Committee for Risk Assessment (RAC)

Ad-hoc RAC Supporting Group

Evaluation of an

Annex XV dossier proposing a restriction on

Lead and its compounds

in outdoor shooting and fishing

Work Package B.3

Effectiveness of Risk Management Measures at shooting ranges

3 June 2022

Contents

1. Description of the Work Package

1.1. Background

This work package report assesses the effectiveness and practicability of the risk management measures at shooting ranges for sports shooting. For the purpose of this assessment, a shooting range is considered as a designated temporary or permanent area where the use of ammunition, gunshot or projectiles made out of lead takes place. In Europe shooting ranges vary in size and type, ranging from large complexes which may be intended to host sports competitions (with state of art environmental risk management measures in place) to small areas used for recreational activities only (with only basic or no environmental risk management measures in place). Consequently, the design of a shooting range differs a lot among EU Member States.

The Dossier Submitter has used a qualitative approach to describe the risks resulting from sports shooting, considering different scenarios for use of lead gunshot and use of lead projectiles not defined as gunshot (i.e. bullets and airgun pellets). The Dossier Submitter considers that, in addition to the requirements specified in the CSR (2020) of the REACH registration dossiers, any agricultural use at a permanent range should be banned due to the residual risks to the environment. A remediation of the area at the end of life cycle would ensure removal of remaining contamination.

According to the Dossier Submitter, the environmental risks during service life and at the end of life for all types of shooting ranges are represented by risks to soil, surface (run-off) water, groundwater and to birds and livestock in shooting ranges and areas used as agricultural land. These risks have been evaluated by RAC under work packages WP A.1 and WP A.2. From there, the mortality in terrestrial birds is expected to be quite high in areas with intensive shooting activity. Grazing on or foraging from active or abandoned shooting ranges constitutes a risk for livestock (poultry, ruminants). Additionally, under the work package WP A.2, RAC concluded that risks to the environment during the service life and at the end of life of a shooting range/lands included significant risks to top soil, and the receiving surface (run-off) water but generally not to groundwater (or its derived drinking water)(but can be high locally depending on the soil characteristics and hydrogeological conditions). Monitoring and treatment of surface (run-off) water will be important to control this risk, as would the installation of risk management measures (RMMs) to control lead contaminated run-off water and prevent the pollution of any rivers and lakes/lagoons, and surface water in general.

The human health risks during shooting activities have been evaluated by RAC under work package WP A.3. RAC concluded that outdoor shooting using firearms (lead gunshot and other projectiles) results in exposure to lead and elevation of blood lead levels in shooters resulting in low to moderate risks. Shooting with airguns seems to result in lower risks to shooters.

The risks to environment and indirect human health receptors from uses of lead at shooting ranges have been evaluated by RAC under WP A.5. Evidence indicates potential moderate risks in permanent shooting areas where lead gunshot is used with no RMMs, or in intensive shooting areas.

Shooting ranges for lead gunshot are divided in temporary or permanent outdoor shooting areas with no RMMs in place, and permanent outdoor shooting areas with different levels of RMMs in place.

Shooting ranges for lead projectiles (e.g. bullets and airgun pellets) are divided in shooting ranges for rifle and pistols with different levels of RMMs (e.g., different types of berms, roof, remediation plan). The shooting can be further divided in static shooting (on targets) and dynamic shooting (on a moving target).

1.2 Objectives

The following topics are covered in the present work package:

- How effective the RMMs at shooting ranges are – the level of reduction or elimination of risks of exposure.
- The practicality of the RMMs at shooting ranges – the achievability of the suitability to implement containment and recovery measures.

2. Summary of the proposal by the Dossier Submitter

The restriction proposed by the Dossier Submitter includes a non-preferred derogation for the use of lead gunshot for sports shooting at designated shooting ranges. The proposal introduces a derogation for licenced individual athletes to use lead gunshot at a designated location that has a permit granted by the Member State for use of lead gunshot for sports shooting where the following measures are implemented: regular (at least once a year) lead gunshot recovery with >90 % effectiveness (calculated based on mass balance of lead used vs lead recovered in the previous year) to be achieved by appropriate means (such as wall and/or nets and/or surface coverage) and containment, monitoring and, where necessary, treatment of drainage water from projectile impact areas (including surface water run-off control) to ensure compliance with the environmental quality standards (EQS) for lead specified under the Water Framework Directive to minimise the risks. In addition, the proposal contains a ban of any agricultural use within site boundary together with annual reporting to the Commission of permits, licences and quantity of used lead gunshot.

For the derogation of the use of other lead projectiles (e.g. bullets and airgun pellets) at shooting ranges, lead projectile containment and recovery is necessary via trap chamber or a ‘best practice’ sand trap comprising of a sand trap with a water impermeable barrier between the base of the sand trap and the underlying soil and an overhanging roof or a permanent cover. In addition, containment, monitoring and, where necessary, treatment of drainage water from projectile impact areas (including surface water run-off) need to be in place to ensure compliance with the environmental quality standard (EQS) for lead specified under the Water Framework Directive.

The Dossier Submitter considers that the risk management measures (RMMs) identified in the derogations for the use of lead gunshot and other projectiles in sports shooting are required to ensure an effective minimisation of risks resulting from the use of lead ammunition in shooting ranges. The recommended RMMs in the CSR of the registration dossier (CSR, 2020) are not appropriate in reducing the risks.

The CSR of the REACH registration (CSR, 2020), covers the use of lead ammunition in three different types of shooting ranges (outdoor pistol /rifle, clay target and sporting clay target range). The RMMs identified in the CSR to prevent releases during service life at the different types of shooting ranges are the following:

- Measures to prevent rivers from crossing the lead deposition area
- Bullet containment and recovery in the shooting range: at least one or a combination of bullet traps, trap chambers, sand/soil traps or steel traps or berms
- Overhanging roof over the lead impact zone to prevent surface water run-off
- Control of water run-off – immobilisation plan and drainage/collection system
- Lead shot deposition must be within the boundaries of the shooting range
- Remediation plan upon closure

The measures to prevent rivers crossing the deposition area, the collection of lead and the remediation plan upon closure are recommended for the three types of shooting ranges. Bullet containment and overhanging roof in the impact area are only recommended at outdoor pistol/rifle ranges while a water run-off control system is only defined for clay target ranges.

A remediation plan for the end of service life is recommended in the CSR of the REACH registration (CSR, 2020), suggesting that further actions are required in addition to applying RMMs during service life. This is because for all shooting ranges, even for rifle or pistol ranges with almost 100% lead recovery, contamination of the soil of a shooting range above background level is to be assumed.

Training and competitions can take place at shooting ranges with varying degrees of operational conditions and risk management measures (e.g. using berms and/or nets, and/or surface coverage). However, the Dossier Submitter has noted that the recommended RMMs are not always in place. Additionally, different conditions and measures are specified by various international sport shooting organisations.

The Dossier Submitter has evaluated the effectiveness of the RMMs at shooting ranges at a qualitative level (see Table 1 below, Table 1-7 from the Background Document).

Table 1. Effectiveness of different RMMs applied in shooting ranges according to the Dossier Submitter

	Measure	effectiveness	Comment
Lead recovery	Wall and/or nets and/or soil coverage	Effective: effectiveness depending on the specific type of shooting practised and corresponding type of shooting ground	To achieve a high percentage of recovery, several measures might need to be in place. It may not be applicable in all types of shooting grounds (e.g. wooded areas for 'sporting' clays). Unrecovered lead gunshot may be ingested by birds.
	Bullet) traps such as trap chambers or sand traps with containment of the lead	Very effective	Regular lead recovery: is possible. Depending on the type of trap, measures may be needed to control surface and groundwater contamination
	Backstop berm (with or without a cover) and without an impermeable layer to soil)	Not effective	Often considered as a "safety" measure, specifically when no cover is present. Mechanical disturbance of the berm during lead recovery may increase soil and surface water contamination

	Measure	effectiveness	Comment
Reduction of lead mobilisation	Lime amendment	Measures may contribute in some sites to reduce lead mobilisation but are not proved to be effective in natural soil systems in the long term to prevent lead migration , especially at the end of service life when such measures would be discontinued. Amendment practices are not expected to be applicable in temporary shooting grounds	Adjustment of pH to reduce migration potential of lead expected to be discontinued at the end of service life
	Phosphate amendment		Immobilisation of lead in natural soil systems may not be successful; it may have a negative impact on the environment (eutrophication).
	Vegetation		Vegetation reduces mobilisation of lead but needs to be removed before or during lead recovery
Surface water (run-off) control	Such as: - Filter beds - Containment traps and detention ponds - Dams and dikes - Ground contouring	Effective	Especially in clay target ranges or rifle/pistol ranges with sand traps or sand/soil berms
Groundwater control	Measurements of leaching water or groundwater	Effective	Especially relevant for older shooting ranges with heavy soil contamination and located in water sensitive areas or with specific soil conditions that promote leaching of lead to groundwater; if leachate or groundwater measurements show elevated concentrations, remediation of the soil or installation of bullet trap is required
Remediation	remediation	Effective	Remediation is very expensive.

It is further noted that the appropriate RMMs should be implemented based on expert advice taking into account the location of the range and the site-specific characteristics. Also in many instances, RMMs (as surface water run-off control) applied during service life may need to be continued after the end of service life unless remediation is performed.

Human health risks from lead exposure to shooters are according to different contributions to the consultation (i.e., sport shooting federations and shooting associations) mitigated by:

- Providing training to shooters handling lead ammunition on the potential health risks and special training (e.g. risks in using black powder and shooting with muzzle loaders);
- Having good hygiene practice in place at the shooting ranges (guidance for washing hands, no food consumption when handling lead ammunition, use of gloves and keeping shooting clothes separate);
- An open air environment providing natural ventilation conditions;
- Lead containment in the cartridges: it has been stated that lead exposure to shooters can be reduced when using large calibre ammunition jacketed with copper and zinc;
- Shooting positions 2 to 2.5 metres apart;

- The firing distance to the target or berm preventing exposure from the projectile splashing;
- Roof-covered (outdoor) shooting ranges have ventilation conveying fresh air in the direction of the shooting openings and it has been also stated that the roof over the shooters may not extend more than 3m in front of the shooter.

3. Relevant information from the consultation of the Annex XV restriction report

During the consultation on the Annex XV dossier, around 100 comments from different stakeholders with relevance to this work package were submitted.

47 comments were received on measures to limit the release of lead gunshot to the environment from sport shooting. Some comments requested a ban on the use of lead gun shot in sport shooting. Other comments concerned the use of lead gunshot under strict environmental conditions, thus allowing a high recovery rate. These comments were taken into account by the Dossier Submitter in their refined assessment of several restriction options, including options for continuing the use of lead gunshot under strict environmental conditions (see Background Document section 2.3 and 1.4.4.2.2.1). For sports shooting with gunshot, the Dossier Submitter considers it necessary to specify both the regular recovery frequency (at least once a year) and the effectiveness of recovery (> 90 %) to minimise all identified risks.

83 comments were received on measures to limit the release of lead bullets to the environment. Also after the consultation the Dossier Submitter still proposes to only allow the use of lead bullets under strict environmental conditions at locations designated for sports shooting. The received comments demonstrate that the term “bullet trap” is used and understood in multiple ways. Consequently, the Dossier Submitter updated the Background Document to clarify the terminology used, e.g. by using the term ‘trap chamber’.

In chapter 4.1.7.3. of the Background Document “Type of bullet containments”, the Dossier Submitter in detail reflects on the received comments and amended the Background Document with the information received on the types of bullet containments (section 1.4.4.2) and assessed the impacts (section 2.6) on the identified risks via soil, surface water and groundwater caused by other bullet containment systems than bullet trap chambers such as i) sand traps (with an impermeable layer to soil), ii) sand/soil berms (without an impermeably layer to soil) and iii) soil berms. Based on this assessment, the Dossier Submitter now proposes to add as alternative to a bullet trap chamber a ‘best practice sand trap’, consisting of a sand trap with an impermeable layer to the soil, an overhanging roof or a coverage, and a water management system to contain, monitor and treat surface water.

In the original Annex XV report, the Dossier Submitter proposed ‘*Regular lead recovery with [>90 %] effectiveness (calculated based on mass balance of lead used vs lead recovered)*’ as a condition under which the use of lead bullets on designated shooting areas could be derogated from the restriction. With the addition of a ‘best practice’ sand trap as an alternative bullet containment option, the Dossier Submitter considers that this specification of effectiveness is no longer applicable because lead bullet recovery might take place only every 3 to 5 years for a typical ‘best practice sand trap’.

53 comments were received on the topic of “remediation”. The comments confirmed that different legislations with regards to remediation of shooting ranges are in place across the

EU and that not all shooting ranges may be remediated at the end of life. Therefore, the Dossier Submitter considers that the current restriction proposal with the implementation of strict RMMs at shooting ranges *during* service life would help to minimise lead mobilisation to the environment and would facilitate an effective "clean-up" of lead at the end of service life (see Background Document section 1.4.4). and that remediation is not required in the proposal.

RAC has assessed the comments and the responses from the Dossier Submitter and supports the Dossier Submitter.

4. Evaluation

The Dossier Submitter presents a number of risk management measures (RMMs) to control the identified risks which are described below. RAC supports the conclusion of the Dossier Submitter on the efficiency and practicality of the measures for risk reduction.

Measures to reduce the mobilisation of lead

The Dossier Submitter introduces several measures to reduce the **mobilisation** of lead described in the literature:

Lime amendment raises the pH of the topsoil and reduce the migration potential of lead. However, increase of the water-soluble lead in the berm have been shown which increases lead leaching from the berm. The effect of the treatment should be checked annually with multiple samples. Lime could be applied around earthen backstops, sand traps, trap and skeet shortfall zones, sporting clays courses and any other areas where the bullets/shots or lead fragments/dust accumulate.

Phosphate amendment may theoretically bind the lead particles to form pyromorphite, but only if spreading is repeated frequently. However, because of high uncertainty about the effectivity, the phosphate amendment is not suitable equally for all different concentrations of lead contaminations.

Vegetative ground covers can mechanically impact the mobility of lead and lead compounds by the vegetation absorbing the rainwater, thereby reducing the time that lead is in contact with water. Also by slowing down surface water run-off, preventing the lead from migrating off-site. But this would require removal of the vegetation cover during recovery and could attract birds and wildlife which should be avoided to not facilitate lead ingestion. Excessively wooded areas (such as those often used for sporting clay ranges) inhibit lead recovery by making the soils inaccessible to some large, lead-removal machinery. New shooting ranges should be designed with as few plants as possible to improve lead recovery. RAC notes that recovery requires removal of the vegetation before or during this activity and that vegetation which attracts birds and other wildlife should be avoided to prevent potential ingestion of lead.

Removable surface covers may be used at outdoor trap and skeet ranges. In this case, impermeable materials (e.g. plastic liners) are placed over the shot fall zone during non-use periods. This provides the range with two benefits during periods of rainfall: (1) the shotfall zone is protected from erosion; and (2) the spent lead shot is contained in the shotfall zone and does not come in contact with rainwater.

Measures for surface (run-off) water and groundwater control

Surface (run-off) water control may influence the amount of lead transported offsite by surface water run-off depending on two factors: the amount of lead fragments left on the range and the velocity of the run-off. Run-off control may be of greatest concern when a range is located in an area of heavy annual rainfall because of an increased risk of lead migration due to heavy rainfall events. Examples of run-off controls include:

- filter beds to collect and filter surface water
- containment traps and detention ponds to settle out lead particles during heavy rainfall
- dams and dikes to reduce the velocity of surface water run-off
- using vegetation and trees to prevent lead from being transported off site.

Synthetic liners (e.g. asphalt, Astroturf ™, rubber, other synthetic liners) are used to prevent leaching through lead contaminated soil, however creating increased run-off from new lead shot, which must be managed.

These run-off controls are especially important at ranges at which the lead accumulation areas are located up-gradient of a surface water body or an adjacent property. Since lead particles are heavier than most other suspended particles, slowing the velocity of surface water run-off can reduce the amount of lead transported. The use of a roof to cover the berm may be an option at rifle and pistol ranges to reduce water run-off. After the end of life of a range without remediation, it is unlikely that maintenance will be made to control run-off, with increased risks for nearby surface water and other receptors.

Measurement of ground or leaching water is specifically relevant for older or shutdown shooting ranges with heavy soil contamination that are located in water sensitive areas or with specific soil conditions; if leaching water or groundwater measurements show levels above the national threshold, remediation of the soil is required. Monitoring of lead concentrations in surface (run-off) water from shooting ranges appears not to be very common. It is argued that when appropriate measures are applied (e.g. impermeable layer, frequent projectile removal, pH balancing), risks would be minimised and monitoring of groundwater would not be warranted.

An immobilisation plan and construction of a drainage and collection system for the management of lead-contaminated drainage water is often required, as lead shot is expected to remain on top of the soil between removal intervals with the risk of mobilisation to run-off water.

It is unclear whether appropriate monitoring of soil contamination is carried out in all EU countries.

Remediation of contaminated soil is the RMM often applied in case a risk to groundwater is to be assumed or has been demonstrated. It is the most expensive measure. Remediation is often performed in ranges located in a water sensitive area and being operated for several years or even decades with accumulation of lead shot or lead bullets in the soil. The level of implementation of this measure depends on the national legislation requirements to identify contaminated sites and on funding availability. Therefore, there is no certainty about the

actual implementation of this measure, despite the recommendation for a remediation plan indicated in the CSR of the REACH registration (CSR, 2020) as a RMM to prevent lead releases. For those ranges with a regular recovery of lead shot and bullets, the need for remediation at the end of service life is expected to be limited compared to ranges where recovery of lead ammunition is not implemented. Recovery reduces the lead burden at shooting ranges. However, depending on the discipline and method of recovery, fragments may remain in the soil even after recovery. Therefore, remediation of a permanent range may be necessary at the end of service life, for example in case of risk to groundwater.

The Dossier Submitter concludes that lead shot and bullets are often deposited directly on and into soil during shooting and remain in the soil between removal and even after recovery measures have been applied with the risk of corrosion and mobilisation of lead to run-off water. The Dossier Submitter also adds that the specific compounds created, and their rate of migration, are greatly influenced by soil characteristics, such as pH and soil types. Knowing the soil characteristics of an existing range is a key component to developing an effective lead management plan.

Lead gunshot recovery

There are different RMMs that can be implemented to improve the recovery of lead gunshot at shooting ranges. The range layout may be designed to optimize lead recovery with overlapping shot fall areas which may improve the efficiency of lead recovery. However, this measure can be applied effectively at trap/skeet ranges but may not be suitable for all shooting range layouts in the “sporting” shotgun disciplines.

An impermeable barrier could be applied at existing ranges. However, removal of the contaminated soil is needed before installation as noted by the Dossier Submitter. It would be ineffective to cover already contaminated soil with an impermeable barrier due to percolation and anaerobic soil conditions affecting the soil chemistry.

Vertical barriers are most frequently used e.g. walls and nets. Vertical barriers have the benefit to reduce the shot fall zone and to concentrate the lead shot to assist recovery.

Horizontal barriers may be additionally required for proper recovery of lead shot at shooting ranges and to ensure that no lead shot would land outside the range boundaries.

Mechanical intervention is done by extracting gunshot deposited on the surface and concealed in the ground with screening and purification equipment. Filtering and replacing the soil and cleaning of recovered gunshot allows to perform lead melting. No information was provided on the effectiveness of lead recovery using this method.

Manual interventions can be used to recover lead gunshot from difficult terrains. Lead collection from podzolic soils is claimed to be possible however, according to the information provided in the Background Document, it would require significant infrastructure when the shooting range is in operation. The recovery of lead from shooting ranges located in difficult terrain would usually only be possible after the final shut down of the shooting range.

Manually collecting lead shot by individuals have been shown to achieve up to 40% recovery rate. It has been mentioned by a shooting federation that at ranges with vertical barriers lead shot is collected and reclaimed one to three times a year, depending on the intensity of use either by hand using simple devices (broom and shovel) or smaller machines (wheel loader with trailer) during a period of one to two days.

Mechanical sieving can break down weathered metallic lead-bullets into small pieces, increasing total lead concentration in the soil.

Lead bullet containment and recovery

Different RMMs for the collection of bullets at shooting ranges are described in the Background Document.

Berms with or without an impermeable layer to soil catch ammunition usually into an earth/soil, gravel and/or sand layer so that the contamination hotspots are the target area and the berm.

The backstops and target area surfaces can be covered with a layer of wood chips, sawdust or similar to protect surrounding areas from secondary ricochets. This thick layer (approx. 50 cm) is reported to effectively prevent wildlife from ingesting bullets or shot in the backstop. A 'self-healing' surface coverage (e.g. cloth) or a rubber granulate layer containing a waterproof membrane on top of the soil embankment and a drain pipe could also be applied. The backstops and target areas may be covered with a roof or other permanent cover to prevent rainwater from contacting berms (e.g. for outdoor rifle and pistol ranges). The roof must be carefully designed to avoid safety issues as well as to avoid that the berm gets too dry so that it could crack and erode which would also increase the risk of contamination through wind as dust. A roof or a permanent cover could reduce the weathering of lead projectiles.

Sand berms (with low soil moisture, low organic matter and high pH) could slow down lead weathering, but may increase lead leachability in the long term. Weathering consists of both chemical (transformation of metallic to ionic lead) and physical reactions (transfer of lead-bullets to soil fraction). The use of 'bullet traps with sand' can be developed further (runoff control, the use of membranes, filters etc.) to minimise the possibility of leaching. Lead bullet weathering of 5 % in sand traps and 34 % in soil berms is reported.

Soil replacement is required for lead recovery from the backstops and the target area. Removal of contaminated soil and addition of new layer of soil and/or sand/soil is also relevant for minimising ricochet risk and to remedy slope integrity due to "impact pockets" development. Replacement of a soil berm with sand/soil berm has been shown to reduce lead bullet weathering as total leachable lead concentrations in sand is shown to be lower than in soil. Regular removal of the soil in the impact areas is particularly effective at new ranges when used regularly, allowing the removal of the most significant part of the ammunition. At old ranges, some of the load is often deeper in the backstop berm and not affected by the technique. This technique is considered suitable for pistol and rifle ranges where the bullets accumulate in the impact areas. Berm renovation can include regular removal or screening of the soil in the impact areas with an interval depending on the number of shots but recommended every three to five years. After screening the soil, soil can either be returned or disposed of as waste, whereas the lead can be recycled. Removal or screening of soil is considered suitable for new constructions and at a limited type of ranges (e.g. pistol and rifle) where the bullets accumulate in the impact areas. A more expensive but effective method is to remove the soil, separating any ammunition scrap and install a layer of new soil.

Sand traps comprise sand mass or a similar material contained within a concrete or other structure which is open towards the firing point. Sand absorbs the energy of the bullets and

helps the separation of spent bullets and fragments during recovery and disposal operations. The base of the sand should be isolated from the underlying soil to prevent any lead contamination, infiltration water must be collected from the top of the lining via underground drains and treated if necessary. An overhanging baffle/roof should be fitted to prevent leaching and dissolving of lead bullet fragments. Ricochets risk should be mitigated by regular removal of accumulated bullets.

A 'best practice' sand trap is considered to consist of a sand trap with an impermeable layer to the underlying soil, covered either with an overhanging roof/baffle or other permanent cover combined with a water management system for containment, monitoring and treatment (where necessary) of surface (run-off) water and sub-surface drainage to ensure compliance with the environmental quality standard (EQS) for lead specified under the Water Framework Directive. The 'best practice' sand traps could be an alternative to bullet trap chambers, especially for dynamic disciplines with a moving target where a trap chamber doesn't work. Recovery is typically done only every 3 to 5 years for 'best practice' sand traps, and can be rather high, without environmental releases, if done correctly.

Trap chambers are self-contained fully enclosed assemblies with an opening towards the shooting point adapted to the intended use and type of ammunition and typically made of metal. They allow for effectively controlled containment, easy and frequent collection and also recycling of lead projectiles.

According to the CSR of the registration dossier (CSR,2020), at least one or a combination of bullet trap chambers, sand traps or steel trap is required for bullet containment at shooting ranges. A berm covered with appropriate material or a wall may be required in addition to the bullet trap chamber (e.g. for biathlon or for silhouette shooting).

Recovery of bullets/lead from bullet trap chambers, sand berms, sand/soil berms or soil berms could create metal containing dust which need to be controlled with additional measures.

RAC evaluation of the effectiveness of the risk management measures

RAC agrees with the Dossier Submitter that different national regulations (implying the use of different types of risk management measures during the life cycle and at the end of life stage) may exist for the operation of shooting ranges, but that no EU harmonised measure is in place to manage risks resulting from the use of lead ammunition in sports shooting at shooting ranges. The Dossier Submitter notes that effective risk management measures at shooting ranges need to be site-specific taking into account various "factors" such as the type of shooting, ammunition used, slope of the site, type of soil, vegetation, climate, potential for run-off to surface water and potential for leaching to groundwater. Lack of a harmonised EU-wide framework for monitoring and removal of contamination of the surface or run-off water, groundwater and soil of the shooting ranges are supporting that lead contamination is likely and the need for EU measures.

RAC notes the need for application of a combination of appropriate RRMs for effective mitigation of risks from using lead ammunition at shooting ranges.

RAC agrees with the Dossier Submitter that the described measures available for theoretically reducing the mobilisation of lead (e.g., addition of phosphate or lime) are likely not effective enough in natural soil systems to hinder environmental contamination in the long term. This is due to the uncertainties in effectiveness of the applied measures such as

mechanical sieving that can increase total lead concentration in soil. Another factor is the variability in practical applications at different shooting ranges throughout different practiced disciplines especially at the end of service life when such measures would be discontinued.

In contrast, almost 100% recovery has been achieved for trap chamber systems (for rifles, pistols and airgun weapons) and trap/skeet shotgun ranges with net systems and appropriately prepared deposition areas on earth walls and in the flat.

RAC also agrees with the Dossier Submitter that the described measures for surface (run-off) water and groundwater control are effective to reduce the risk of environmental contamination. As lead gunshot will remain on top of the soil for quite some time between removals, and projectiles in sand traps, with risk of mobilisation to surface (run-off) water, the design of the ranges require measures to manage lead-contaminated run-off water.

RAC notes that monitoring and treatment of surface (run-off) water will be important to control lead (residual) risks due to its mobility. In addition, monitoring of lead in the surface (run-off) and groundwater is key to detect and control lead contamination during and at the end of service life at shooting ranges.

RAC notes that lead ammunition accumulated in shooting ranges may represent a hot-spot of pollution which may result in leakage of lead polluted water into streams and lakes. The relevance and significance of different pathways is often site-specific and may or may not occur at any individual range. In areas of lead ammunition deposition in soil, lead concentrations can be extremely elevated and shotgun ranges are likely to have high levels of lead contamination compared to normal background levels in agricultural environments. RAC agrees with the Dossier Submitter that any agricultural use at shooting ranges should be banned due to evidence of lead contamination above the background level of the shooting range areas and the consequent residual risks for humans (via food) and for livestock.

RAC notes the need to mitigate (residual) risks from the use of lead ammunition at shooting ranges as lead related contamination may occur both on-site and away from the point of use (off-site), for example in: agricultural and/or residential, recreational soils as well as surface (run-off) water and/or groundwater and concomitant risks to birds and livestock (poultry, ruminants).

Adequate risk management measures implemented during the service life of a range are likely to reduce (to some extent) the need for subsequent remediation at the end of service life. Even if risks are minimised during the service life of the shooting range, remediation (e.g., final lead gunshot recovery with topsoil removal) at the cessation of use may still be required, depending on how the land will be used in the future.

RAC agrees with the Dossier Submitter that a remediation plan is a useful measure to ensure the removal of remaining contamination at the end of service life of a shooting range. RAC also supports the need to establish an immobilisation plan and construction of a drainage and collection system for the management of lead-contaminated drainage water.

Use of gunshot in shooting areas

For the use of gunshot in permanent shooting areas, RAC agrees with the Dossier Submitter that where RMMs are implemented such as regular at least once a year lead gunshot recovery and containment, soil protection, monitoring and treatment of surface (run-off) water, the level of risks are reduced. Consequently, RAC concludes that the environmental

risks from lead gunshot can be minimised by using appropriate environmental RRMs.

Temporary outdoor shooting areas are considered to have limited shooting and thus likely lower environmental risks to soil, surface water and agricultural use but risks might rise to a relevant level in case lead gunshot accumulate in small areas. Also, even if there is fewer gunshot, there is still a risk for birds ingesting gunshot and for gunshot ending in harvested materials if agricultural use is allowed. Thus, there is still a risk to mitigate at temporary outdoor shooting areas.

Use of projectiles in shooting areas

Permanent outdoor rifle and pistol ranges with intensive shooting activity may today use sand/soil berms or soil berms to trap projectiles. Sand/soil berms are used frequently in Nordic countries. Soil berms are often used in old ranges that have been in operation for a long time. The Dossier Submitter considers the contamination of the berm area presents a high environmental risk to soil, surface water and potentially groundwater. Covering berms with a roof reduces the risk from the mobilisation of lead by rain/snow but does not minimise the risk of contamination of soil, groundwater or surface water. The Dossier Submitter notes that the effectiveness of recovery of lead bullets from sand/soil berms were reported to be 65 %. RAC agrees that the available data indicate that sand/soil berms are not sufficiently efficient in trapping lead. Trap chambers or 'best practice' sand traps applied on permanent outdoor rifle and pistol ranges are considered by the Dossier submitter to reflect the requirements specified in the CSR of the registration (CSR,2020) with appropriate containment as the main means to control the risk from lead projectiles. The Dossier Submitter considers that appropriate trap chambers allow recovery of up to 100 % of spent lead ammunition and notes that the data on recovery from 'best practice' sand traps are not available but are likely to be rather high. The Dossier Submitter considers that in case appropriate trap chambers or 'best practice' sand traps are used to contain the projectiles, the risks are minimised. RAC supports this assessment and requiring the use of appropriate trap chambers or 'best practice' sand traps at permanent shooting ranges for projectiles.

The Dossier Submitter considers that in addition to the requirements specified in the CSR (2020) for sand traps (containment with an overhanging roof and a sealing to soil), a water management system to contain, monitor and treat surface water would minimise lead contamination of water runoff. In addition, the required measure such as trap chamber or sand trap with an overhanging roof might not be suitable for dynamic shooting disciplines, for which a permanent cover would be required to reduce rainwater from entering the trap. In addition, any agricultural use should be banned due to the residual risks.

RAC agrees with the Dossier Submitter and considers bullet trap chambers and 'best practise' sand traps designed to minimise the risk to soil by an impermeable layer and to surface water by a water management system more effective measures than different type of berms for lead bullet containment.

Measures for the containment of lead bullets via trap chambers or sand traps (with a roof or cover and an impermeable barrier to the underlying soil) are already in place at many ranges in the EU, contributing to reduce the identified risk to the environment. However, the effectiveness of existing soil berms or sand/soil berms used frequently does not appear to be sufficient to control the identified risks. Renovation of existing sand traps, sand/soil berms or soil berms to 'best practice' sand traps would effectively contribute to control risks, especially risks related to the soil and surface water compartment.

The recovery rates for biathlon may be close to 100% if bullet trap chambers are used. RAC agrees with the Dossier Submitter that trap chambers can be considered effective measures to contain and recover both large and small calibre projectiles. Sand traps and soil berms are more frequently used, but depending on their design are likely to be (significantly) less effective in preventing release of lead to the environment. For dynamic disciplines sand traps or berms may be a more practical measure to contain projectiles, but could be significantly less effective in preventing subsequent release of lead to the environment.

RAC considers that a regular lead shot recovery rate of ≥90% may be achievable when using a combination of adequate RMMs at shooting ranges. However, in practice, these RMMs, as well as regular lead recovery, are today seldom implemented. It is further explained that >90% of effectiveness of recovery based on a mass balance is proposed as an operational threshold with an objective to achieve minimisation of releases of lead to balance high levels of recovery with practicality. The measures to regularly recover lead shot may in practice not reach 100% effectiveness, and a final clean-up of the site at the end of service life might be desirable. RAC concurs with these considerations.

RAC also notes the need to control also the generation of metal containing dust during screening of soil during bullet recovery from backstops.

5. Uncertainties

- There is an uncertainty as to the effectiveness of RMMs at gunshot shooting ranges.
- There is an uncertainty as to the effectiveness of RMMs at shooting ranges for projectiles (e.g., bullets).
- There are uncertainties as to the current implementation of water management systems and remediation plans.
- There is an uncertainty as to how collaborative sport shooting organisations will be, as their rules will affect the effectiveness of the proposed measures.
- The effectiveness of some currently used RMMs at shooting ranges are unclear.

Shooting ranges vary greatly in size and type, varying from state of art sites to shooting ranges with only basic or no RMMs in place during the life cycle and at the end of the life stage of the shooting range. Different shooting ranges have different capacity to achieve the minimum set measures of recovery or containment required. This is not discussed in the restriction dossier and RAC also lacks a discussion on whether the type of shooting activities, the different disciplines practiced, layout and size of the shooting ranges also influence the effectiveness of each RMMs. It is however mentioned that RMMs should be implemented taking into account the location of the range and the site-specific characteristics. Very effective recovery techniques for lead shot may be applicable only at specific type of ranges (trap and skeet) or applicable at new shooting ranges rather than at temporary ranges or at ‘sporting clay’ ranges. Specifying the precise means, such as walls and/or nets and/or surface coverage, to achieve >90% recovery as part of the derogation for using lead gunshot at shooting ranges cannot be done as the choices will depend on site-specific factors.

Concerning shooting ranges for projectiles, application of a combination of RRMs for effective

mitigation of risks from using lead projectiles at shooting ranges is needed, but as shooting ranges differs in many aspects, it is unclear how effective different RMMs will be. Even though applying several measures at once may not be applicable for all types of ranges and/or disciplines for the purpose of reaching a high level of protection from lead contamination, a set of measures is needed depending on the type of ammunition used and the type of sport shooting. Trap chambers are likely to be very effective, but it is unclear precisely how effective best practice sand traps will be. Lead bullet recovery techniques such as removal and screening of soil is only suitable for specific types of ranges (pistol/rifle) and when a specific type of trap (chamber) is used. Berm soil management techniques have several limitations such as metal dust generation and the need to control for it as well as the costs associated with the transport of soil to be treated outside the area. Also the fine-grained metal remaining in the soil during screening activities may become mobile and the increased solubility of lead can thus contribute to soil and/or surface water contamination.

It is unclear to what extent effective water management systems are in place today. Surface (run-off) water control measures are considered especially relevant in clay target or rifle/pistol ranges with sand traps, sand/soil berms or soil berms. Groundwater monitoring is considered especially relevant for older shooting ranges located in water sensitive areas or with specific soil conditions that promote easy leaching of lead to groundwater. If leachate or groundwater measurements show elevated concentrations, remediation of the soil or installation of a bullet trap is required.

It is unclear to what extent remediation plans are in place, even though they are required in the CSR. RAC notes that the use of effective RMMs and water management systems may limit contamination of the environment, but when a shooting range is closed there is need for a remediation plan to limit future contamination of the environment.

As indicated by the potential need for the optional derogation, an uncertainty concerns to what extent the sport shooting organisations will collaborate with the intention of the restriction. It is such rules that require use of lead gunshot in some shooting disciplines. Thus, rules for the various types of shooting activities are set by various sport shooting organisations.

Several environmental RRMs used today at permanent shooting ranges have major limitations and uncertainties with regards to their effectiveness and practicality, e.g., phosphate amendment of soil. There may be also negative effects or additional risks involved with the application of the techniques. Phosphate application may cause increased run-off and contamination of surface water with phosphate and/or lead, possibly enhance the mobility and effects of other contaminants such as arsenic, or increase the growth of vegetation. Vegetation could attract birds and wildlife which should be avoided to not facilitate lead ingestion especially when designing new shooting ranges. Removal of impacted soil is hampered with increased vegetation where manual intervention to recover lead gunshot is required and a grass layer would need to be removed to recover the lead gunshot. There are unclear long-term effects on soil quality for agricultural purposes for some measures especially at the end of service life when such measures would be discontinued.

6. Conclusions

RAC concludes in line with the Dossier Submitter that in case of use of lead gunshot a regular lead recovery rate of > 90% must be achieved.

RAC supports having the effectiveness calculated based on mass balance of lead used vs lead recovered in the previous year. RAC acknowledges that a recovery rate expressed in percentage presents significant challenges for enforcement. The >90% of effectiveness is most probably only achievable with a combination of appropriate risk management measures that will vary depending on the type of shooting range and the type of shooting discipline.

In the case of the use of lead projectiles other than gunshot (bullets and airgun pellets), RAC concludes in line with the Dossier Submitter that at specific types of shooting ranges (e.g., target ranges) and specific types of shooting disciplines (e.g., Olympic sports shooting or biathlon) containment with bullet trap chambers may achieve very effective recovery (>90%). There is still some uncertainty remaining concerning the effectiveness of “best practise sand traps”, but RAC support their use as an alternative solution, especially needed for some specific shooting disciplines.

RAC notes and supports that the derogation for projectiles containment and recovery via trap chamber or a ‘best practice sand trap’ which should consist of a sand trap with a water impermeable barrier between the base of the sand trap and the underlying soil and an overhanging roof or a permanent cover.

RAC recommends remediation at the end of service life of shooting ranges.

RAC concludes that appropriate measures for soil, surface (run-off) water and groundwater control (including monitoring), containment and treatment would lead to mitigation of (residual) risks to birds, livestock and humans.

RAC supports the ban of any agricultural use within the shooting range boundary.

7. References

All references cited are included in the Background Document to the Opinion on the Annex XV dossier proposing restrictions on lead in outdoor shooting and fishing.