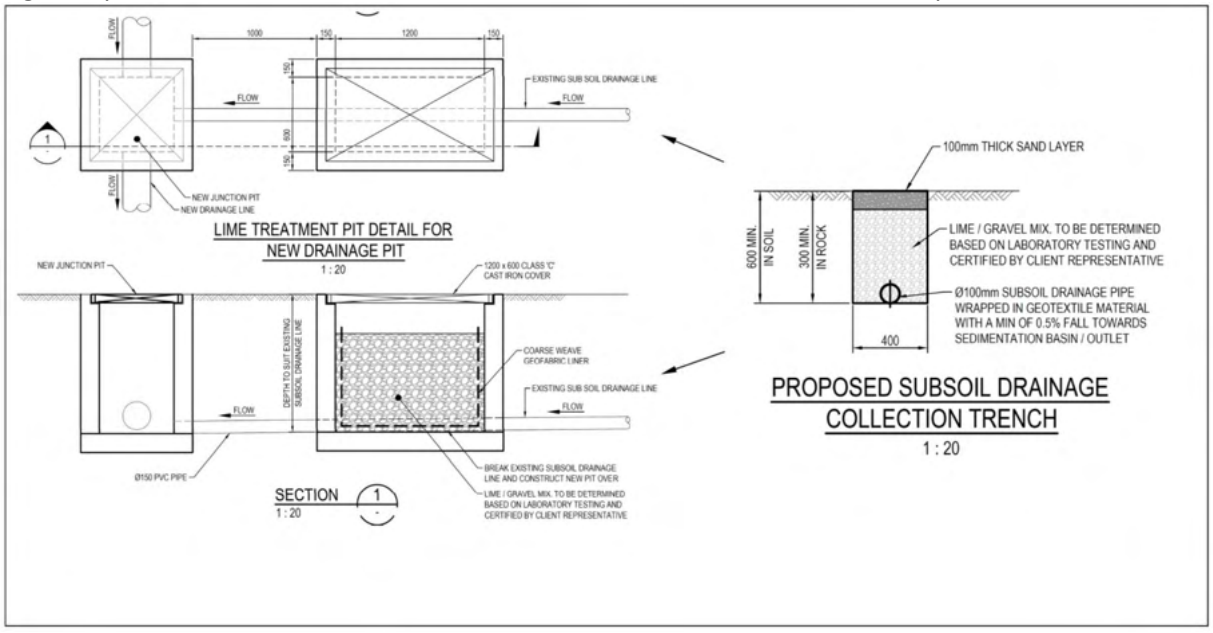

FIGURE 4: Lime treatment and Drainage Details.

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.

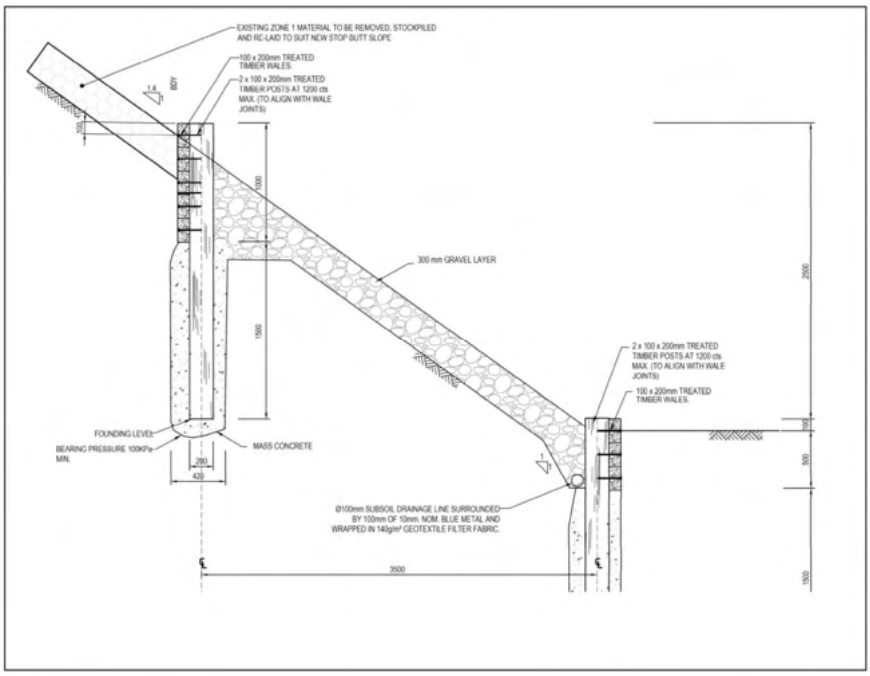

FIGURE 5: Bullet Catcher and Stop Butt Detail.

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 Section

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.

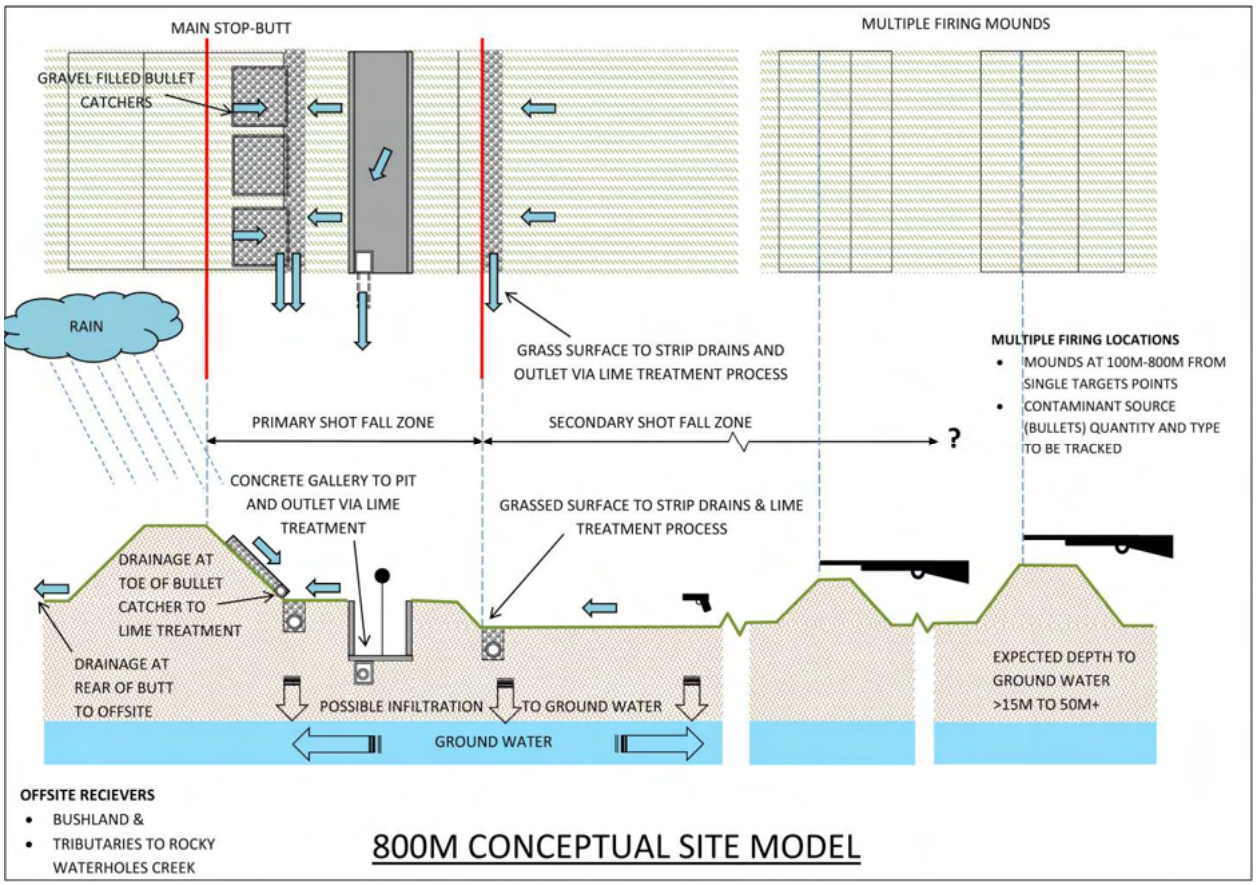

FIGURE 6: 800m Range: Conceptual Site Model (CSM)

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.

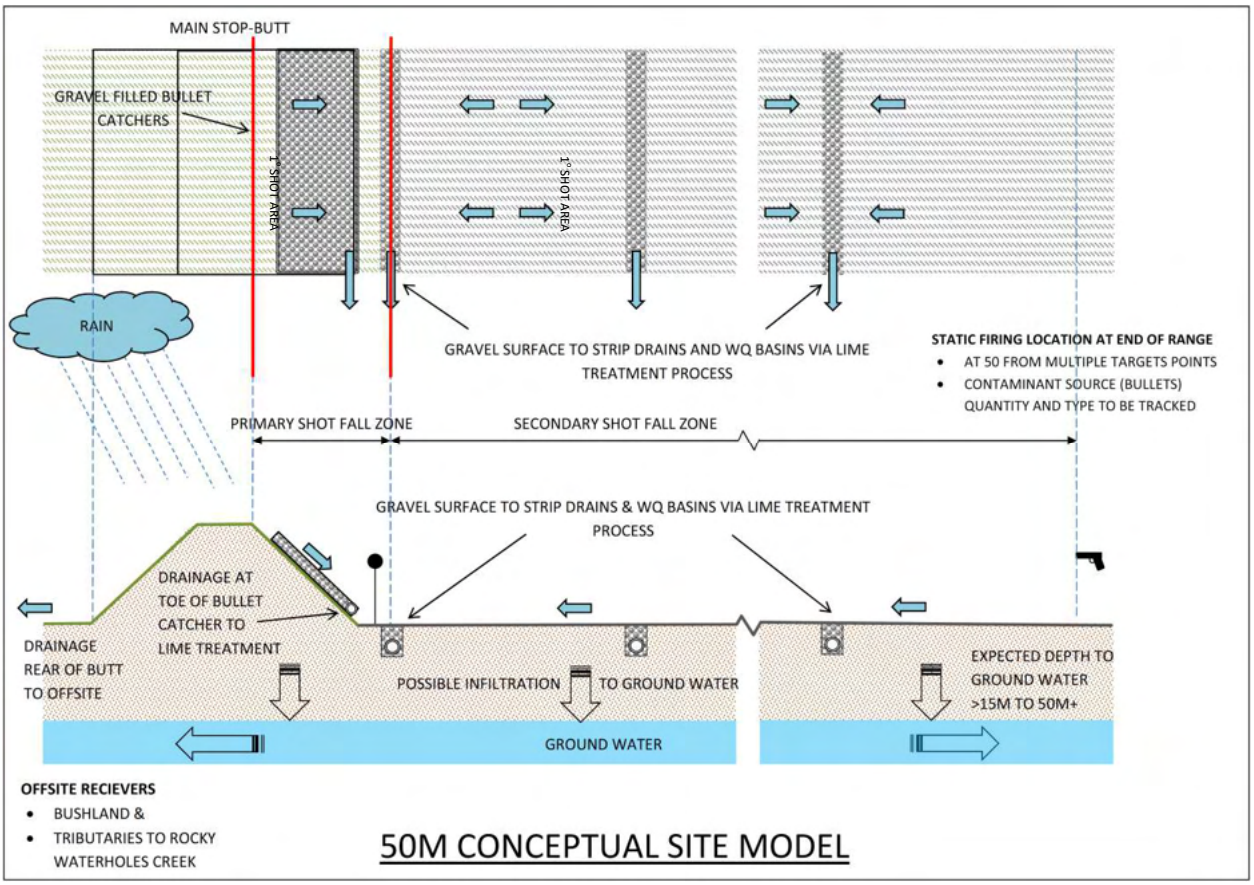

FIGURE 7 - 50m: Conceptual Site Model (CSM)

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.

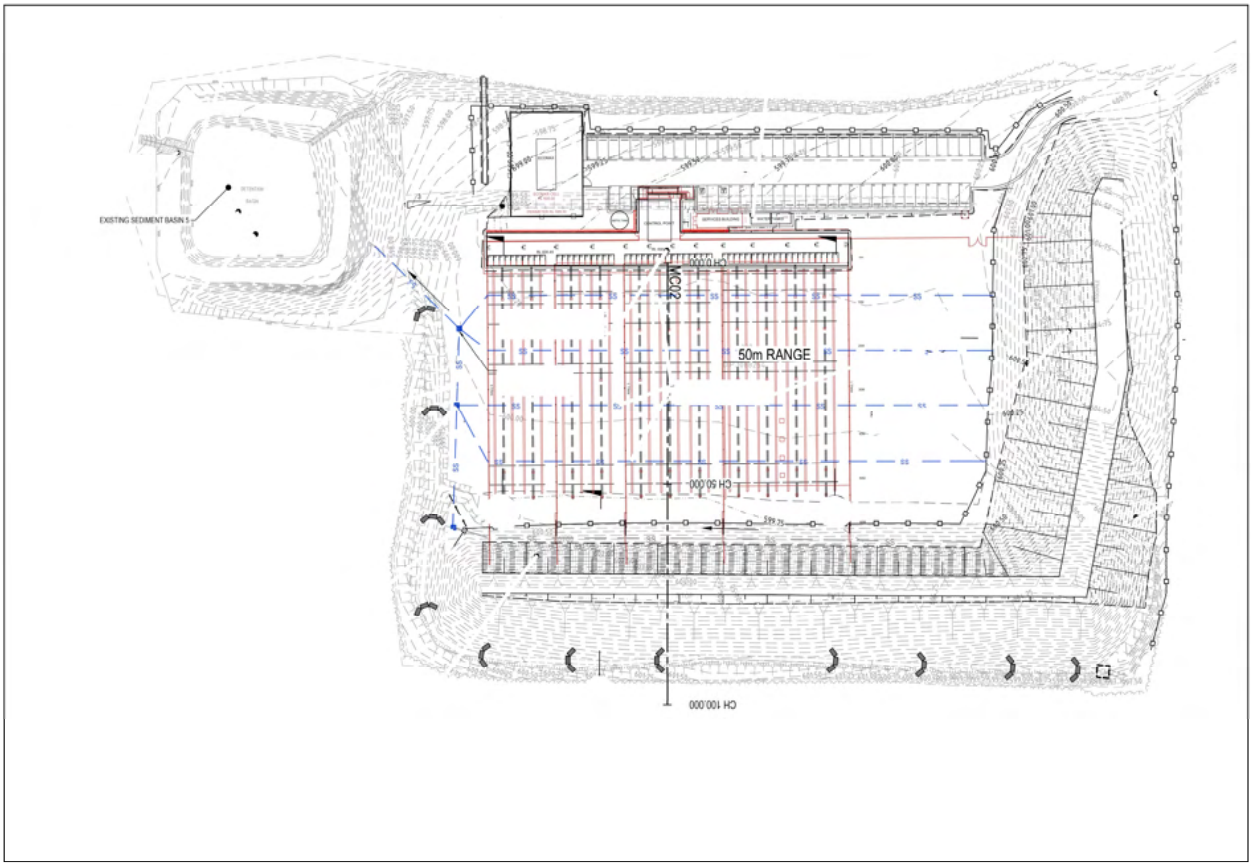

FIGURE 8 - 50m Range Layout

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.

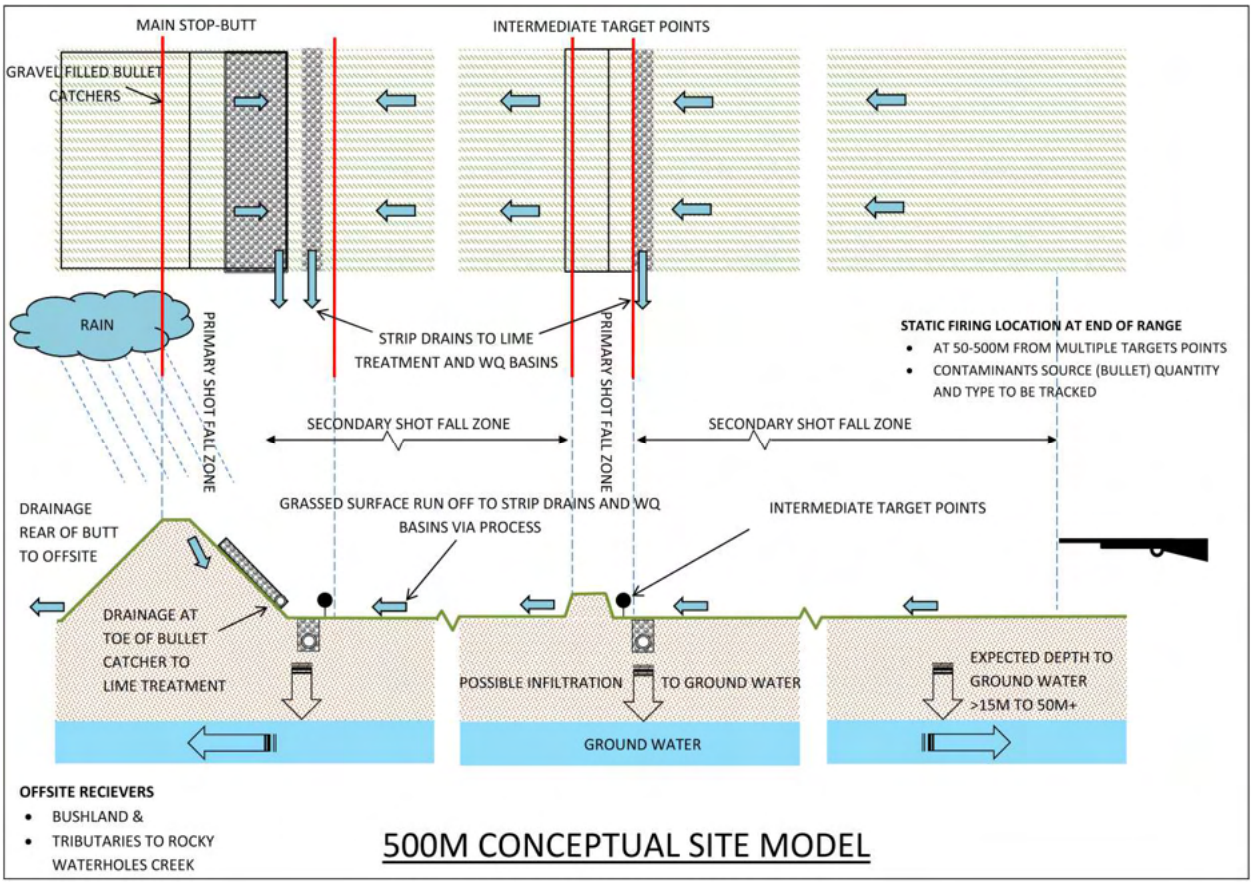

FIGURE 9 - 500m: Conceptual Site Model (CSM)

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.

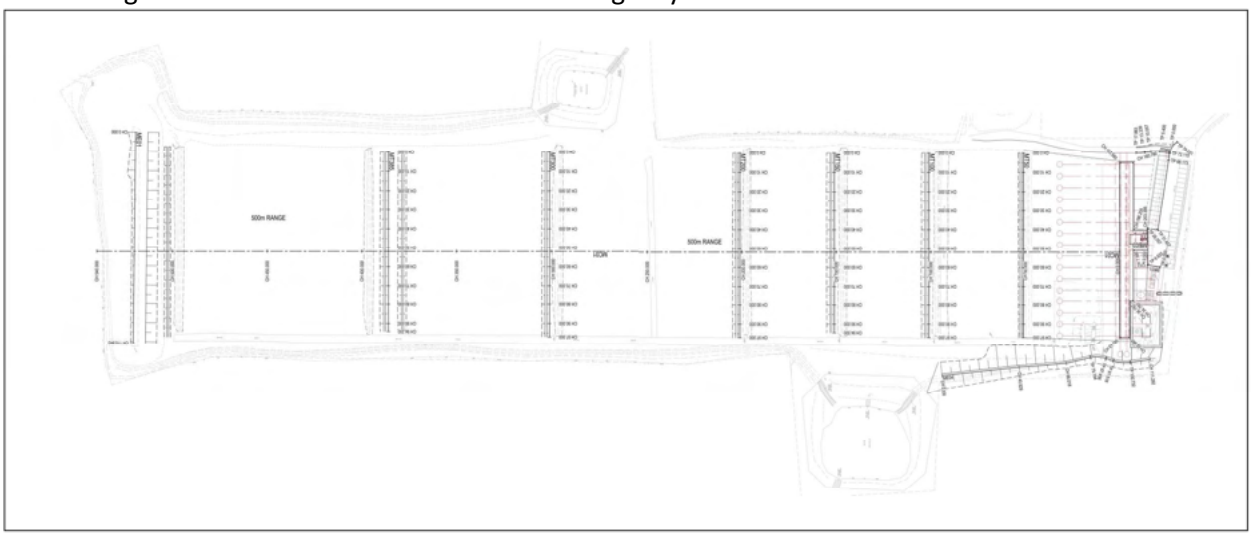

FIGURE 10 - 500m Range Layout

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.

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

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

Phosphorus (TP) Total Nitrogen (TN) Ammonia (NH3) Dissolved Oxygen (DO) pH 1 Lead Copper Zinc Antimony Phosphate	water present)	
	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 laboratories 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.

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	See Report Section
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	Section 9
2	Six Monthly Monitoring pH in Primary and Secondary Impact Areas • Soils • Sediments Six Monthly Monitoring • Surface Waters	See Section 10
3	Field Sampling – pH in Primary and Secondary Impact Areas • Soils • Sediments Six Monthly Visual Inspections	See Section 11

	• 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	See Section 12

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

- Appendix 1: Quarter 1 laboratory results
- Appendix 2: Quarter 3 laboratory results
- Appendix 3: Quarter 4 laboratory results

9 Monitoring Program – Quarter 1

A samplings exercise was undertaken 24th and 25th September 2019 in accordance with Section 8. A summary of the sampling event is given below.

Table 9: Quarter 1 Sampling event

Field Sampling • Soil pH in Primary and Secondary Impact Areas • Sediments
Six Monthly Visual Inspections • WQ Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health

9.1 Field Sampling (pH) Soil and Sediments

The results from the QTR1 sampling exercise are provided for each range following. Results outside the target criteria are indicated in RED.

Results are discussed at Section 9.1.1 following.

9.1.1 Results – Soils and Sediments 50m range

Table 10: pH 50m Range

Sample ID	Location	pH- (Field)	Observations
101	Range floor 5	7.9	Gravel
102	Range floor 3	7.9	Gravel
103	Range floor 2	7.7	Gravel
	Laboratory pH	7.62	
104	Bushland off Range – rear of main butt	6.1	
	Laboratory pH	4.45	
105	Bushland off Range – west of range	6.2	
106	Bushland off Range - north off car park	6.0	
107	Face of Butt- Bullet catcher 5	Not tested: Sample lost	
108	Face of Butt- Bullet catcher 4	7.8	
109	Face of Butt- Bullet catcher 3	7.5	

Sample ID	Location	pH-(Field)	Observations
110	Face of butt – above bullet catcher 5	7.95	
111	Face of butt – above bullet catcher 3	7.0	
112	Soil below invert of bullet catcher	Not taken: Could not access	
113	Within 10m in front of bullet catcher range 4	7.7	
114	Within 10m in front of bullet catcher range 3	8.4	
115	Within 10m in front of bullet catcher range 2	7.5	
116	Range 1 – floor	6.7	Silty soil and clay
117	Sediment – Basin 5 (off 50m)	6.7	No sample kept – bag ruptured

9.1.2 Results – Soils and Sediments 500m range

Table 11: pH 500m Range

Sample ID	Location	pH-(Field)	Obs	Sample ID	Location	pH-(Field)	Obs
201	Range floor (385m-500m)	7.1		218	Main Butt East	7.7	
202	Range floor (300-385m)	7.4		219	Int Mound (385m)	**5.7**	
	Laboratory pH	**(7.62)**		220	Int Mound (300m)	7.2	
203	Range floor (200m-300m)	7.1		221	Int Mound (200m)	7.5	
204	Range floor (150m-200m)	6.92		222	Int Mound (150m)	7.3	
205	Range floor (100-150m)	6.7		223	Int Mound (100m)	7.7	
206	Range floor (50-100m)	6.6		224	Int Mound (50m)	**5.8**	
207	Range floor (0-50m)	6.5		C1	Laboratory pH Composite	7.15	219 -224 Random 3 x samples
208	Range floor (200m-300m)	6.85		225	10m in front of Main butt West	7.5	
209	Range floor (150m-200m)	7.3		226	10m in front of Main butt Central	7.3	
210	Range floor (50-100m)	6.9			Laboratory pH	**5.71**	
211	Bushland South	**5.85**		227	10m in front of Main butt East	6.8	
212	Bushland North	5.17		228	10 m in front of Int Mound 1	6.5	
213	Bushland West	5.20		229	10 m in front of Int Mound 2	7.0	
214	Bushland East - North	5.1		230	10 m in front of Int Mound 3	7.3	
215	Bushland East – South	5.6		231	10 m in front of Int Mound 4	6.8	
216	Main Butt West	7.4		232	10 m in front of Int Mound 5	6.9	

Sample ID	Location	pH-(Field)	Obs	Sample ID	Location	pH-(Field)	Obs
217	Main Butt Central	7.6		233	10 m in front of Int Mound 6	7.0	
					Laboratory pH	**(6.7)**	
2034	Basin 1 (200m)	2034		2037	Basin 4 (car park)	6.62	
2035	Basin 3 (500 E)	2035		2038	Stream below Basin 1 (200m)	NIL	No sediment
2036	Basin 2 (500W)	2036					

9.1.3 Results – Soils and Sediments 800m range

Table 12: pH 800m Range

Sample ID	Location	pH-(Field)	Observations
Demineralised water			7.4, 7.6, 8.0
001	Bullet catcher 7	9.2	Gravel
002	Bullet catcher4	8.85	Gravel
003	Butt- non shot area – top of butt above target box 2	7.78	Compacted stabilised material
004	Butt – non shot – between target box – between 3-4	8.6	Gravel
005	Butt under bullet catcher 6	8.3	Gravel
006	Butt under bullet catcher 2	8.5	Gravel
007	Mantlet – west	7.5	Compacted subsoil material / with gravel
	Laboratory pH	(6.2)	
008	Mantlet- central	6.8	Compacted subsoil material / with gravel
009	Mantlet - east	6.9	Compacted subsoil material / with gravel
010	Area in front of Mantlet - west	7.15	High Clay content / silt with some aggregate
011	Area in front of Mantlet - central	7.34	High Clay content / silt with some aggregate
012	Area in front of Mantlet - east	7.46	High Clay content / silt with some aggregate
013	Bench in front of Butt - west	7.55	Clay and silt
014	Bench in front of Butt - central	7.6	Clay and silt
	Laboratory pH	(7.9)	
015	Bench in front of Butt - east	7.67	Clay and silt
016	Rear of Butt	7.95	High Organic- Sediment in mulch

Sample ID	Location	pH- (Field)	Observations
017	Area over store room	7.0	Compacted high clay soil
018	Stormwater outlet culvert upper	6.25	Natural soil – high sand fraction
019	Stormwater outlet culvert lower	6.18	Natural soil – high sand fraction
020	Rear channel outlet – lower	5.85	Natural soil – high sand fraction
021	Rear channel outlet - upper	5.92	Natural soil – high sand fraction
022	Basin 7 (East of 800m)	6.3	Sediment / Silt
Engineering controls: Nil – could not access pits			

9.2 Six Monthly Visual Inspections

The observations from the QTR1 visual inspection are provided for each range following.

Results are discussed at Section following.

9.2.1 50m range

Table 13: Visual inspections 50m Range and surrounds

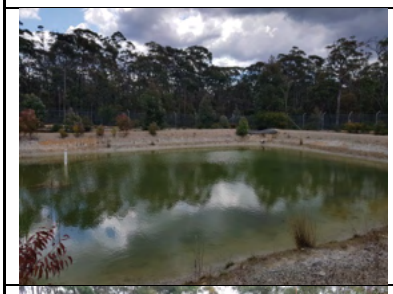
Basin 5	
	**Inlet to Basin 5** • Scour is evident down to native rock invert at inlet to basin • Further scour may be unlikely Monitor in future inspections / sampling events
	**Batters to Basin 5** • Minor scour at batter adjacent to access ramp at gate. This should be monitored in future sampling events.
 	**Outlet from the Basin** 5 • Outlet from basin and spillway control are stable
Vegetation Health/Surface cover	
	**Mound at east side of Range 1** • Ground cover is heavily grazed • Vegetation cover is poor • Sediment loss to lower areas not evident

	**Range floor – Range 1** • Ground cover is heavily grazed • Vegetation cover is poor to nil in some areas
	**Perimeter mound/drainage (Western side of 50m Range)** • Vegetative Cover on mound is absent, • Some mulch and gravel cover • Surface seems generally stable
	**Rear of mound & butt** • Vegetative cover poor • Surface soil material removed by raindrop impact but seems to be stable • Some sedimentation at toe of batter.
Engineering controls: Lime treatment Process • The lime treatment process is a closed sealed unit. • Inspection of the unit is not possible This item should be removed from the 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 9.2.1	
Safety and Signage • Safety and signage for the 50m range is addressed within Section 9.2.1	

9.2.2 500m range:

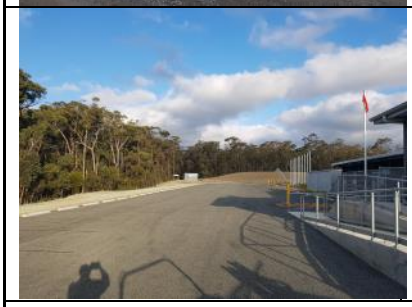
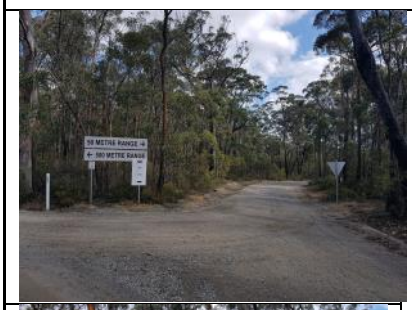
Table 14: Visual inspections 500m Range and surrounds

Basin 1	
	• Batters to basin are stable. • Inlet and outlet measures stable

	
Basin 2	
	• Inlet and Outlet controls stable • Batters to basins stable • Area below outlet is stable
	
Basin 3	
	• Scour to the side of inlet and batter adjacent Monitor this issue in subsequent inspections. • Outlet control from basin is stable
	
	• Minor surface erosion at localised points at batters into basin

	• Area below outlet is stable
Basin 4	
No Photo	• Basin full of water and reeds • Inlet area stable • Batters to basin stable
Vegetation Health Surface Cover	
	**Perimeter berm west side of 500m** • Vegetative cover poor and patchy • Surface seems stable • Topsoil absent
	**Intermediate mound 385m to 500m Butt** • Vegetative cover patchy with some bare areas • Generally 60% plus cover over surface
	**Intermediate mound 300m to intermediate mound 385m** • Vegetative cover good. • Generally 70% or more
	**Intermediate mound 200m to intermediate mound 300m** • Vegetative cover very patchy or absent • Generally approx. 60% cover

	**Intermediate mound 150m to intermediate mound 200m** • Veg cover well. generally 70% or more
	**Intermediate mound 100m to intermediate mound 150m** • Vegetative cover good. • Generally 70% or more
	**Intermediate mound 50m to intermediate mound 100m** • Vegetative cover very patchy • Generally approx. 40% • There is a localised wet patch in middle of range floor
	**Shooting Point 0m to Intermediate mound 50m** • Vegetative cover very patchy or absent • Generally approx. 40%
	**Area east of Basin 1: future 200m range – Non shot area** • Vegetation cover absent – • Surface seems stable
Engineering controls: Road Infrastructure and Drainage	
	• All road areas are stable • Table drains are stable

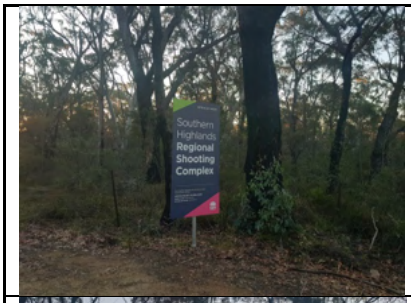
	
	**car park area – new gravel area** • There is evidence of hydro-mulch or tackifier applied to verges • Little vegetative cover evident from treatment
Safety and signage	
	• Safety direction signage in place
	

9.2.3 800m range

Table 15: Visual inspections 800m Range and surrounds

Basin 7	
	**Basin 7/Bushland Pond** • Very low water level – evidence of animal footprints in mud
Vegetation Health	

	**Vegetative health 0-100m from target** • Vegetative cover poor • Generally < 15% • Surface seems stable
	
	**Vegetative health 100m-800m from target** • generally cover greater than 75% - • all areas heavily grazed • Some minor erosion on intermediate butts with evidence of burrowing from rabbits / wombats
Concrete Galley	
	• Surface of Galley well swept • Only a few fragments of bullets over the concrete • Note possible future issue to be addressed – fragments collecting at the side of the concrete spoon drain
Engineering controls: Road Infrastructure and Drainage	
	**Roads and Access tracks** • All surfaces in good condition



Safety and signage

- Safety and directional signage in place

Engineering controls: Lime treatment Process

- The lime treatment process is a closed sealed unit.
- Inspection of the unit is not possible

This item should be removed from the sampling program. Servicing or inspection by a qualified technician may be recommended by monitoring outcomes.

9.3 Discussion of results

9.3.1 Field Sampling (pH) Soil and Sediments

The following samples returned pH values outside the target range of pH 6.5-8.5;

Table 16: Soil pH - locations outside target criteria

Sample ID	Location	pH-(Field)
50m Range		
104	Bushland off Range – rear of main butt	6.1
	Laboratory pH	4.45
105	Bushland off Range – west of range	6.2
106	Bushland off Range - north off car park	6.0
211	Bushland south	**5.85**
219	Int Mound (385m)	**5.7**
224	Int Mound (50m)	**5.8**
226	10m in front of Main butt Central	7.3
	Laboratory pH	**5.71**

Sample ID	Location	pH- (Field)
800m Range		
007	Mantlet – west	7.5
	Laboratory pH	(6.2)
018	Stormwater outlet culvert upper	6.25
019	Stormwater outlet culvert lower	6.18
020	Rear channel outlet – lower	5.85
021	Rear channel outlet - upper	5.92
022	Sediment within Basin 7 (East of 800m)	6.3

Samples 104, 105, 106 and 211 are from bushland areas where a soil pH of less than 6.5 is to be expected.

Samples 018, 019 and 020 are from drainage areas outside the range and in native soils where a soil pH of less than 6.5 is to be expected.

002 is sediment from a bushland basin where soil pH of less than 6.5 is to be expected.

Samples 219 & 224 were taken from on range soils and found to be acidic by field sampling.
Samples 226 and 007 were taken from on range soils and found to be acidic by laboratory analysis

Sampling and Laboratory analysis of these areas is recommended in subsequent exercises to confirm if treatment or correction of the soils is required. It is also recommended that monitoring of pH (field or laboratory pH) be included for water Quality Basins in ongoing Quarter 1 sampling exercises to allow for assessment of any pH impacts in the receiving basins.

One sample (107) was not taken / assessed. This was a sampling error. Other gravel samples from the same Range returned values within acceptable pH Range.

One sample (112 - Soil below invert of bullet catcher) could not be taken as the depth to soil material in the area nominated could not be accessed without significant impact to the range infrastructure. It is recommended that this sample point be removed from the sampling program for future monitoring events.

Sampling of sediment from the lime treatment process was not possible as this infrastructure is sealed and not readily accessible. It is recommended that these sample points be removed from the sampling program for future monitoring events.

9.3.2 Visual Inspections: Water Quality Basins

Outlet controls and outlet surrounds from all basins are stable.

Minor scour / erosion are evident at the inlet area and surrounds to basin 5. This erosion is not

anticipated to progress into an issue requiring management and should be monitored in subsequent inspections.

Significant scour is evident at the inlet and surrounds to Basin 3. This erosion may progress into an issue requiring re work/construction. The range manager is aware of this issue.

9.3.3 Visual Inspections: Lime treatment Process

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

9.3.4 Visual Inspections: Road Infrastructure and Drainage

No issues or concerns were identified by this sampling event.

9.3.5 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.
It was confirmed with the range manager that there is no signage plan for the range.

9.3.6 Visual Inspections: Vegetation health

Significant portions of the range areas heavily grazed with localised bare areas.

It is noted that at the time of the monitoring the site was extremely dry and the region is experiencing severe drought. This may explain the observed condition of vegetative cover.

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.

9.4 Recommendations

The following recommendations are made subsequent to the first quarter monitoring event;

9.4.1 Management Actions

The following management actions are recommended/suggested;

1. Suggest development of a signage plan which details location and description of all signage within the range for inclusion in the OEMP.

   Signage plan would include signage providing information on;
   - directions and access,
   - shooter safety and
   - environmental health and safety

9.4.2 Follow up Monitoring Changes to Sampling Program

1. Sampling and Laboratory analysis of soil pH at the following locations are recommended in subsequent exercises to confirm if treatment or correction of the soils is required.
   - Intermediate mound at 385m
   - Intermediate mound at 50m
   - Mantlet to the 800m target area

9.4.3 Changes to Sampling Program

1. Include monitoring of pH (field or laboratory pH) be included for water Quality Basins in ongoing Quarter 1 sampling exercises to allow for assessment of any pH impacts in the receiving basins.

2. Remove the following sampling points from ongoing monitoring programs
   - Soil material from below invert of bullet catcher
   - Sediment material from sealed lime treatment process

3. Remove the following visual inspection item from ongoing monitoring programs
   - Sealed lime treatment process

10 Monitoring Program – Quarter 2

A summary of the Quarter 2 sampling event is given below.

Table 17: Quarter 2 Sampling event

Six Monthly Monitoring pH in Primary and Secondary Impact Areas • Soils • Sediments Six Monthly Monitoring • Surface Waters

10.1 December 2019 to February 2020

A sampling exercise for the second quarter (QTR2) was scheduled for December 2019-January 2020.

No sampling exercise could be undertaken due to extreme fire risk and active bushfires through the SHRSC during late December through January.

Limitation to access extended through February 2020 with access excluded by the Range Manager due to safety concerns associated with burnt and dead trees which were yet to be removed.

10.2 March 2020

A sampling exercise was attempted 6th of March once the SHRSC was confirmed by the Range Manager as safe to access.

This sampling exercise was abandoned as significant portions of the site were flooded. A record of observations from this time is provided within table 18 below.

Table 18: Site observations 06/03/ 2020

Photo	Observations / Comments
	• Bushland adjacent to range severely burnt • Epicormic growth evident over standing trees and from basal areas of trees • Limited to no regeneration of lower story vegetation

	
	Range 1 of 50m flooded
 	Portions of 500m range area flooded

11 Monitoring Program – Quarter 3

The Second quarter sampling event was abandoned (See Section 10).

A modified third quarter (QTR 3) sampling exercise was prepared which amalgamated critical aspects of the second and third quarter sampling events while maintaining the structure of the remaining program as much as possible for the remaining 2019-20 period.

The modified third quarter monitoring exercise was undertaken 23rd March 2020

This is modified structure is presented in table 19 below.

Table 19: Quarter 3 Sampling event

Aspect	From
Six Monthly Monitoring pH in Primary and Secondary Impact Areas • Soils • Sediments	From QTR2 Replacing QTR3 field pH monitoring
Six Monthly pH Monitoring • Surface Waters	Modified QTR2 (pH only) Annual full monitoring in QTR 4
Six Monthly Visual Inspections • Water Quality Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health	From QTR3 unchanged
Annual Visual Inspection • Range perimeter for shot loss.	

11.1 Six monthly Monitoring Soils and Sediment (pH)

11.1.1 Results – Soils and Sediments 50m range

Table 20: Soil/Sediment pH 50m Range

Sample ID	Location	pH- (Laboratory)	Observations
101	Range floor 1	7.3	Gravel
	Duplicate	7.4	
102	Range floor 4	8.2	Gravel
103	Range floor 3	8.5	Gravel
104	Face of Butt- Bullet catcher 2	6.7	Gravel
105	Face of Butt- Bullet catcher 4	6.5	Gravel

Sample ID	Location	pH- (Laboratory)	Observations
106	Face of Butt- Bullet catcher 5	7.7	Gravel
107	Face of butt – above bullet catcher 3	8.3	Compacted fill
108	Face of butt – above bullet catcher 4	8.9	Compacted fill
109	10m Zone in front of bullet catcher range 4	9.2	Gravel
110	10m Zone in front of bullet catcher range 3	8.2	Gravel
111	10m Zone in front of bullet catcher range 2	8.8	Gravel
112	Bushland off range – south of range	5.4	Silty/granular top and sub soil – desiccated by fire Very little Organic Matter
113	Bushland off range – west of range	5.4	Silty/granular top and sub soil – desiccated by fire Very little Organic Matter
114	Bushland off range – north of range	5.7	Silty/granular top and sub soil – desiccated by fire Very little Organic Matter
	Duplicate	5.7	
115	Sediment Basin 5	6.7	
117	Basin 1	7.6	
119	Sediment from creek below 200m Basin 1	5.7	

11.1.2 Results – Soils and Sediments 500m range

Table 21: Soil/Sediment pH 500m Range

Sample ID	Location	pH- (Laboratory)	Observations
201	Range floor (385m-500m)	5.5	
202	Range floor (300m-385m)	5.8	
203	Range floor (200m-300m)	6.3	
204	Range floor (150m-200m)	6.2	
205	Range floor (100m-150m)	6.9	
	Duplicate	6.9	
206	Range floor (50m-100m)	7.3	
207	Range floor (0m-50m)	7.5	
208	Range floor (385m-500m)	6.5	
209	Range floor (300m-385m)	5.9	
210	Range floor (150m-200m)	6.1	

Sample ID	Location	pH- (Laboratory)	Observations
211	Off range Bushland East	5.7	
212	Off range Bushland West (Central)	5.7	
	Duplicate	5.7	
213	Off range Bushland South	5.2	
214	Off range Bushland West (South)	5.5	
215	Off range Bushland North	5.3	
216	Face of Main Stop butt - East	6.9	Gravel
217	Face of Main Stop butt - Central	6.9	
218	Face of Main Stop butt - West	6.5	
219	Intermediate Mound 385m	5.5	
220	Intermediate Mound 300m	8	
	Intermediate Mound 300m	8.3	
221	Intermediate Mound 200m	8.3	
222	Intermediate Mound 150m	8.1	
223	Intermediate Mound 100m	8.3	
224	Intermediate Mound 50m	5.0	
226	10m Zone front of main butt East	6.3	
227	10m Zone front of main butt Central	6.4	
228	10m Zone front of main butt West	5.9	
229	10 m in front of Int Mound 385m	5.8	
230	10m Zone front of Int Mound 300m	6.1	
231	10m Zone front of Int Mound 200m	7.8	
232	10m Zone front of Int Mound 150m	7.4	
233	10 m Zone front of Int Mound 100m	7.0	
234	10 m Zone front of Int Mound 50m	7.4	
236	Sediment Basin 2	8.8	
238	Sediment Basin 3	7.2	
240	Sediment Basin 4	7.3	

11.1.3 Results – Soils and Sediments 800m range

Table 22: Soil/Sediment pH 800m Range

Sample ID	Location	pH- (Laboratory)	Observations
301	Sediment from basin (eastern side)	6.1	Sediment – off range
303	Shot butt/Bullet Catcher 1	9.2	Gravel
304	Shot butt/Bullet Catcher NA	-	Could not obtain – bullet catchers covered with conveyor belt
305	Shot butt Between Bullet Catchers 2-3	8.9	Gravel
306	Shot butt Between Bullet Catchers 5-6	9.6	Gravel
307	Shot butt under Bullet Catcher 7	8.9	Gravel
308	Shot butt under Bullet Catcher 3	9.6	Gravel
309	Bench in front of Butt - west	8.1	High Clay content / silt with some aggregate
310	Bench in front of Butt - central	8.2	High Clay content / silt with some aggregate
311	Bench in front of Butt - east	8.1	High Clay content / silt with some aggregate
312	Mantlet - west	7.6	Compacted fill material
	Duplicate	7.5	
313	Mantlet - Central	7.4	Compacted fill material
014	Mantlet - East	7.4	Compacted fill material
315	6m zone in front of mantlet -west	7.9	Compacted high clay soil with silt
316	6m zone in front of mantlet –central	7.7	Compacted high clay soil with silt
317	6m zone in front of mantlet -east	7.8	Compacted high clay soil with silt
318	Rear of stop butt	8.3	High Organic- Sediment in mulch
319	Area over store room	5.7	Natural soil – high sand fraction
320	Sediment below culvert from gallery – upper	6.4	Natural soil – high sand fraction
321	Sediment below culvert from gallery – lower	6.9	Natural soil – high sand fraction
322	Rear drainage channel – upper	6.4	Natural soil – high sand fraction
	Duplicate	6.2	
323	Rear drainage channel – lower	6.8	Natural soil – high sand fraction
324	NEW Sediment from batter to gallery	8.5	Sediment
Engineering controls: Nil – could not access pits			

11.2 Six monthly Monitoring Surface Waters (pH)

11.2.1 Results – Surface Waters

Table 23: Surface waters pH - all areas

Sample ID	Location	pH- (Laboratory)	Observations
116	Basin 5	8.3	
117	Sediment from 200m basin	7.6	
118	Basin 1	7.8	
120	Creek below Basin 1	6.4	
237	Basin 2	8.2	
239	Basin 3	9.1	
241	Basin 4	7.3	
302	Basin 7	6.9	Water – off range

11.3 Six Monthly Visual Inspections

Table 24: General Observations – Surrounding bushland

	• Bushland area was severely impacted by Bushfires (December 2019-Feb 2020) • No leaf litter evident • Some epicormic growth at base and along stems (limited) post fire • Some germination evident of ground covers post fire • Soil desiccated with upper profile heaved and structure-less (feeling spongey under foot) due to organic matter being burned to depth and subsoil burned

11.3.1 50m Range

Table 25: Visual inspections 50m Range and surrounds

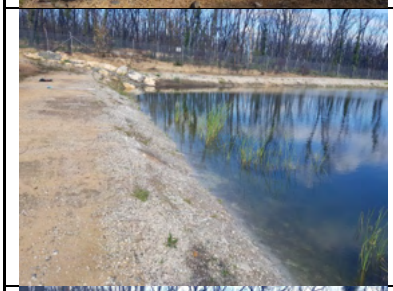
General observations	• Small numbers of weeds establishing on Butts / Bullet catchers and on gravel surfaces of ranges • Weeds over butt and septic tank area • Many small arms casings over firing point at range 4
Basin 5	

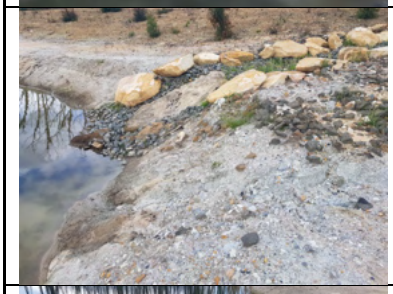
	• WQ within 50m basin visually clear • Full to overflow level
	• Minor scour at gate from surface flow drainage – Monitor for stability over time
	• Per above
	• Minor scour at either side of gabion spillway – • Monitor for stability over time
Vegetation Health/Surface cover	
Vegetation health • See comments RANGE 1 below • Other RANGES (2-5) are gravel surface with no vegetation	
	**Range floor – Range 1** • Vegetative cover very poor • < 10% - associated with poor drainage and ponding in central area • Note observations of flooded range 6th March 2020 Monitor this area for ongoing stability in future inspections to confirm if vegetation cover improves.
Engineering controls: other areas	

	• Minor and localised Erosion on butts above bullet catcher • This is associated with the shape of the butt and existence of the flat top of the butt Resolution could be achieved by shaping the top of the butt with a small in-fall to create a swale leading to defined outlet points(s) with scour protection or grading to one side so water sheets off
Engineering controls: Lime treatment Process • The lime treatment process is a closed sealed unit. • Inspection of the unit is not possible This item should be removed from the 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 11.3.2	
Safety and Signage • Safety and signage for the 50m range is addressed within Section 11.3.2	
Range perimeter for shot loss – ALL RANGES. • No shot loss evident – Note this is difficult /impossible to ascertain due to bushfire impact	

11.3.2 500m Range:

Table 26: Visual inspections 500m Range and surrounds

Basin 1	
	• Basin almost full • Water very clear
	• Minor scour at batters to basin
	• Minor scour at northern side of spillway • May be due to debris on spillway • Monitor for progress over time

	• Significant scour below spillway area but seems to be within accumulated sediment with ex mulched material and not significantly into natural material <u>Monitor for progress over time</u>
Basin 2	
	• Water very clear • Outlet area and perimeter stable
	•
Basin 3	
 	• Water very clear • Scour in multiple locations at perimeter access track where drainage focuses flow to low points leading to scour Inlet area failing – monitor for change
 	• Scour at inlet where rock material failed and moved
 	• Outlet pipe/low flow melted in two locations • Scour below

	
Basin 4	
	• Batters and outlet stable • Water black with tannins • Likely derived from mulch stockpile located upstream in car park area • Monitor for tannin staining in future inspections
	
Basin 7	
	• Water within side pond/basin clear • Bushland burnt surrounding • Tadpoles observed in basin
Vegetation Health Surface Cover	
	**Intermediate mound 385m to Butt 500m** • Vegetative cover patchy to absent over ~30% of area • Where present, vegetation cover over 70% cover • Surface stable
	**Intermediate mound 300m to intermediate mound 385m** • Good cover over 70% + over 100% of area including moss cover • Surface stable

	**Intermediate mound 200m to intermediate mound 300m** • Vegetative cover patchy to absent over ~50% of area • Where present vegetation cover over is 70% • Surface stable
	**Intermediate mound 150m to intermediate mound 200m** • Good cover over 100% of area with ~50%-70%+ • Surface stable
	**Intermediate mound 100m to intermediate mound 150m** • Good cover over 100% of area with ~70%+ • Surface stable
	**Intermediate mound 50m to intermediate mound 100m** • Good cover over 100% of area with ~70%+ except in central area where water ponds • Surface stable
	**Shooting Point 0m to intermediate mound 550m** • Patchy cover with 50% of area bare • Cover ~50% where present • Surface stable
	• Slump in Eastern landscape bund where landscape has failed
Engineering Controls – Drainage	

<table>
<tr><td>  </td><td rowspan="2"><u>Drainage (South west corner)</u>
• Swales leading to South West are bare with vegetative cover burnt
• Drainage controls burnt out Pipe outlet from stormwater pit melted internally

To be repaired

• Moderate sediment movement

Monitor invert of swales for stability in future inspections to confirm if vegetation cover improves.</td></tr>
<tr><td>  </td></tr>
<tr><td>  </td><td rowspan="3"><u>500m Drainage (eastern side)</u>
• Swales: cover burnt
• Significant sediment movement and scour

The swale may require maintenance and erosion control to prevent the swales failing to the bushland to east</td></tr>
<tr><td>  </td></tr>
<tr><td>  </td></tr>
<tr><td colspan="2">Engineering controls: Road Infrastructure and Drainage</td></tr>
<tr><td>  </td><td>• Track surfaces stable and well drained across all areas – no issues</td></tr>
</table>

 	• Significant sediment accumulation in table drains and other drainage derived from adjacent bushland. This sediment loss is likely exacerbated post the fires • This may impact on function of swales and table drains over time and is expected to progress further over intermediate period due to loss of vegetative and mulch cover during fires Recommend that this is Monitored over time with scheduled maintenance when required
Safety and signage	
	**50/500m** • Basin safety signage in place • General road signage in place however some damaged
Range perimeter for shot loss – ALL RANGES. • No shot loss evident – Note this is difficult /impossible to ascertain due to bushfire impact	

11.3.3 800m Range

Table 27: Visual inspections 800m Range and surrounds

Basin 7	
	• Water within side pond/basin clear • Bushland burnt surrounding • Tadpoles observed in basin
Vegetation Health	

	• Surface cover patchy per previous inspections especially in the first 50-100m • Heavily grazed • Surface stable
Engineering Controls	
	**Shipping containers rear of Stop Butt** • Significant damage to infrastructure during fires
	**Concrete Galley** • Significant damage to infrastructure during fires
	**Concrete Galley** • Limited gravel and sediment accumulated within the gallery • Plus other debris post fire (limited)
	**Concrete Galley** • Significant sediment loss from batter on south side of gallery • Following loss of stabilising surface • Sediment to be sampled • Monitor area and include stabilisation in rectification works
	**Stop butt & Bullet Catchers** • Bullet catchers covered with conveyor belting • Limits collection of samples per SAQP • Bullet catcher 1 – belting and bullet catcher surround burnt – sample taken from this area only

Engineering Controls Drainage

- Areas below culvert outlets stable

Engineering controls: Road Infrastructure and Drainage

- Access tracks surface and drainage stable
- Significant debris remaining over surface of tracks

Safety and signage

800m range

- Signage either replaced or maintained post bushfire
- Gates and fences severely damaged
- Metal gate still secure and access controlled

Engineering controls: Lime treatment Process

- The lime treatment process is a closed sealed unit.
- Inspection of the unit is not possible

This item should be removed from the sampling program. Servicing or inspection by a qualified technician may be recommended by monitoring outcomes.

Range perimeter for shot loss – ALL RANGES.

- No shot loss evident – Note this is difficult /impossible to ascertain due to bushfire impact

11.4 Discussion of results

11.4.1 Soil and Sediments (pH)

The following samples returned pH values outside the target range of pH 6.5-8.5;

Table 28: Soil pH - locations outside target criteria

Sample ID	Location	pH- (Laboratory)
50m and surrounds		
108	Face of butt – above bullet catcher 4	8.9
109	10m Zone in front of bullet catcher range 4	9.2
111	10m Zone in front of bullet catcher range 2	8.8
112	Bushland off range – south of range	5.4
113	Bushland off range – west of range	5.4
114	Bushland off range – north of range	5.7
	Duplicate	5.7
119	Sediment from creek below 200m Basin 1	5.7
500m and surrounds		
201	Range floor (385m-500m)	5.5
202	Range floor (300m-385m)	5.8
203	Range floor (200m-300m)	6.3
204	Range floor (150m-200m)	6.2
209	Range floor (300m-385m)	5.9
210	Range floor (150m-200m)	6.1
211	Off range Bushland East	5.7
212	Off range Bushland West (Central)	5.7
	Duplicate	5.7
213	Off range Bushland South	5.2
214	Off range Bushland West (South)	5.5
215	Off range Bushland North	5.3
219	Intermediate Mound 385m	5.5
224	Intermediate Mound 50m	5.0
226	10m Zone front of main butt East	6.3

Sample ID	Location	pH- (Laboratory)
227	10m Zone front of main butt Central	6.4
228	10m Zone front of main butt West	5.9
229	10 m in front of Int Mound 385m	5.8
230	10m Zone front of Int Mound 300m	6.1
236	Sediment from Basin 2	8.8
800m and surrounds		
301	Sediment from Basin 3	6.1
303	Shot butt/Bullet Catcher 1	9.2
304	Shot butt/Bullet Catcher NA – due to conveyor belting over bullet catchers.	-
305	Shot butt Between Bullet Catchers 2-3	8.9
306	Shot butt Between Bullet Catchers 5-6	9.6
307	Shot butt under Bullet Catcher 7	8.9
308	Shot butt under Bullet Catcher 3	9.6
319	Area over store room	5.7
320	Sediment below culvert from gallery – upper	6.4
322	Rear drainage channel – upper	6.4
	Duplicate	6.2

Bushland areas

- Samples 112, 113, and 114119 are from off range areas or bushland around the 50m range
- Sample 119 is from the invert of a channel within the bushland below Basin 1.
- Samples 211, 212, 213, 214 and 215 are from off range areas or bushland around the 500m range.
- Samples 320 and 322 are from drainage outlets off range.

These samples are from bushland areas where a soil pH of less than 6.5 is to be expected.

Basalt gravels

- Samples 108, 109 and 111 are of the blue metal (basalt) gravel of the bullet catcher and range floors of the 50m range (reporting to Basin 5).
- Samples 303, 304,305,306 307 and 308 are of the blue metal (basalt) gravel of the bullet catcher and range floors of the 800m range (reporting to the culvert outlet on eastern side of the 800m gallery).

These samples have returned pH in the range of pH 8.8-9.2 (alkaline). This is pH may be a characteristic of the basalt rock used in the construction or from treatment of the bullet catcher and surrounds. The pH of this material was not known when placed. pH of this material will be

compared during subsequent monitoring events.

The pH within the basin/outlets which these sample points report to may be used to indicate any potential issues with the basalt material; returned

- Basin 5 returned a pH of 8.3 which is within the acceptable range for surface waters.
- Soil/Sediment from the culvert east of the gallery returned a pH of 6.4 (sample 322) which is acidic and what may be expected from natural soils off range.

Range floor areas (500m and 800m)

- Samples 201, 202, 203, 204, 209 210, 2019, 224, 226, 227, 228, 2229 and 230 are from range floor areas and intermediate mounds within the 500m range.
- Sample 319 is from the shallow soil over the concrete store west of the 800m Gallery.

These samples have returned pH in the range of pH 5.5 to 6.3 (acidic).
Sample 224 is from the 50m intermediate mound at the 500m range. This area returned a similarly low pH within the Quarter 1 sampling exercise.

The extent of the lowered pH over the range floor areas within the 500m range may also be consequent to the effect of the recent bush fires. pH of this material will be compared during subsequent monitoring events. pH within the basins which these sample points report to will be used to indicate any issues with the material.

Confirmation of this issue by subsequent monitoring should be used indicate requirement management attention such as treatment with agricultural lime to the 500m range floor.

Sediment Basin 2
Sample 236 is of sediment/invert material from Basin 2. The pH of this sample is 9.2 (alkaline). This Basin receives water from 500m range floor catchments where some soil samples returned a pH below the target range of pH6.5-8.5. This would indicate that the observed pH is not associated with the effect of the reporting catchment.

11.4.2 Surface Waters (pH)

The following samples returned pH values outside the target range of pH 6.5-8.5;

Table 28: Surface waters pH - locations outside target range

Sample ID	Location	pH- (Laboratory)
120	Creek below Basin 1	6.4
239	Basin 3	9.1

Sample 120 is from a bushland channel below Basin 1. Basin 1 does not receive water from any shot fall areas or lime treatment process. This pH may be expected within the bushland channel.

Sample 239 is from Basin 3 which receives surface water This Basin receives water from 500m range floor catchments where some soil samples was returned a pH below the target range of pH6.5-8.5. This would indicate that the observed pH is not associated with the effect of the reporting catchment.

Basins 2, 3 and 5 returned pH of surface water in the range of pH8.2-9.1.
This elevated pH may be consequent to the recent bushfires and ash fall or may be associated

with the lime treatment process. The pH within these basins will be reviewed in subsequent monitoring events.

11.4.3 Visual Inspection: Water Quality Basins

Impacts from the recent bushfires and heavy rains were evident within the basins and surrounds.

Minor scour is evident at the northern side of the spillway to Basin 1. More significant erosion has been exposed within the accumulated sediment and mulch below the outlet from Basin 1. This has not progressed into the underlying natural soil material

These localised points of erosion will be monitored for change during subsequent monitoring events.

Significant scour at the inlet to Basin 3 was identified as part of the Quarter 1 visual inspections. This scour is does not seem to have progressed significantly. This will require significant works to replace.

The PVC pipe /low flow through the gabion spillway of Basin 3 has been melted by recent fires at both the inlet and outlet end and will require significant works to replace. The range manager is aware of this damage.

Minor scour at the inlet to Basin 5 was identified within the Quarter 1. This scour is does not seem to have progressed significantly. Minor scour was observed at either side of the spillway from Basin 5. This should be monitored for change during subsequent monitoring events.

11.4.4 Visual Inspection: Engineering Controls

Recent bush fires have impacted the engineering controls and infrastructure across all ranges. Impacts extend from actual destruction by fire to loss of vegetative or other protective covers. Loss of vegetation from adjacent areas (range and bushland) has led to accumulated sediment within drainage structures which over time can act to reduce capacity and function.

Minor and localised erosion is evident from the top of the stop butt to the 50m Range. This would take significant reshaping of the butt to resolve and should be monitored for change in subsequent visual inspections.

The stormwater pit and pipe outlet at the south western corner of the 500m range (behind the 500m stop butt) has been severely impacted by the fires with the PVC pipe melted within the pit. This will need to be replaced.

Sediment has accumulated within the swale drain on the eastern side of the 500m range. This swale may require maintenance with provision of additional erosion control if a vegetative cover does not re-establish. It is recommended that this is monitored in subsequent visual inspections and maintenance be scheduled if/when required.

Significant damage and destruction has occurred at the 800m range. This damage will require complete rebuilding/replacement of much of the infrastructure. Erosion control and surface cover of the batter below the 800m stop butt has been removed by the fires. This will need to be replaced or reinstated.

11.4.5 Visual Inspections: Road Infrastructure and Drainage

Access track surfaces are stable.

Sediment has accumulation in table drains and other drainage within the 50m/500m access areas. This sediment has been derived from adjacent bushland post the fires. It is recommended that this is monitored in subsequent visual inspections and maintenance be scheduled if/when required.

11.4.6 Visual Inspection: Lime Treatment Process

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

11.4.7 Visual Inspection: Safety and Signage

Signage is in place and maintained at the 50m/500m Ranges and surrounds.
Signage at the 800m range has either been maintained or replaced.

11.4.8 Visual Inspection: Vegetation Health

The bushland areas surrounding all range areas have been severely impacted by the bushfires. Leaf litter and Lower story vegetation has been removed with only standing trees remaining. Post fire regrowth is evident however this is primarily epicormic growth from the remaining trees.

The vegetation cover within the shooting range 1 floor at the 50m Range is very poor this seems to be associated with recent flooding of the area. This will be monitored in subsequent visual inspections. Erosion and sediment movement is not significant in this area.

Vegetative cover over the 500m range floor is variable but generally acceptable. Cover in some areas is patchy however no significant erosion or sediment movement is evident.

There is a localised slump in the landscape bund east of the 500m range. This does not seem to be progressing and can be addressed as part of regular scheduled maintenance.

11.5 Recommendations

The following recommendations are made subsequent to the third quarter monitoring event;

11.5.1 Management Actions

Significant repair / reconstruction works are required following the extreme bushfire event. The following have been identified.

1. Repair/replacement of the low flow outlet from Basin 3
2. Repair/replacement of the pit and pipe outlet control located to the South West of the 500m stop but
3. Repair/Rebuilding of extensive damage to infrastructure at the 800m range
4. Reinstatement of erosion protection to exposed batters below the 800m stop-butt

Clearing and maintenance of surface water drainage swales may be required. This will be confirmed in the Fourth Quarter Monitoring exercise.

11.5.2 Follow up Monitoring

Soil pH of the range floor and intermediate mounds within the 500m range should be reviewed following the Fourth Quarter Monitoring Exercise to confirm if treatment of the surface with agricultural lime is required.

11.5.3 Changes to Sampling Program

No additional changes to the annual sampling program have been identified
See 9.4.3 for recommended changes following the First Quarter Monitoring exercise

12 Monitoring Program – Quarter 4

The modified Quarter 3 monitoring exercise was undertaken 23rd March 2020

This allowed performance of the a Quarter 4 monitoring exercise per the 2019-20 Monitoring Program and SAQP.

Table 30: Quarter 4 Sampling event

Annual Monitoring • Soil • Surface Waters • Sediments

12.1 Annual Monitoring Soils

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

- Table 30: 2020 Soil Results 50m Range
- Table 31: 2020 Soil Results 500m Range
- Table 32: 2020 Soil Results 800m Range

12.2 Annual Monitoring Sediments

Results for the annual monitoring for sediments are given in the table following;

- Table 33: 2020 Sediment Results -all areas

12.3 Annual Monitoring Surface Waters

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

- Table 34: 2020 Surface Water Results – all areas

Table 31: 2020 Soil Results 50m Range																		
Sample ID	Sample Location	PAH-Total	PAH-B(a)PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Antimony	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
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
EIL from WCMP				**(ESL)0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**		**6.5-8.5**	**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30,000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400,000**						
301	Gravel floor Bay 3	<0.05	<0.5	<0.5	<4	<0.4	8	4	66	<0.1	3	20	2	<7	6900	5.6	8.1	[NT]
301	Gravel floor Bay 3	<0.05	<0.5	<0.5	<4	<0.4	7	3	48	<0.1	3	16	1	<7	6300	5		
302	Gravel floor Bay 2	<0.05	<0.5	<0.5	<4	<0.4	7	3	150	<0.1	3	18	3	<7	7600	8.5	8.4	[NT]
303	Soil floor Bay 1	2.5	<0.5	<0.5	<4	<0.4	6	13	44	<0.1	4	50	2	<7	7800	12	8.4	11
303	Soil floor Bay 1																8.4	
304	Off range bushland North	<0.05	<0.5	<0.5	<4	<0.4	9	<1	10	<0.1	1	5	<1	<7	7700	<1	5	17
305	Off range bushland West	<0.05	<0.5	<0.5	<4	<0.4	11	<1	14	<0.1	2	6	<1	<7	10000	<1	5.6	12
306	Off range bushland South	<0.05	<0.5	<0.5	<4	<0.4	10	<1	12	<0.1	2	6	2	<7	10000	<1	5.6	16
307	Bullet catcher Bay 2	<0.05	<0.5	<0.5	<4	<0.4	3	2	81	<0.1	1	8	2	<7	3600	2.4	8.5	[NT]
308	Bullet catcher Bay 4	<0.05	<0.5	<0.5	<4	<0.4	6	5	1400	<0.1	1	9	25	70	4000	2.1	7.7	[NT]
309	Bullet catcher Bay 5	<0.05	<0.5	<0.5	<4	<0.4	3	9	2800	<0.1	1	10	50	150	2700	2.3	8.9	[NT]
310	Butt above bullet catcher B4	<0.05	<0.5	<0.5	4	<0.4	7	5	180	<0.1	4	21	4	<7	18000	10	8.7	8
310	Butt above bullet catcher B4																8.8	
311	Butt above bullet catcher B3	<0.05	<0.5	<0.5	6	<0.4	9	32	1600	<0.1	3	15	43	110	15000	12	8.8	9
311	Butt above bullet catcher B3	<0.05	<0.5	<0.5	6	<0.4	9	88	1800	<0.1	4	21	66	160	17000	9.3		
312	Butt above bullet catcher B2	<0.05	<0.5	<0.5	5	<0.4	10	4	170	<0.1	3	17	4	<7	16000	12	8.9	10
311 - [TRIPLICATE]					4	<0.4	7	8	1600	<0.1	3	13	53	120	15000			

Table 32: 2020 Soil Results 500m Range																		
Sample ID	Sample Location	PAH-Total	PAH-B(a)PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Antimony	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
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**		**6.5-8.5**	**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30,000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400,000**						
201	Target bay 0-50m	<0.05	<0.5	<0.5	<4	<0.4	11	5	9	<0.1	3	15	<1	<7	14000	5.7	7.6	17
201	Target bay 0-50m	<0.05	<0.5	<0.5	<4	<0.4	8	4	8	<0.1	2	13	<1	<7	11000	5.9		
202	Target bay 50-100m	0.3	<0.5	<0.5	<4	<0.4	7	12	29	<0.1	4	56	2	<7	7100	17	8.6	18
202	Target bay 50-100m																8.5	
203	Target bay 100-150m	<0.05	<0.5	<0.5	<4	<0.4	21	1	32	<0.1	2	5	<1	<7	22000	7.9	7.2	26
204	Target bay 150-200m	<0.05	<0.5	<0.5	<4	<0.4	15	<1	12	<0.1	2	5	<1	<7	16000	4	6.6	21
205	Target bay 200-300m	<0.05	<0.5	<0.5	<4	<0.4	16	3	13	<0.1	2	14	1	<7	19000	14	7.8	24
206	Target bay 300-385m	<0.05	<0.5	<0.5	<4	<0.4	14	<1	9	<0.1	2	5	<1	<7	13000	4.8	6.8	21
207	Target bay 385-500m	<0.05	<0.5	<0.5	<4	<0.4	14	<1	8	<0.1	2	4	<1	<7	12000	6.5	6.7	23
208	Target bay 0-50m	<0.05	<0.5	<0.5	<4	<0.4	8	5	9	<0.1	4	16	<1	<7	14000	5.2	7.8	17
208	Target bay 0-50m																7.8	
209	Target bay 50-100m	<0.05	<0.5	<0.5	<4	<0.4	13	9	9	<0.1	2	18	<1	<7	14000	9.3	7.9	25
210	Target bay 150-200m	<0.05	<0.5	<0.5	<4	<0.4	21	1	10	<0.1	2	6	<1	<7	22000	7.6	6.7	24
211	Off range Bushland South	<0.05	<0.5	<0.5	<4	<0.4	12	2	16	<0.1	3	9	<1	<7	10000	6.5	6.9	13

Table 32: 2020 Soil Results 500m Range																	
Sample ID	Sample Location	PAH-Total	PAH-B(a)PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Antimony	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
211	Off range Bushland South	<0.05	<0.5	<0.5	<4	<0.4	14	3	17	<0.1	3	11	1	<7	11000	7.9		
212	Off range Bushland West 1	<0.05	<0.5	<0.5	<4	<0.4	13	1	15	<0.1	2	6	<1	<7	14000	8.3	6.1	14
213	Off range Bushland West 2	0.1	<0.5	<0.5	<4	<0.4	15	1	14	<0.1	3	4	<1	<7	15000	1.4	5.8	24
213	Off range Bushland West 2	0.1	<0.5	<0.5	<4	<0.4	16	1	14	<0.1	3	5	<1	<7	16000			
214	Off range Bushland East 1	0.3	<0.5	<0.5	<4	<0.4	15	<1	11	<0.1	2	4	<1	<7	15000	1.4	5.5	14
215	Off range Bushland North	<0.05	<0.5	<0.5	<4	<0.4	12	<1	12	<0.1	3	4	<1	<7	12000	1.8	6.1	22
215	Off range Bushland North															1.7		
216	Face of stop butt East	<0.05	<0.5	<0.5	<4	<0.4	2	2	16	<0.1	1	10	<1	<7	3100	3.9	8	[NT]
217	Face of stop butt Centre	<0.05	<0.5	<0.5	<4	<0.4	6	3	32	<0.1	3	12	<1	<7	4100	10	9.3	[NT]
218	Face of stop butt West	<0.05	<0.5	<0.5	<4	<0.4	1	<1	2	<0.1	1	4	<1	<7	1600	2	9.6	[NT]
219	Intermediate mound 50m	<0.05	<0.5	<0.5	<4	<0.4	7	3	12	<0.1	3	13	<1	<7	11000	1.2	5.6	16
219	Intermediate mound 50m																5.4	
220	Intermediate mound 100m	<0.05	<0.5	<0.5	<4	<0.4	9	29	260	<0.1	2	13	<1	<7	13000	8.8	8.2	14
221	Intermediate mound 150m	<0.05	<0.5	<0.5	<4	<0.4	7	4	79	<0.1	2	14	<1	<7	9200	11	7.5	13
222	Intermediate mound 200m	<0.05	<0.5	<0.5	<4	<0.4	7	22	570	<0.1	2	11	<1	10	10000	13	8.8	13
223	Intermediate mound 300m	<0.05	<0.5	<0.5	<4	<0.4	6	3	35	<0.1	2	11	1	<7	9200	15	8.3	16
223	Intermediate mound 300m	<0.05	<0.5	<0.5	<4	<0.4	6	2	14	<0.1	2	10	3	<7	9000	14	8.4	

Table 32: 2020 Soil Results 500m Range																		
Sample ID	Sample Location	PAH-Total	PAH-B(a)PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Antimony	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
224	Intermediate mound 385m	<0.05	<0.5	<0.5	<4	<0.4	7	4	40	<0.1	2	14	<1	<7	11000	2	7.8	17
223 - [TRIPLICATE]					5	<0.4	9	6	110	<0.1	2	12	<1	<7	11000			
225	10m zone @ stop butt East	<0.05	<0.5	<0.5	<4	<0.4	16	3	9	<0.1	2	11	<1	<7	15000	24	8	19
225	10m zone @ stop butt East	<0.05	<0.5	<0.5	<4	<0.4	15	4	9	<0.1	2	13	1	<7	12000			
226	10m @ stop butt Centre	<0.05	<0.5	<0.5	<4	<0.4	19	2	9	<0.1	2	8	<1	<7	17000	8.8	7.8	22
227	10m @ front stop butt West	<0.05	<0.5	<0.5	<4	<0.4	13	3	11	<0.1	3	14	<1	<7	16000	6.1	7.2	12
228	in front of Mound 0-50	<0.05	<0.5	<0.5	<4	<0.4	7	10	10	<0.1	3	38	2	<7	6900	17	8.3	14
229	in front of Mound 50-100	<0.05	<0.5	<0.5	4	<0.4	11	12	17	<0.1	2	11	<1	<7	13000	6.6	7.7	22
230	in front of Mound 100-150	<0.05	<0.5	<0.5	<4	<0.4	10	13	320	<0.1	2	16	<1	<7	11000	13	8.3	19
231	in front of Mound 150-200	<0.05	<0.5	<0.5	<4	<0.4	12	4	15	<0.1	2	11	<1	<7	14000	12	8.1	[NT]
232	in front of Mound 200-300	<0.05	<0.5	<0.5	<4	<0.4	11	3	24	<0.1	2	7	<1	<7	12000	9.4	7.7	[NT]
232	in front of Mound 200-300															10		
233	in front of Mound 300-385	<0.05	<0.5	<0.5	<4	<0.4	11	2	180	<0.1	2	8	<1	<7	11000	4.4	6.6	[NT]

Table 33: 2020 Soil Results 800m Range																		
Sample ID	Sample Location	PAH-Total	PAH-B(a)PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Antimony	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
Practical Quantitation Limit or Limit of Reporting (PQL)		0.5	0.5	0.5	4	0.4	1	1	1	0.1	1	1	1	7	10	1		
EIL from WCMP				**(ESL)0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**		**6.5-8.5**	**OBS ONLY**
HIL (C)		**300**	**3**	**-**	**300**	**90**	**300**	**17000**	**600**	**13**	**1200**	**30,000**		**252**				
HIL (D)			**-**	**-**	**3000**	**900**	**3600**	**240000**	**1500**	**180**	**6000**	**400,000**						
101	Bullet catcher 2	<0.5	<0.5	<0.5	<4	<0.4	9	11	110	<0.1	1	9	<1	<7	3300	3.6	9.4	
101	Bullet catcher 2	<0.5	<0.5	<0.5	<4	<0.4	3	19	740	<0.1	1	5	<1	<7	1900	2.6		
102	Bullet catcher 5	<0.5	<0.5	<0.5	<4	<0.4	3	1	10	<0.1	1	4	<1	<7	1600	2.7	8.9	
103	Between bullet catcher 5-6	<0.5	<0.5	<0.5	<4	<0.4	7	3	270	<0.1	3	9	<1	<7	3600	2.6	8.3	
104	Between bullet catcher 3-4	<0.5	<0.5	<0.5	6	<0.4	6	13	900	<0.1	2	9	4	8	3000	5.6	9.4	
105	Under bullet catcher 1	<0.5	<0.5	<0.5	<4	<0.4	6	120	2300	<0.1	2	200	<1	20	3800	4.9	9.3	
106	Under bullet catcher 7	<0.5	<0.5	<0.5	<4	<0.4	2	25	1600	<0.1	2	9	<1	9	2800	2.6	9.3	
107	Bench foot of stop butt E	<0.5	<0.5	<0.5	<4	<0.4	11	180	2300	<0.1	4	34	5	20	13000	35	8.3	23
107	Bench foot of stop butt E																8.2	
108	Bench foot of stop butt C	<0.5	<0.5	<0.5	<4	<0.4	14	350	2100	<0.1	7	59	3	20	22000	33	8.2	22
109	Bench foot of stop butt W	<0.5	<0.5	<0.5	9	<0.4	14	100	1200	<0.1	3	23	1	9	13000	16	8.3	20
110	Target mound /Mantlet E	<0.5	<0.5	<0.5	<4	<0.4	9	4	75	<0.1	1	7	<1	<7	12000	4	7.3	14
111	Target mound /Mantlet C	<0.5	<0.5	<0.5	<4	<0.4	7	5	110	<0.1	2	9	<1	<7	10000	2	6.4	21

Table 33: 2020 Soil Results 800m Range																		
Sample ID	Sample Location	PAH-Total	PAH-B(a)PTEQ	PAH-B(a)P	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Tin	Antimony	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 /100 g	pH Units	% W/W
111	Target mound /Mantlet C	<0.5	<0.5	<0.5	<4	<0.4	7	4	120	<0.1	2	10	<1	<7	10000	2.4		
112	Target mound /Mantlet W	<0.5	<0.5	<0.5	<4	<0.4	8	4	49	<0.1	3	8	<1	<7	9600	3.7	7.4	16
113	6m zone front of mantlet E	<0.5	<0.5	<0.5	<4	<0.4	6	6	78	<0.1	1	7	1	<7	7700	5.1	7.8	14
113	6m zone front of mantlet E																7.7	
114	6m zone front of mantlet C	<0.5	<0.5	<0.5	<4	<0.4	11	22	440	<0.1	2	15	1	<7	12000	13	8.4	13
115	6m zone front of mantlet W	<0.5	<0.5	<0.5	<4	<0.4	12	26	390	<0.1	2	15	2	<7	13000	19	8.1	14
116	Stop butt rear	<0.5	<0.5	<0.5	<4	<0.4	12	6	81	<0.1	2	8	2	<7	11000	18	8.1	18
117	West of Gallery over store	<0.5	<0.5	<0.5	<4	<0.4	13	13	150	<0.1	3	14	<1	<7	15000	7.4	7.2	22
118	Below culvert fr stop butt U	<0.5	<0.5	<0.5	9	<0.4	19	20	220	<0.1	6	40	<1	<7	17000	14	7.6	17
119	Below culvert fr stop butt L	<0.5	<0.5	<0.5	5	<0.4	11	9	92	<0.1	3	22	1	<7	12000	10	7.3	18
120	channel rear butt Upper	<0.5	<0.5	<0.5	8	<0.4	7	10	130	<0.1	3	12	<1	<7	92000	8.9	6.9	12
121	channel rear butt Lower	<0.5	<0.5	<0.5	<4	<0.4	3	1	15	<0.1	<1	5	<1	<7	4900	1.2	6.6	19
121	channel rear butt Lower	<0.5	<0.5	<0.5	<4	<0.4	3	1	15	<0.1	<1	4	<1	<7	5200	1.1	6.5	
122	Deposited Sed back of gallery	<0.5	<0.5	<0.5	<4	<0.4	11	240	2400	0.4	4	44	3	20	15000	27	8.7	19
Dup 1		<0.5	<0.5	<0.5	<4	<0.4	3	1	95	<0.1	2	6	<1	<7	2400	3.8	9.3	
Dup 2		<0.5	<0.5	<0.5	<4	<0.4	3	1	21	<0.1	<1	4	<1	<7	6100	<1	6.7	
101 - [TRIPLICATE]					<4	<0.4	3	3	79	<0.1	2	20	1	<7	3200			14

Table 34: 2020 Sediment Results -all areas																		
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
Practical Quantitation Limit or Limit of Reporting (PQL)		0.05			4	0.4	1	1	1	0.1	1	1	1	7	10	1		
EIL from WCMP				**(ESL) 0.7**	**100**	**-**	**414**	**132**	**1113**	**-**	**34**	**190**	**OBS ONLY**	**-**	**OBS ONLY**		6.5-8.5	**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**						
Sediment Samples - 50m & 500m																		
130	Basin 7 east of 800	<0.5	<0.5	<0.5	<4	<0.4	4	1	11	<0.1	1	10	<1	<7	6100	1	6.4	11
241	Basin 4- car park	<0.05	<0.5	<0.5	5	<0.4	21	14	18	<0.1	7	41	<1	<7	20000	15	6.7	[NT]
241	Basin 4- car park	0.4	<0.5	<0.5	4	<0.4	22	15	19	<0.1	6	34	<1	<7	23000			
242	Basin 3- 500 east	<0.05	<0.5	<0.5	<4	<0.4	4	14	11	<0.1	2	13	<1	<7	1900	1.6	7.4	[NT]
242	Basin 3- 500 east																7.4	
243	Basin 2 500 west	<0.05	<0.5	<0.5	<4	<0.4	5	24	11	<0.1	8	44	<1	<7	4500	4.2	9.1	[NT]
244	Basin 1 200m	<0.05	<0.5	<0.5	<4	<0.4	15	4	9	<0.1	4	12	<1	<7	16000	3.3	7.3	28
245	Basin 5 50m	<0.05	<0.5	<0.5	<4	<0.4	6	13	11	<0.1	4	24	<1	<7	3700	3.4	7.6	[NT]
246	Creek 500 East	<0.05	<0.5	<0.5	<4	<0.4	9	3	13	<0.1	2	14	<1	<7	8300	8.5	6.8	19
247	Creek 200 West	<0.05	<0.5	<0.5	<4	<0.4	12	4	23	<0.1	4	28	4	<7	12000	6	6.4	17
Sediment Samples - 800m																		
130	Basin / Pond east of 800	<0.5	<0.5	<0.5	<4	<0.4	4	1	11	<0.1	1	10	<1	<7	6100	1	6.4	11

Table 35: 2020 Surface Water Results – all areas															
Sample ID	LOCATION	pH	Turbidity	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
151	Water Basin 7 east of 800	6.4	14	0.5	0.35	9.2	<0.005		<1	<1	<1	<1	<1	3	<1
152	Water Channel rear of 800	6.2	NT	1.2	1.2	8.3	<0.005		<1	<1	<1	3	3	1	<1
250	Basin 4 - car park 50/500	7.5	17	0.1	<0.005	8.8	<0.005	<0.05	<1	<1	<1	<1	<1	3	<1
250	Basin 4 - car park 50/500	[NT]	14	0.1	<0.005	[NT]	<0.005								
251	Basin 3 - 500m east	9.5	3.2	0.2	<0.005	8.7	<0.005	<0.05	1	<1	<1	<1	2	5	<1
251	Basin 3 - 500m east	9.5	[NT]	[NT]	[NT]	[NT]	[NT]								
252	Basin 2 - 500m west	9.4	1.8	0.2	<0.005	8.8	<0.005	<0.05	<1	4	<1	<1	2	2	2
253	Basin 1 - 200m	7.8	8.1	0.1	<0.005	8.3	<0.005	<0.05	<1	<1	<1	<1	<1	3	<1
253	Basin 1- 200m								[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
254	Basin 5 - 50m	9.1	2.4	0.1	<0.005	8.3	<0.005	<0.05	<1	1	1	<1	1	2	5
255	Creek waters off range - NA														
256	Creek waters off range - NA														

12.4 Discussion of results

12.4.1 Soil and Sediments (pH)

The following samples returned pH values outside the target range of pH 6.5-8.5;

Table 36: Soil and Sediment pH - locations outside target range

Sample ID	Location	pH- (Laboratory)
Soils: 50m Range and Surrounds		
304	Off range bushland North	5
305	Off range bushland West	5.6
306	Off range bushland South	5.6
Soils: 500m Range and Surrounds		
202	Target bay 50-100m	8.6
213	Off range Bushland West 2	5.8
214	Off range Bushland East 1	5.5
215	Off range Bushland North	6.1
217	Face of stop butt Centre	9.3
218	Face of stop butt West	9.6
219	Intermediate mound 50m	5.6
	Intermediate mound 50m	5.4
222	Intermediate mound 200m	8.8
Soils: 800m range and Surrounds		
101	Bullet catcher 2	9.4
102	Bullet catcher 5	8.9
104	Between bullet catcher 3-4	9.4
105	Under bullet catcher 1	9.3
106	Under bullet catcher 7	9.3
111	Target mound /Mantlet (Centre)	6.4
122	Deposited Sed back of gallery	8.7
Dup 1		9.3
Sediment: All Areas		
243	Sediment: Basin 2 500 west	9.1

Sample ID	Location	pH- (Laboratory)
247	Sediment : Creek below Basin 1	6.4
130	Sediment: Basin 7 east of 800	6.4

Bushland areas

- Samples 304, 305 and 306 are from off range areas or bushland around the 50m
- Sample 213, 214 and 215 are from off range areas or bushland around the 500m range.
- Sample 247 is from the invert of a channel within the bushland below Basin 1.
- Sample 130 is from Basin 7 located within bushland east of the 800m Range

These samples are from bushland areas where a soil pH of less than 6.5 is to be expected.

Basalt gravels

- Samples 202 and 217, 218 and 111 are of the blue metal (basalt) gravel of the bullet catcher/stop butt at the 500m range (reporting to Basin 2).
- Samples 101 102, 104, 105 & 106 are of the blue metal (basalt) gravel of the bullet catcher and stop butt of the 800m range (reporting to the culvert outlet on eastern side of the 800m gallery).

These samples have returned pH in the range of pH 8.8-9.2 (alkaline). The pH of this material is consistent with and confirms the results returned by the Quarter 3 monitoring exercise.

This is pH may be a characteristic of the basalt rock used in the construction or from treatment of the bullet catcher and surrounds.

The pH of this material was not known when placed however the pH of other basalt gravel used at the SHRSC indicate pH generally over 8.0

The pH within the basin/outlets which these sample points report to may be used to indicate any potential effect from this basalt material;

- Sediment within Basin 2 returned a pH of 9.1
- Water within Basin 2 returned a pH of 9.4 which is above the accepted range for surface waters.
- Soil/Sediment from the culvert east of the gallery returned a pH of 7.6 (sample 118) which is within the accepted range for soils however represents a higher pH when compared to other natural bushland soils from off range.

Shot fall areas (500m and 800m)

Soil samples taken from the range floor of the 500m Range as part of the Quarter 3 monitoring exercise returned numerous results with pH below the target range of pH 6.5 to 8.5. The results from the Quarter 4 monitoring exercise return soil pH within the target range. It is therefore suggested that the Quarter 3 values may have been consequent to the effect of the severe recent bushfires and ash fall.

Sample 219 (50m intermediate mound) has returned a pH of 5.6/5.4 which is below the target pH range for soils. This confirms observations from both the Quarter 1 and Quarter 3 monitoring exercise. It will be recommended that this mound is to be treated with crushed limestone or agricultural lime to attempt to correct the pH of this material.

Sample 222 (200m intermediate mound) has returned a pH of 8.8 over the target pH range for soils. Other intermediate mounds at the 500m range (excluding the 50m discussed above) returned values of pH7.8-8.3. The pH from these mounds will be reviewed as part of subsequent monitoring exercise.

Sample 111 (mantlet to 800m range) returned a pH of 6.4 which is just below the target range for soils. Adjacent samples from the mantlet returned pH values of 7.3 and 7.4.

Sample 112 (Deposited sediment at back of the Gallery) returned a pH of 8.7. This sediment is derived from the exposed batter below the 800m stop butt and access bench. This material may be impacted by surface water from the alkaline blue metal stop butt and bullet catchers. It will be recommended that this sediment be regularly cleared until the batter can be adequately stabilised.

The Quarter 3 monitoring exercise indicated the soil west of the 800m Gallery had a pH of 5.7. The sample from the same area taken within the Quarter 4 monitoring exercise has returned a soil pH within the target range.

Sediment Basin 2
Sample 243 is of sediment/invert material from Basin 2.
The pH of this sample is 9.1 (alkaline) and confirms the results from the Quarter 3 monitoring exercise.

This Basin receives water from 500m range floor catchments including the stop butt areas which are comprised of alkaline blue metal. This basin also receives water from the lime treatment process.

Ongoing review of the sediment and water quality results from this basin is required to confirm if it represents an ongoing or developing concern to the range management. This review is accommodated by the existing monitoring program with inclusion of an additional monitoring of pH (field or laboratory pH) water quality basins.

12.4.2 Surface Waters (pH)

The following samples returned pH values outside the target range of pH 6.5-8.5;

Table 37: Surface Water pH - locations outside criteria

Sample ID	Location	pH- (Laboratory)
151	Water Basin 7 east of 800	6.4
152	Water Channel rear of 800	6.2
251	Basin 3 - 500m east	9.5
252	Basin 2 - 500m west	9.4
254	Basin 5 - 50m	9.1

Sample 151 is from a bushland basin which does not receive runoff from the 800m. pH of surface waters in bushland lower than pH 6.5 may be expected.

Sample 152 is from the channel which drains the spoil material spread at the rear of the 800m stop

butt. This material contains significant amounts of mulch which may have the effect of lowering the pH of surface water and water leaching from the material. The pH of water at this location should be monitored. It may be desirable to treat the catchment area with agricultural lime or outlet channel with lime stone gravel/rock

Samples 151, 152, and 154 are from sediment basins at the 50/500m range. All these basins receive water via lime treatment process which may explain the elevated pH values. Alternatively there may be some latent effect consequent to ash fall during the extreme bushfires of 2019/2020.

Water quality results from these basins will be monitored to confirm if the elevated pH raises any management issues.

It is recommended that monitoring of pH (field or laboratory pH) be included for water quality basins in ongoing sampling exercises to allow for assessment of pH trends or any pH impacts in the receiving basins.

12.4.3 Soil and Sediments (Heavy Metals)

The following samples returned values for nominated heavy metals above the adopted criteria.

Table 38: Soils and Sediments – Heavy Metals

Sample ID	Location	Copper	Lead	Zinc
50m Range and surrounds				
308	Bullet catcher Bay 4	1400	1400	
309	Bullet catcher Bay 5	2800	2800	
311	Butt above bullet catcher B3	1600	1600	
311	Butt above bullet catcher B3	1800	1800	
			1600	
800m Range and surrounds				
101	Bullet catcher 2		740	
104	Between bullet catcher 3-4		900	
105	Under bullet catcher 1		2300	200
106	Under bullet catcher 7		1600	
107	Bench foot of stop butt E	180	2300	
108	Bench foot of stop butt C	350	2100	
109	Bench foot of stop butt W		1200	
122	Deposited Sed back of gallery	240	2400	

All above samples are taken from primary impact areas or immediately adjacent/down gradient of

primary impact areas.

No values for heavy metals above the adopted criteria were returned for samples taken outside shot fall areas.

12.4.4 Surface Waters (Heavy Metals)

No values for heavy metals above the adopted criteria were returned for surface water samples.

12.4.5 Soil and Sediments (PAH)

The following samples returned values for Poly Aromatic Hydrocarbons above the adopted criteria.

12.4.6 Surface Waters (Other)

Sample 152 being pooled water taken from the channel at the rear of the 800m stop-butt returned a value for ammonia of 1.2 mg/L.

This channel which drains the spoil material spread at the rear of the 800m stop butt. This material contains significant amounts of mulch which may be responsible for generating some ammonia as these vegetation material composts or breaks down.

This channel is ephemeral. Samples should be taken from this channel following rainfall to confirm if this is a persistent issue.

It is noted that the surface waters were analysed for turbidity (NTU) rather than TSS. This is not in accordance with the WCMP. The NTU values returned for the surface waters were very low ranging from 1.8 to 8.1 NTU for constructed basins within the SHRSC with also low values from 14 to 17 NTU for surface waters from existing ponds or channels.

The low NTU values indicate similarly low to very low TSS well under the 50ppm criteria. As such re sampling of the surface waters was not considered to be required.

12.5 Recommendations

The following recommendations are made subsequent to the Fourth Quarter monitoring. Recommendations from other Quarters 1-3 are included to provide an annual summary

12.5.1 Management Actions

The following management actions are recommended/suggested;

1. Development of a signage plan which details location and description of all signage within the range for inclusion in the OEMP.

   Signage plan would include signage providing information on;
   - directions and access,
   - shooter safety and
   - environmental health and safety

2. Repair/replacement of the low flow outlet from Basin 3

3. Repair/reconstruction of the inlet to Basin 3

4. Repair/replacement of the pit and pipe outlet control located to the South West of the 500m stop butt

5. Repair/Rebuilding of extensive damage to infrastructure at the 800m range

6. Reinstatement of erosion protection to exposed batter below the 800m stop-butt down to the galley

7. Schedule regular clearing and disposal of accumulated sediment accumulating at the base of the batter below the 800m stop butt within the galley. This material should be cleared on an ongoing basis until the batter above is stabilised.

8. Investigate treatment of the 50m intermediate mound at the 500m range to correct observed low pH (assume pH~5.5). Note that placement of ground limestone may provide a longer term effect but should be confirmed with the range manager as appropriate.

12.5.2 Follow up Monitoring

All follow up observations can be accommodated within the existing monitoring program with inclusion of recommended changes provided below.

12.5.3 Changes to Sampling Program

The following changes to the annual sampling program are recommended;

1. Include monitoring of pH (field or laboratory pH) be included for water Quality Basins in ongoing Quarter 1 sampling exercises to allow for assessment of any pH impacts in the receiving basins.

2. Include sampling of accumulated sediment from the toe of the batter on the southern side of the 800m galley within the SAQP for the annual program. This location should be included with the nominated sample points for soils /sediment.

3. Remove the following sampling points from ongoing monitoring programs
    - Soil material from below invert of bullet catcher at 50m range.
    - Sediment material from sealed lime treatment process.

13 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)