

Environmental Risk Assessment at Outdoor Shooting Ranges

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Introduction

Environmental concerns about lead and other issues at outdoor shooting ranges are being raised by regulators, groups concerned about the environment and anti-gun groups using any available means to attack ranges. Regardless of the motivation, environmental attention to ranges is increasing, and this trend likely will continue.

In this climate, range owners and operators increasingly need to manage environmental issues at their ranges proactively and be prepared to participate knowledgeably in environmental evaluations of their ranges done by others. When environmental evaluations are necessary, they typically will be conducted by experienced consultants hired by the range, regulatory agency personnel or agency consultants. Even though range personnel seldom actually perform detailed environmental evaluations, they should work closely and knowledgeably with their own consultants or agency representatives conducting evaluations. This provides range personnel the best opportunity to know and influence what is done, be aware of findings as they develop and protect interests of the range to the maximum extent possible.

Someone associated with every range should be aware of fundamental environmental issues, regulations and procedures relevant to ranges. Information on relevant issues, laws and regulations is available from the National Shooting Sports Foundation and National Rifle Association. Contact information for these organizations is presented at the end of this paper. Range evaluation requires site-specific data on a variety of parameters. These data are generated through standardized tests according to detailed technical procedures. It is as important to conduct the right tests as it is to conduct the tests the right way. It is equally important various test results be synthesized properly and considered in their entirety to provide a complete and useful picture of prevailing environmental conditions. This paper provides an overview of an approach or organizational framework for conducting environmental investigations and evaluating the resulting data that offers advantages for the range, the scientist and the regulator, and is becoming the accepted basic approach for many kinds of environmental evaluations.

Environmental Risk Assessment

Environmental risk assessment is an organized, systematic approach for evaluating the potential for impacts to occur under a specific set of conditions. The U.S. Environmental Protection

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Agency (EPA) has advanced and encouraged the use of environmental risk assessment over approximately the past decade, and the approach is widely accepted and used by EPA, many other federal and state agencies, and the academic and scientific communities.

Risk assessment is a process for evaluating the impact of a chemical on the health of individual humans or the environmental well-being of a population or community of animals and plants. In its most basic form, risk assessment means answering several simple questions that usually underlie environmental evaluations. These include:

1. What humans, organisms or habitats (all called "receptors") are near the range, and what chemicals or physical hazards associated with the range might affect these receptors? The process of answering this question is "problem formulation."
2. Is there a known quantity of the chemical or physical hazard that results in an adverse effect to the likely receptors? This is "effects assessment."
3. Are there any conservative but realistic activities or physical and biological pathways by which the receptors may encounter the chemical or physical hazards associated with the range? This is "exposure assessment."
4. Under conditions at the range, will this encounter result in exposure of a receptor to the chemical or physical hazard at a level likely to cause an adverse effect? This is "risk characterization."
5. How confident are we in our answer? This is "uncertainty analysis."

Generally, if the answer to question 4 above is "no" with an acceptable degree of confidence, then we assume that whatever risk might be associated with the range is acceptably small. If the answer is "yes," then there is some potential of unacceptable risk. Depending on the situation, we then may refine and expand our data and repeat the evaluation at a greater level of detail, or begin to search for ways to modify the range facilities or management to lower the exposure and, hence, lower the risk.

Viewed as a formal approach to answering these common fundamental questions, risk assessment is a way of organizing a familiar thought process. A risk assessment is essentially complete when it provides defensible answers to the above questions at a level of detail sufficient for the purpose of the investigation. The risk assessment framework has advantages regardless of the degree of complexity. Some situations only require a "back-of-the-envelope" level of detail and precision, but the risk assessment approach can be used in any investigation, whatever the complexity necessary to properly investigate the situation.

Features of Risk Assessment

The risk assessment framework is a systematic structure for evaluating data. It provides the flexibility to focus an investigation on the specific issues important at that particular site. However, the flexibility that allows an investigation to be optimized also allows it to be misdirected. Therefore, it is important to understand some of the basic features of risk assessment.

A risk assessment is based on a number of fundamental decisions that determine the focus of the investigation, the tests that are performed and the context in which the results are evaluated.

Important decisions, called “assumptions” in risk assessment jargon, underlie key elements of a risk assessment, including:

- identification of “receptors of concern” (ROC). These are the types of human range users (e.g., shooters, range officers) or wildlife species whose risks will be determined. Wildlife ROC often are selected to represent groups of species to maximize the applicability of the risk assessment to the local ecosystem. For example, red-tailed hawks may be selected as an ROC representing all raptor species in the area.
- identification of “contaminants of concern” (COC). These are the contaminants relevant to the specific activities occurring at the site under investigation. For example, at a skeet range, the COC might include lead and arsenic in the shot and polycyclic aromatic hydrocarbons (PAH) from the pitch in clay targets.
- identification of exposure pathways. These are the specific activities that bring an ROC into direct physiological contact with a COC. For example, “lead on the ground getting into small mammals” is not an adequate statement of a potential complete exposure pathway because it does not describe the specific activity that could bring lead into direct physiological contact with particular small mammals and, therefore, is too vague to be evaluated quantitatively. “Lead shot on the ground surface incidentally ingested by cottontail rabbits as they feed on clover” is an adequate statement of a potential complete exposure pathway that describes how lead might enter the bodies of specific animals and is sufficiently detailed to be evaluated quantitatively.

Application of Risk Assessment at a Shooting Range

The Westchester County, New York, Department of Parks, Recreation and Conservation operates rifle, pistol, trap and skeet ranges at the Blue Mountain Sportsman’s Center (Center). Faced with suit and regulatory action under the Resource Conservation and Recovery Act (RCRA), the county entered an Administrative Order on Consent with the U.S. Environmental Protection Agency regarding environmental impact analysis and potential remediation at the Center. As part of the compliance with the order, a human health and ecological risk assessment was conducted at the ranges. The purpose was to identify and quantify risks to provide a basis for determining whether remediation was warranted and, if so, what specific actions would be most appropriate. The results of the human health and ecological risk assessment are published in the scientific literature (Peddicord and LaKind 2000), and summarized below.

Ecological receptors of concern (ROC) included red-tailed hawks, white-tailed deer, red foxes, ruffed grouse, robins, eastern phoebes, field mice and cottontail rabbits. Contaminants of concern (COC) were lead, arsenic, antimony, copper, zinc and polycyclic aromatic hydrocarbons (PAH) associated with the clay targets on the shotgun range. Exposure pathways involved incidental ingestion of shot by birds while feeding; incidental ingestion of shot by deer, rabbits and mice while feeding; and consumption of contaminated water or food (including prey) by all species.

Risks were minimal to all ecological receptors at the Center from all contaminants of concern (except lead) acting through all exposure pathways. Lead at the Center posed no increased risk to hawks or other raptors, foxes or deer. Lead in dietary items posed a risk to individual grit-ingesting birds (i.e., ruffed grouse) and a small risk to individual birds that do not ingest grit (i.e.,

phoebe and robins). Individual grit-ingesting birds (i.e., ruffed grouse) also were at risk from the incidental ingestion of lead shot within the shotfall zone at the Center's trap and skeet range. Lead in dietary items posed no more than a minor potential for risk to individual small mammals (i.e., rabbits and mice). If a small mammal were to ingest lead shot, it would be at risk, but there was no direct evidence of these animals actually ingesting shot, and the likelihood of them doing so was considered small. Risks associated with lead at the Center may occur at the level of individual organisms. Although individual small mammals and grit-ingesting birds may be at risk from shot ingestion, ecological impacts were not expected at the population, community or ecosystem levels. This was because the small proportion of the total range of the local populations represented by the site and, thus, the small proportion of the populations' total activity on the site, made the potential for population-level impacts slight.

Human receptors included shooters, range maintenance workers, range officers, and children and adults trespassers. Human COC were the same as those for ecological receptors. The potential exposure pathways for shooters near the firing line were incidental ingestion of soil via hand-to-mouth activities (i.e., eating, smoking) and inhalation of dust. The potential exposure pathways for employees were inhaling dust, and incidental ingestion of soil, sediment or water in the areas occupied by employees engaged in maintenance and range officer activities. The potential exposure pathways for trespassers included incidental ingestion of soil and surface water by adult and child trespassers engaged in unauthorized hunting, hiking and playing; incidental ingestion of sediment by child trespassers playing in the stream running through the ranges; and ingestion of deer taken from the Center grounds by adult trespassers engaged in unauthorized hunting.

Cancer risks to all human receptors from all COC via all exposure pathways were less than 10^{-4} (e.g., less than 1 in 10,000), generally considered an acceptable upper bound excess lifetime cancer risk to an individual. The only noncarcinogenic risk was a preliminary indication of risk associated with inhalation of copper by frequent shooters. Two approaches were taken to modeling blood lead in children associated with intermittent exposure via the pathways evaluated. Under the most likely exposure scenario, the mean blood lead level of trespassing children was approximately 2 $\mu\text{g}/\text{dL}$, with less than 1 percent of children exceeding the 10 $\mu\text{g}/\text{dL}$ level of concern. Higher blood lead levels could be possible if children were to play in off-limit areas of the shooting range (e.g., backstop berms and the shotfall zone at the trap and skeet range).

The quantitative ecological and human health risk assessment demonstrated that risks to most ROC from most COC through all exposure pathways were negligible. It identified specific receptors potentially at risk from lead associated with particular activities and provided an estimate of the magnitude of those risks. This provided an objective basis for identifying and recommending efficient and cost-effective actions designed to minimize the actual risks specific to the Blue Mountain Sportsman's Center. Implementation of those actions now is being planned.

Inappropriate Application of Risk Assessment at Shooting Ranges

In the mid- to late 1990s, a federal agency had a consulting firm conduct a risk assessment at a range operated by a gun club on agency land in the Southwest. The club intended to continue operating the range after modifying facilities or operations as necessary for environmental reasons. While the government contractor apparently performed the various environmental tests

correctly, the risk assessment was flawed in several fundamental ways, including focusing on requirements of inappropriate law and regulations, not developing and following a realistic site model with plausible exposure pathways, inadequate exposure assessment, and inadequate consideration of uncertainties. These issues are described briefly below to illustrate how improper framing of a risk assessment can lead to unwarranted conclusions and give them an appearance of objectivity.

Inappropriate Law and Regulations

The environmental evaluation was inappropriately focused from the very beginning. Although the range was in operation and planned to remain so, it was evaluated as if it were a CERCLA site. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) is a federal statute geared toward a one-time fix of a terminated activity, particularly if a responsible owner cannot be identified. The range in question did not fit any aspect of this description nor do many ranges at which environmental assessments may be done in the future.

Although CERCLA investigations often use the complex risk assessment methodology originally developed primarily for that purpose, the basic risk assessment principles also can be applied beneficially at initial screening and moderate levels of complexity. The risk assessment process readily can be applied entirely independently of CERCLA. While risk assessment is a useful approach for environmental evaluations at ranges, CERCLA is neither necessary nor appropriate from technical or regulatory perspectives for comprehensive, reliable and technically sound evaluation and management of outdoor shooting ranges. Comprehensive environmental evaluations, including thorough, quantitative human health and ecological risk assessments, have been conducted at shooting ranges and appropriate management programs implemented without the use of CERCLA.

CERCLA is as much about quantifying and assigning response, compensation and especially liability, as it is about environmental protection. It is possible to conduct environmentally sound evaluation and management under CERCLA. However, under CERCLA, the process is nearly as important as the outcome. While CERCLA is appropriate in situations for which it was designed, it easily can be misapplied to other types of sites. The CERCLA process does little to encourage environmentally sound evaluations and may discourage them in a variety of ways. The CERCLA process can tend to constrain thinking to well-established, routine patterns which sometimes can interfere with formulating effective but non-routine solutions. Some of the presumptions and thought patterns encouraged by the CERCLA process include:

- The formal and compartmentalized CERCLA format can hinder innovation.. An integrated, multi-faceted evaluation does not fit neatly into the standard CERCLA compartments. Development and evaluation of such approaches is possible and fully compatible with CERCLA, but the CERCLA process hinders innovation, including environmental stewardship-based approaches to range management.*
- CERCLA fosters overly pessimistic, preconceived ideas about the range, such as the attitude that because CERCLA is being applied, this must be a hazardous waste site. If a range is not viewed in a CERCLA context, the targets, bullets and shot would be viewed as materials, rather than as CERCLA wastes. Concerns would be based on the characteristics of the materials, the environment in which they occur and*

the resources potentially at risk, rather than their CERCLA “hazardous” components. The resulting evaluation could be comprehensive, thorough and rigorous, but would avoid all the artificial regulatory implications of CERCLA.

- CERCLA is not intended for evaluation and management of continuing operation of the facility in question. CERCLA is geared toward a one-time fix of a terminated activity. It is not amenable to evaluation of ongoing activities at a shooting range with the goal of continuing operation in an environmentally sound manner. Therefore, evaluations conducted under CERCLA typically give little consideration to future operation of the range, and an environmental stewardship-based approach typically is not considered. This characteristic makes CERCLA inappropriate for most shooting range issues.
- Most CERCLA investigations focus almost entirely on human health and pay disproportionately little attention to ecological issues. CERCLA consists of two components that, in practice, often are treated as distinct stand-alone parts. CERCLA includes the Natural Resource Damage Assessment (NRDA) regulations. NRDA basically address ecological impacts of activities that are not ongoing, and comes into play only under specific conditions. These conditions are not part of the other stand-alone component of CERCLA, typically thought of when CERCLA is mentioned, which focuses primarily on human health impacts of activities that have been terminated. Thus, the typical CERCLA approach often is not appropriate for thorough evaluation and management of environmental issues that include ecological concerns. The example evaluation used the following contrived approach to increase the weight of ecological considerations in the CERCLA evaluation. Ecological screening concentrations do not meet the CERCLA definition of Applicable or Relevant and Appropriate Requirements (ARAR), so they were not used as such. Instead, ecological screening concentrations were used to establish the site-specific target levels (SSTLs) for clean up, and thus, were given a major role that ecological criteria would not otherwise have had in the CERCLA process. At best, this is a contrived way around CERCLA’s lack of emphasis on ecological issues.
- The CERCLA process can result in artificial approaches that are used only because they are administrative parts of CERCLA. The ARAR process illustrates this: The whole ARAR concept is an administrative artifact of the CERCLA approach and is not necessary for a complete site evaluation and environmentally protective management of any problems identified. The example evaluation presented no basis for considering concentrations of contaminants in soil set by the state environmental agency as screening level upper thresholds of safety in residential soil to be either applicable or relevant and appropriate for this non-residential site, yet they were used as ARARs and formed a major basis for the entire evaluation. This appears to be a case of the tail wagging the dog. Because of a CERCLA mindset from the start, ARARs were needed, and the soil threshold values were used because they were the only local soil values available. The result was that a risk was identified because of the process used, not because environmental conditions actually posed a real risk. The proper process would have conducted a risk-based evaluation, with little reliance on outside reference values, such as the soil threshold values, and complete avoidance of administratively imposed artificial procedures not necessary for thorough evaluation and management.

- CERCLA encourages excessive, complex and expensive actions. Because 1) CERCLA predisposes thinking in terms of hazardous waste, and 2) CERCLA hazardous waste sites often are associated with large and potentially open-ended, long-term liabilities, the tendency is to favor excessive, complex and expensive once-and-for-all actions. In situations where CERCLA has been imposed but an environmentally sound evaluation has not been conducted, the result typically is an unnecessarily complex and expensive action that achieves no greater human health or environmental protection than would have been accomplished if CERCLA had not been imposed. The excessive costs without commensurate benefits often are borne largely by the range operator and landowner.

Unrealistic Site Model

The inappropriate risk assessment in the example under discussion approached the range as a set of discrete areas and evaluated each separately with little emphasis on the whole. Not only did this conceptual site model discourage an integrated evaluation of the overall environmental status of the range, it was based on inadequate understanding of range operations that resulted in evaluation of implausible exposure pathways, identification of risk where actual risks were very low and an overall impression that conditions at the range were far worse than they actually were.

The human health risk assessment divided the rifle/pistol range into multiple areas (e.g., firing lines, range floor in front of the targets, berms and downrange area beyond the berms), and evaluated risks independently in each area. Some of the fundamental assumptions of the risk assessment and the critique of those assumptions follow.

- Assumption: Shooters and workers were assumed to spend their entire time at the range (and thus receive their full exposure to the COC) in each of the areas.
- Critique: This is logically impossible. A person can only be in one place at a time. At the most extreme, a person could spend his/her entire time at the range (and receive their exposure to COC) in any one of the areas, which would mean no time in any of the other areas. More realistically, a shooter might divide his/her time among the areas, with nearly all the time being at the firing points of the rifle/pistol range or the trap/skeet range.

This also is completely unreasonable for the range floor, berms and downrange areas. The exposure assumptions for these areas were so illogical as to be meaningless:

The area incorrectly called the firing line actually was the range floor between the firing points and the targets. Typical range safety rules enforced by a range officer allow shooters to be in this area (if at all) only during very short, infrequent and strictly enforced cease-fire periods to check/replace targets. There is no reason for shooters or workers to spend more than occasional brief period in this area.

There is no reason at all for any shooter to go onto a berm, and this typically is against safety rules. Workers might be expected to spend a few days per year repairing berms. Any worker that attempted to spend his/her entire 40-hour work week on the berms throughout a 30-year career, as assumed in the example risk assessment, would seem very unlikely to remain an employee for 30 years.

The so-called downrange area actually was behind the backstop berms. There is nothing in this area to be repaired or maintained. If there is little reason for shooters or workers to visit the berms, there is even less reason for them to ever go downrange, let alone spend their entire time at the range in this area.

- Assumption: All human health evaluations in the example risk assessment assumed exposure over the entire area to the highest concentration measured anywhere in the area.
- Critique: Four samples were taken from the firing line to be analyzed for antimony. The antimony concentrations in these four samples were not detectable, 27, 52 and 2,700 mg/kg or parts per million. The risk assessment was based on an assumed exposure to 2,700 mg/kg at all points in the firing line area, which is an obvious over-statement of possible exposure. The firing line measured 3 feet by 417 feet for a total area of 1,251 square feet. The risk assessment assumed that workers spent their entire 40-hour work week within this area for their entire 30 years of employment at the range.
- Assumption: Concentrations of contaminants in soil set by the state environmental agency as upper thresholds of safety for soil are a sufficient basis for identifying risk, even absent demonstration of complete exposure pathways.
- Critique: The example risk assessment based many of its evaluations on concentrations of contaminants in soil set by the state environmental agency as upper thresholds of safety for soil in residential and non-residential areas. The thresholds were developed as concentrations in soil above which there is sufficient concern to warrant further site-specific study. The residential values are soil concentrations considered the upper threshold of safety for a resident who ingests 0.1 gram of soil (about the equivalent size of an aspirin tablet) every day for 30 years. This might be possible, for example, for an avid home gardener who habitually eats or smokes with dirty hands, but it seems highly unlikely at a shooting range. The use of residential values at a site that was not residential and at which residences were not even considered a possible future land use is not justified. Even though no complete exposure pathways were demonstrated, exceeding a residential value was wrongly considered a demonstration of risk to human health, inconsistent with the stated purpose of the values as merely a justification for further site-specific study. Even if the completely unreasonable amount of time assumed spent on the firing line were correct, there was no discussion of plausible activities (i.e., complete exposure pathways) that would cause workers to actually ingest 0.1 g of soil every day for 30 years. Lacking demonstration of a complete and plausible exposure pathway, there is no basis for stating that a human health risk exists.

Incomplete or Implausible Exposure Pathways

The analyses described in the example risk assessment for all samples measure total contaminant present and cannot distinguish environmentally inactive forms of the contaminants from potentially biologically active forms. This distinction is especially important for metals, since all soils contain some metals in completely inactive ore forms, and a substantial proportion of the remaining metal in environmentally inactive forms. The example risk assessment states that the climate at the range was highly unlikely to produce the more soluble forms of lead. This is important because the less soluble lead forms that are produced by the range climate also are less

environmentally active and less biologically available. This is crucial to the issue of complete exposure pathways, without which a risk cannot exist. Complete exposure pathways were not demonstrated in the example risk assessment, and the form of lead is important in this crucial shortcoming.

In addition to the inadequate treatment of various potential human exposure pathways described above, potential ecological exposure pathways also were inadequately demonstrated. For example, plant samples were collected at 10 locations around the range, including one background location, as a basis for evaluating contaminant effects on plants. Only two non-background samples were the same species of plant as the background sample. Only for these two samples can the elevation (if any) above background be determined. There apparently was no attempt to remove surficial soil or dust before analysis, nor any other attempts to distinguish lead on the plant leaves or roots from lead in the plants; the data must be assumed to reflect the combination of both. Therefore, there was no basis for determining whether lead 1) was taken into or absorbed by the plants; or 2) presented an ecological risk to the plants, since external lead would not affect the plants. The report stated that the distribution of plant lead data corresponded to the distribution of soil lead data and that this correspondence may indicate that lead had been incorporated into plants from the soil. This ignores the possibility that the plant data reflected primarily lead associated with soil on the surface of the plants or clinging to the roots. Any such soil would contribute to the total lead measured in the analysis but would be no more biologically available than any other lead associated with the soil.

Inadequate Exposure Assessment

Air was sampled to provide a basis for determining human risks from airborne contaminants. The air sampling results were presented but then dismissed in favor of speculation. The air sampling consisted of an average of 8.5 hours of sampling spread over a four-day period to account for variations in wind speed and direction. Samples were collected during the day to simulate the most active worker and recreational user periods at the range. The samples were collected on four days with light wind, even though high winds had been observed at the range, and no reason was given that sampling could not have included windy days. No metals were detected in the air samples. The report suggests that dust inhalation did not present a risk during periods of light wind, and then dismisses this as misleading, since samples were not collected overnight when winds can increase. However, samples were specifically collected during daylight because this is when people are present. Samples could have been collected any time of day, and the fact that the sampling time selected did not show metals in the air is no reason to dismiss the data. Later the report rejects the air data in favor of speculation about what might happen under conditions that could have been sampled, but consciously were not. The likelihood of fewer people being outdoors at the range during conditions of high wind-blown dust or at night, or the wind mixing and diluting dust from the range with dust from the surrounding area were not considered.

Inadequate Consideration of Uncertainties

The discussion of uncertainty in the example is typical of most risk assessment documents in failing utterly to give the reader any realistic appreciation for whether risks might have been under- or overestimated, and by how much. For example, the report says the assumption that the

highest contaminant value measured was representative of the entire area “contributes to uncertainty.” This is standard language, and tells the reader almost nothing. The reader should have been reminded in the uncertainty discussion that this approach was used and that it clearly overestimates potential exposure, as evidenced by all the lower measured concentrations that were ignored. Many important uncertainties were not mentioned, including the following that contribute to overestimation of risk:

- no plausible human health or ecological exposure pathways were even hypothesized;
- assumption that a worker spends his/her entire career in each of the areas evaluated;
- assumption that a shooter spends his/her entire time at the range in each of the areas evaluated;
- assumption that a worker or shooter stays in the berm or downrange areas, when, in reality, more than an occasional brief visit is extremely unlikely;
- application of residential soil threshold values in nonresidential areas; and
- assumption that soil threshold values indicate risk, which, when developed, merely show need for further site-specific investigation.

Toxicity Characteristic Leaching Procedure (TCLP)

The toxicity characteristic leaching procedure (TCLP) often is applied at ranges by agencies and their contractors in a misguided attempt to provide a simple evaluation of environmental risks. The TCLP is a soil extract and analysis procedure with a designed purpose of determining whether a waste is classifiable as “hazardous” under the Resource Conservation and Recovery Act (RCRA). It determines the environmental activity of a particular waste under conditions typical of municipal landfills containing household refuse. It is a laboratory simulation that attempts to measure the extent to which certain components of the waste will dissolve and leach into water under the acid conditions typical of municipal landfills. The conditions typical of municipal landfills are very different from conditions that exist at many ranges. Therefore, the TCLP test does not accurately predict the environmental activity of lead at many ranges.

Under the regulations, TCLP is designed and used for characterizing wastes. It should not be applied to materials that do not meet the RCRA definition of waste, i.e., materials that are not intended for disposal. Even so, agencies and their contractors commonly use it in attempts to evaluate environmental conditions at ranges. The TCLP conditions simulating a municipal landfill are much harsher than conditions typical of most outdoor ranges. Therefore, TCLP typically removes much more lead from bullets, shot or soil than would be removed under the natural conditions occurring at most ranges. Consequently, if TCLP is used to evaluate environmental conditions at a range, it usually grossly overestimates any potential problem that may exist. Thorough screening of soil to remove shot, bullets or lead particles before any testing is conducted on range soils will lessen the extent to which TCLP overestimates potential problems, but it will not eliminate this overestimation. The appropriate applications, common misapplications and more useful alternatives to TCLP and the related Synthetic Precipitation Leachate Procedure (SPLP) are discussed in the National Shooting Sports Foundation’s *Synopsis of Applications and Limitations of TCLP and SPLP at Outdoor Shooting Ranges* (NSSF 1998).

Conclusions

Risk assessment provides an appropriate and useful framework for structuring environmental evaluations at outdoor shooting ranges. Federal and state regulatory agencies, academia and the courts accept risk assessment. Risk assessments can be conducted at any level of detail, from a simple screening level through more detailed evaluations to the most complex investigations. Properly applied, risk assessment has been a useful approach for documenting minimal effects at ranges, identifying specific environmental issues that do exist and identifying possible approaches for resolving those specific issues. However, the flexibility that allows risk assessment to be tailored to specific situations also allows it to be misapplied. Possible misapplications in the general areas of focusing on requirements of inappropriate law and regulations, not developing and following a realistic site model with plausible exposure pathways, inadequate exposure assessment and inadequate consideration of uncertainties are illustrated above. From the discussion in this paper, it is clear that no single test can replace an objective consideration of receptors, contaminants, effects and exposure in a risk assessment context. As environmental attention to ranges increases in the future, someone associated with every range should become aware of basic environmental issues the range may face and be prepared to work knowledgably with their own consultants or with regulators to protect their interests if environmental evaluations of the range are conducted.

References

- National Shooting Sports Foundation. 1998. Synopsis of applications and limitations of TCLP and SPLP at outdoor shooting ranges. Facility Development Ser. No. 4. National Shooting Sports Foundation, Newtown, CT.*
- Peddicord, R. K. and J. L. LaKind. 2000. Ecological and human health risks at an outdoor firing range. Vol. 19, No 10. Environmental Toxicology and Chemistry, pages 2,602-2,613.*

Contacts

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