

Sampling Strategy for Environmental Safety Hazards at Recreational Shooting Sites

Bureau of Land Management (BLM)

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Submitted by:

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Acronyms

Acronym	Definition
ADEQ	Arizona Department of Environmental Quality
ANOVA	Analysis of Variance
ASQC	American Society of Quality Control
ATSDR	Agency for Toxic Substances and Disease Registry
BLM	Bureau of Land Management
BTV	Background Threshold Value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COI	Constituents of Interest
CSM	Conceptual Site Model
DOD	Department of Defense
DQO	Data Quality Objective
DU	Decision Unit
EB	Equipment Blank
EPA	Environmental Protection Agency
ERDC	Engineering Research and Development Center
FD	Field Duplicate
HASP	Health and Safety Plan
HPLC	High-Performance Liquid Chromatography
HSG	Herndon Solutions Group
IDW	Investigation-Derived Waste
ISM	Incremental Sampling Methodology
ITRC	Interstate Technology and Regulatory Council
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NRCS	National Resources Conservation Service
PAH	Polycyclic Aromatic Hydrocarbon
QA	Quality Assurance
QC	Quality Control
RBA	Relative Bioavailability
RBSL	Risk-Based Screening Level
SAP	Sampling and Analysis Plan
SIM	Selected Ion Monitoring
SLRA	Screening-Level Risk Assessment
SPLP	Synthetic Precipitation Leaching Procedure
SSCS	Site-Specific Calibration Standard
TCLP	Toxicity Characteristic Leaching Procedure
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

Recreational shooting is a long-standing and allowable use of the Bureau of Land Management (BLM) managed public lands. Over time, recreational target shooting at some sites has come to pose an unknown and unquantified potential risk through deposition of lead and other substances likely present as summarized in **Table 1-1**. Due to the variability of sites based on location, accessibility, use frequency, presence or absence of maintenance, and defined or undefined shooting lanes, among other conditions, a common sampling and analytical approach is needed to allow relative ranking of BLM recreational shooting areas or sites for potential risk mitigation and land-use decision making by managers.

Table 1-1. Contaminants Often Found at Small Arms Firing Areas*

Constituent	Comment
Lead	▪ Primary constituent of most projectiles
Lead Styphnate/Lead Azide	▪ Primary constituent of most primers
Antimony	▪ Increases projectile hardness
Antimony Sulfide	▪ Used in most primer compounds
Arsenic	▪ Present in lead (A small amount of arsenic is necessary in the production of small shot to increase the surface tension of dropped lead, thereby improving lead shot roundness.)
Copper Bullet Core Alloy	▪ Increases projectile hardness ▪ Sometimes a primary alloy in center-fire ammunition and some small caliber rifle bullets; also used in frangible pistol ammunition
Tin	▪ Increases projectile hardness
Copper and Zinc	▪ Jacket alloy metal
Iron	▪ Iron tips on penetrator rounds
Tungsten	▪ Alternative projectile material to lead
Nickel	▪ Coating to improve shot performance ▪ Alloy in center-fire ammunition
Cobalt and Chromium	▪ Alloys in some ammunition rounds
PAHs (polycyclic aromatic hydrocarbons)	▪ Concentration of PAHs in clay targets varies from one manufacturer to the next but may be as high as 1,000 milligram per kilogram (mg/kg). Existing studies show that PAHs bound within limestone matrixes may not be bioavailable.

** Information obtained from Interstate Technology and Regulatory Council (ITRC) (2003 and 2005). Note that this information is for small arms firing ranges. Other materials may be found on BLM shooting areas due to the use of a variety of items as targets and unauthorized dumping.*

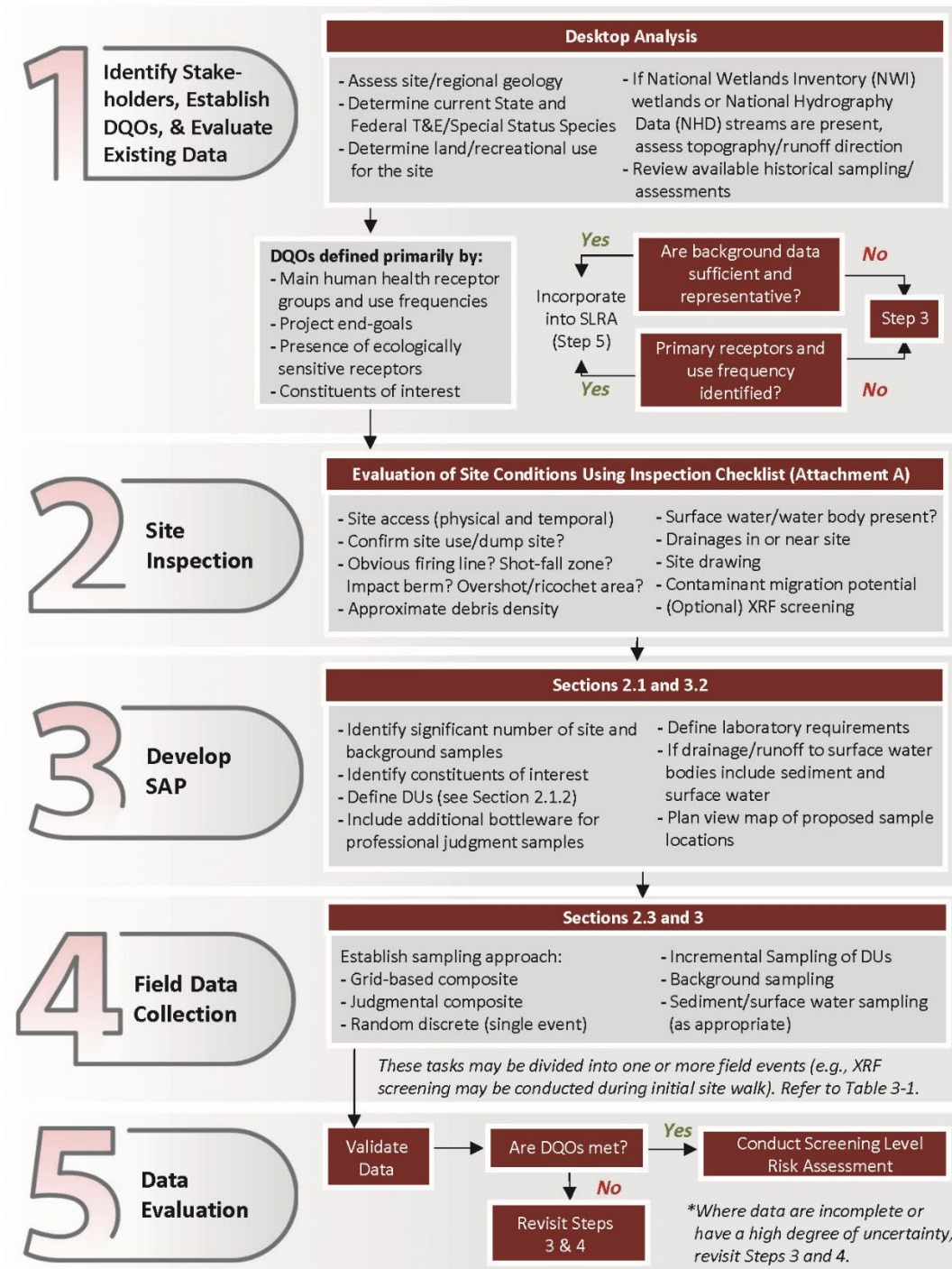
This guidance was developed to assist BLM managers and field staff in developing a sampling and analysis plan that can be tailored to site-specific needs. **Figure 1-1** provides a graphical overview of the process proposed to develop and implement a sampling plan at a recreational shooting area. The graphic also provides the location within this report of key elements of the process. **Section 2** provides a range of recommended approaches and how each can be applied to a site to meet project objectives. Details relevant to each approach are either provided in an appendix or are publicly available. **Section 3** summarizes how the approaches can be applied and used to allow sites to be compared and ranked, if needed.

This guidance was intentionally developed to allow BLM managers flexibility in developing a site-specific sampling and analysis process. It is important to note that the approach at any site should be tailored to site-specific conditions, future land use, and the intended uses of the data. BLM managers will also need

to adapt their approaches to a site based on current BLM policies, the requirements and concerns of regulators and local communities, and knowledge of the site users.

This guidance will not result in a one-size-fits-all sampling plan, rather it aims to generate results that would enable a systematic ranking and comparison of recreational shooting areas across BLM land management areas.

Figure 1-1. Process Overview



2.0 REVIEW AND COMPARISON OF AVAILABLE INVESTIGATION APPROACHES

Many tools are available to support investigation design and planning. This section summarizes available resources and guidance documents available to support field planning and decision making. Some pros and cons of each resource are presented to allow land managers the ability to carefully consider each for applicability to a site. Recommendations and associated rationale are provided to identify preferred methods and procedures.

2.1 Developing a Sampling Approach

If decision makers are to have the necessary confidence in the quality of environmental data used to support their decisions, there must be a structured process for quality (U.S. Environmental Protection Agency [EPA] 2001). EPA's policy for quality planning is based on American National Standards Institute/American Society of Quality Control (ASQC) E4-1994, Specifications and Guidelines for Environmental Data Collection and Environmental Technology Programs (ASQC 1994).

2.1.1 Data Quality Objectives (DQOs)

One of the critical steps in quality planning is defining the DQOs for each site/project. It is important to determine the project's end goals and support the risk management decision process. The development of DQOs is the EPA's recommended planning process when environmental data are used to select between two alternatives or derive an estimate of contamination. The DQO process is used to develop performance and acceptance criteria that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. For more information on the DQO process, see *Guidance on Systematic Planning Using the Data Quality Objectives Process* (QA/G-4) (EPA 2006).

2.1.2 Initial Planning and Evaluation

The following list of items are needed to support the planning and design of a defensible sampling plan. An overview of the inputs needed to support sample design is presented in **Figure 2-1**.

DQOs. Decide on end goals and study questions and formulate the risk management decision process. The seven steps of the DQO process include 1) state the problem, 2) identify the decision, 3) identify the inputs to the decision, 4) define the boundaries of the study, 5) develop a decision rule, 6) specify tolerable limits on decision errors, and 7) optimize the design for obtaining data.

Historical Documents. Identify historical and recent aerial photographs, historical investigation results/assessments, U.S. Geological Survey (USGS) maps/papers, and other state or agency documents to understand past use and anticipate site conditions such as steep topography and limited access roads that may impact field planning. This process should also identify potential, nearby surface water bodies or wetlands; associated drainage or migration pathways; and sensitive ecological receptors present in the area.

Kick-Off Meeting. Identify needed personnel to consider information gleaned during the document review, plan for the site visit by identifying areas of concern (such as potential access restrictions or known physical hazards), classify site conditions, and categorize maintenance. **Attachment A** includes a questionnaire to ensure that common items, such as history of the site, maintenance history, a description of operations, and environmental conditions and habitat, are not missed and to formally document the meeting.

Initial Site Visit and Evaluation. Due to variability of these shooting areas across states and regions within states, it is important to conduct a thorough site visit and initial evaluation. The site visit checklist presented in **Attachment A** is recommended to verify conditions at the site and increase the likelihood that necessary data are collected. In addition to the checklist, the following are recommended:

- A global positioning system or similar tool to collect coordinates of the site visit sample locations, background sample area, debris extent, and relevant items.
- Photographs to document the existing site conditions.
- An x-ray fluorescence (XRF) tool to evaluate initial concentrations relative to background or historical data; refine the sample area; and help identify hot spots, laboratory confirmation sample locations, and decision units (DUs).
- A mesh screen to estimate bullet or debris density (fragment, debris, or bullet counts per 1 square foot area).
- A recent aerial photograph for documenting sample locations, debris areas and associated debris density, illegal dump locations (if present), and other relevant observations.

The site visit should identify the following:

- Extent of potential contamination
- Representative background location
- Presence and location of firing lines/preferred shooting angles
- Other site uses (such as waste dumping, homeless encampment)
- Bullet or debris density (including dump sites and overshoot or ricochet areas)
- Presence, condition, and lithology of backstops
- Site access restrictions or other limitations that may impact sample design and planning
- Proximity to private property
- Presence and compositional makeup of targets and debris
- Evidence of munitions type/trap skeet use
- Drainages on site or potential for offsite transport and associated transport mechanisms
- Adjacent land use
- Condition and migration extent with respect to wetlands or surface water bodies

The site visit may include collecting background and site soil grab samples for XRF (mostly) and laboratory (subset of XRF samples) analysis. If collected, these data should identify the following:

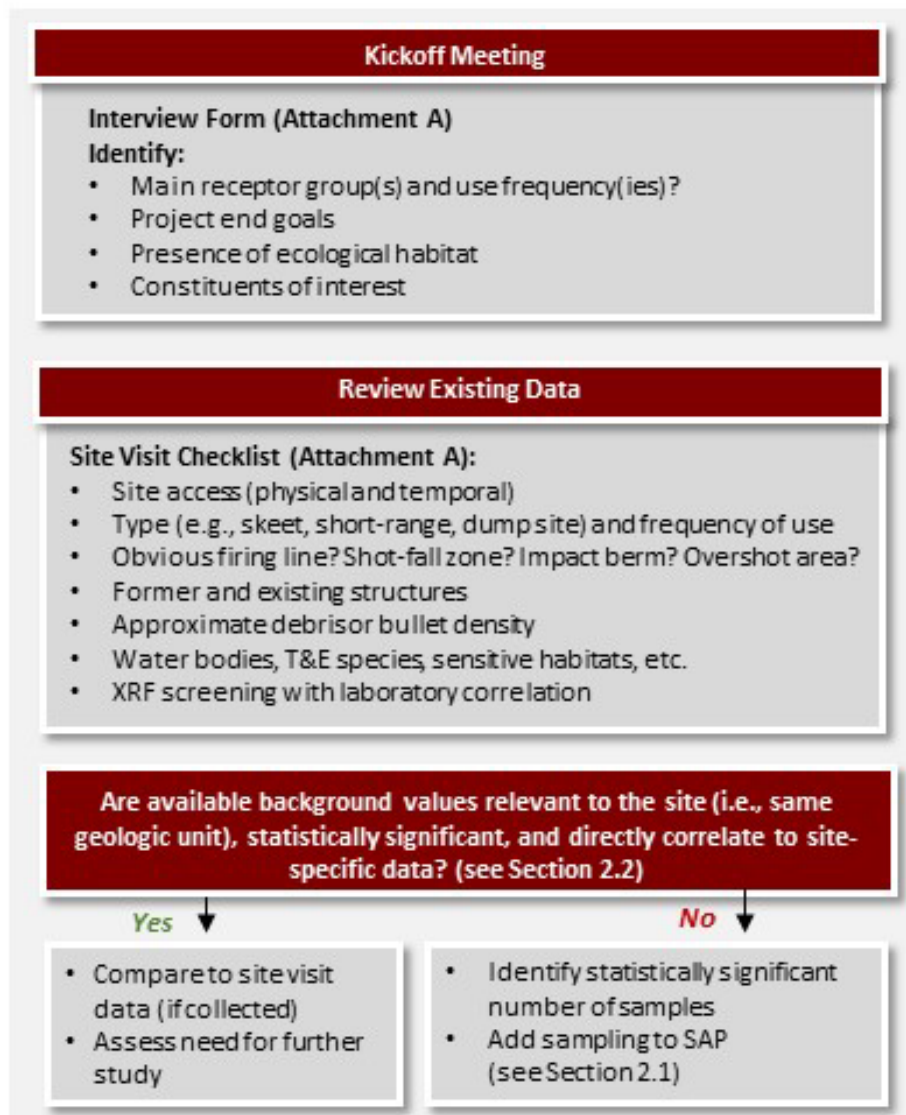
- General range of background soil concentrations for comparison to available data
- General range of shooting area soil concentrations relative to background or historical concentrations
- Whether further investigation is warranted

Conceptual Site Model (CSM). The CSM should incorporate the results of the site visit and associated soil concentrations. These data should identify whether the site warrants further investigation. The CSM will document where possible, debris areas and their relative debris density/components (including bullet density), firing lines, drainages or offsite transport mechanisms/direction, impacted media, and human and ecological receptors and associated receptor pathways.

If the site visit, sampling results (when collected), and CSM indicate a need for further investigation, DUs or study areas should be identified. The size of a DU or study area is site-specific and represents the

smallest area of soil about which a decision is to be made based on the CSM and project DQOs. Note that these sample areas may cover a large extent.

Figure 2-1. Inputs to Develop Meaningful DQOs



2.1.3 Sampling Design

Factors in selecting a sample design often include evaluating a statistical significance of results or estimating a background threshold value (BTV). **Figure 2-2** presents an overview of the inputs and constraints that should be considered when selecting a sampling approach. To support field planning, there are a growing number of software packages with statistical methods and graphic tools that address many environmental sampling and statistical issues. **Table B-1 (Attachment B)** provides a summary of both publicly available (free) and commercially available (for purchase) tools to support statistical sampling design and/or data analysis. These tools can be used to help answer how many samples are needed, where samples should be collected, what decisions are supported by existing data,

and the level of confidence that those decisions can meet DQOs. Project staff should consider using one or more of these software tools to support both planning and data evaluation.

In addition to software tools, there are studies and guidance documents available to support statistical planning. Zhang et al. presents the results of a study to determine optional sample size with a precision of ± 10 percent at a 95 percent confidence level (2016). *Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan* provides direction on statics-based sampling schemes including judgmental, simple random, stratified, systematic and grid, ranked set, adaptive cluster, and composite designs (EPA 2002a). Additional details are in **Section 2.3**.

Regardless of the planning tool/process, the most critical components are the design inputs (e.g., DQOs, historical document/aerial reviews, site inspection, field season length).

Figure 2-2. Factors in Selecting a Sampling Design

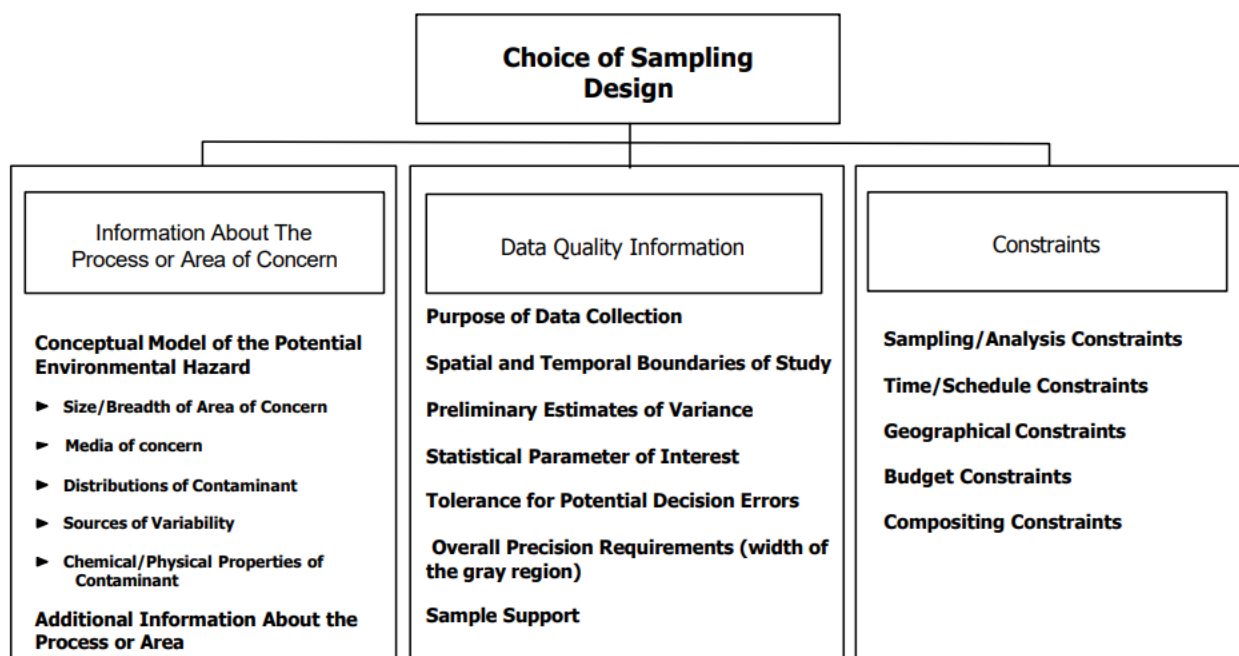


Figure from EPA, 2002a.

2.2 Establishing Background Concentrations

Establishing background concentrations is a multi-step process that begins with careful definition of the target population. This section summarizes available federal and state or local guidance for metals in background soil, additional considerations for evaluating PAHs in background soil, and factors to consider for field planning.

2.2.1 Metals

According to EPA's *Guidance for Comparing Background and Chemical Concentrations in Soil for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Sites* (EPA 2002b), background metals concentrations are necessary when establishing a site's contamination level. Background data help address issues such as the effects of past land use and establishing lower limits for screening-level risk assessments (SLRAs). The USGS Global Land Information system provides background levels for many states that may be used to augment site-specific or state-specific values.

Several states have documented state- or area-specific concentrations of metals in background soil. **Table B-2 (Attachment B)** summarizes available guidance documents for states where the majority of BLM-managed land is located. Although some states have documented concentrations of background metals (including USGS Professional Papers) where no guidance is available, EPA guidance (EPA 2002b) is recommended to establish background values. Because guidance documents were not identified for Utah and South Dakota, they are not included in the table. Additional sources of data include the National Geochemical Database: Soil, an interactive map of USGS soil studies going back to 1964, or the USGS Background Soil-Lead Survey interactive map provided by the EPA.

2.2.2 Polycyclic Aromatic Hydrocarbons (PAHs)

Similar to metals, PAHs are naturally occurring compounds and are ubiquitous in the environment requiring an estimate of background concentrations. PAHs are produced by combustion of fossil fuels, structural fires, wildfires, and volcanoes (Agency for Toxic Substances and Disease Registry [ATSDR] 1995). Other anthropogenic sources that may not be site-related include:

- Burning fuels such as coal, wood, petroleum, petroleum products, or oil;
- Burning refuse, used tires, polypropylene, or polystyrene;
- Coke production; and
- Motor vehicle exhaust (ATSDR 2009).

Because PAHs may be present at a site, a multiple-lines-of-evidence approach should be used to evaluate the need for PAH analysis. Historical document review and site visit should identify whether clay targets were used at the site or whether there is evidence of campfires. The presence of either of these conditions warrant sampling and analysis for PAHs and, subsequently, an evaluation of background concentrations. Although background studies have been conducted at various states and countries, concentrations vary based on site history; therefore, collecting site-specific background concentrations that are representative of unimpacted site conditions is recommended (Electric Power Research Institute 2008). Considerations for evaluating PAHs in local background include, but are not limited to:

- Is the area downwind of a recent forest fire?
- Has the area had a forest fire?
- Are there camping areas nearby?
- Is the site located adjacent to an asphalt road?
- Is asphalt present onsite?
- Are there buildings onsite with asphalt shingle roofs?

2.2.3 Field Planning for Background Sampling

Although some background values are available from literature, due to anticipated variability of site-specific conditions, project teams should plan to collect local background samples to augment existing data (including XRF or laboratory soil results collected during the site visit). In particular, when variable lithologic units have unique metal characteristics that may not be comparable to values in literature, PAHs are COIs, or there is potential offsite migration to a surface water body requiring evaluation of upstream conditions. In addition, samples will be needed at sites where there are no existing data. Where available, state-specific guidance for identifying the number and location of background samples and how BTVs are calculated should be followed (**Table B-2, Appendix B**).

In addition to site-specific considerations like differing geologic units, DQOs (such as when sampling is being conducted to support a presumptive remedy) may impact the number of site-specific background

samples needed; the cost of the background study should not exceed the cost of the remedy. Example considerations include:

- When the decision rationale does not rely heavily on precise background comparisons (such as where large-scale removal is planned), existing data may be appropriate.
- If the decision maker wants to minimize remediation, a carefully developed background study is recommended.

A site-specific background should consider the implications of follow-on actions such as potential land-use changes, whether presumptive remedies are being considered and what those look like (for example, large-scale versus targeted removal), or whether state-specific procedures or values are/are not representative of site conditions.

2.3 Field Sampling Approaches

A well-planned sampling design is intended to ensure that resulting data are adequately representative of the sampled area (DU, background, etc.) and defensible for their intended use. Understanding the goals of a sampling design will affect method selection. Typical objectives of a sampling design for environmental data collection are:

- To support a decision about whether contamination levels exceed a threshold of unacceptable risk.
- To determine whether certain characteristics of two populations differ by some amount.
- To estimate the mean characteristics of a population or the proportion of a population that has certain characteristics of interest.
- To identify the location of “hot spots” (areas having high levels of contamination).
- To characterize the nature and extent of contamination at a site.
- To conduct a human health or ecological risk assessment.

2.3.1 Discrete and Grab Sampling

A discrete sample differs from a grab sample in that a grab sample is an aliquot of soil collected from one location. Since 1999, small arms firing ranges have been investigated using a 22 x 22 foot area to collect several increments to form a discrete sample (ITRC 2003). Discrete sampling is also often identified as samples composited from an area typically no greater than 1 square meter (9 square feet). Increments within the discrete sample are typically collected from a five-on-a-die subsample pattern prior to compositing. For the purpose of site characterization, these smaller five-on-a-die composites are recommended for discrete sampling.

There are two main categories of discrete sampling designs: probability-based and judgmental.

Table 2-1 summarizes the main features of each. When using probabilistic sampling, the data analyst can draw quantitative conclusions about the sampled population. When using judgmental sampling, statistical analysis cannot be used to draw conclusions about the target population. Conclusions can only be drawn based on professional judgment (EPA 2002a). The remainder of this section provides additional details about various discrete sampling methods.

Table 2-1. Comparison of Probability-Based and Judgmental Sampling Strategies

	Probability-Based Sampling Strategies	Judgmental Sampling Strategies
Advantages	- Provides ability to calculate uncertainty associated with estimates. - Provides reproducible results within uncertainty limits. - Provides ability to make statistical inferences. - Can handle decision error criteria.	- Can be less expensive than probabilistic designs. - Can be very efficient with knowledge of the site. - Easy to implement.
Disadvantages	- Random locations may be difficult to locate. - An optimal design depends on an accurate conceptual model.	- Depends on expert knowledge. - Cannot reliably evaluate precision of estimates. - Depends on personal judgment to interpret data relative to study objectives.

2.3.1.1 Judgmental Sampling

Sample units are based on professional knowledge and judgment. Conclusions about the target population are limited and depend entirely on the validity and accuracy of professional judgment; ***probabilistic statements about parameters are not possible.***

2.3.1.2 Simple Random Sampling

Sampling locations are selected randomly across the sample area. This method is most useful when the population of interest is relatively homogeneous. ***Advantages are that it provides a statistically unbiased estimate of the mean, proportions, and variability across the sample area.*** It is easy to understand and implement. Also, sample size calculations and data analysis are very straight forward.

2.3.1.3 Stratified Sampling

The target population is separated into nonoverlapping subareas considered to be more homogeneous so there is less variation among sample units in the same area. Strata would be identified during the site investigation similar to the identification of a DU. This design is useful for estimating a parameter when the target population is heterogeneous and the area can be subdivided based on expected contamination levels. ***Advantages are that it has potential for achieving greater precision in estimates of the mean and variance, and that it allows computation of reliable estimates for population subgroups of special interest.***

2.3.1.4 Systemic and Grid Sampling

Sample locations are collected at regularly spaced intervals over a grid. In random systematic sampling, an initial sampling location is chosen at random and remaining samples are located according to a regular pattern (Cressie 1993). For example, at the points identified by the intersection of each line of a grid. This type of sampling can be used to search for hot spots and infer means, percentiles, spatial patterns in the data, and other parameters. ***This is a practical and easy method for designating sample locations and ensuring uniform coverage of a site.***

2.3.1.5 Ranked Set Sampling

Ranked set sampling uses a two-phase sampling design that identifies sets of field locations and uses inexpensive measurements to rank locations (such as XRF) and select one location from each set for

sampling. ***Ranked set sampling is useful when the cost of locating and ranking locations in the field is low compared to laboratory measurements.***

2.3.1.6 Adaptive Cluster Sampling

In adaptive cluster sampling, *n* samples are taken using simple random sampling, and additional samples are taken at locations where measurements exceed some threshold value. Several additional rounds of sampling and analysis may be needed. Adaptive cluster sampling tracks the selection probabilities for later phases of sampling so that an unbiased estimate of the population mean can be calculated. This method is useful for estimating rare characteristics in a population and is appropriate for inexpensive, rapid measurements. ***It enables delineating the boundaries of hot spots and using data collected with appropriate weighting to give unbiased estimates of the mean.***

2.3.2 Multi-Increment Sampling

Multi-increment sampling, or incremental sampling methodology (ISM), addresses the inherent variability from matrix heterogeneity by collecting multiple soil increments of equal mass from locations throughout a defined soil sampling area and depth interval (known as a DU) and combining the increments into a single field sample. The resulting field sample is then homogenized and processed such that it is representative of the defined DU and exposure mechanisms or assumptions (EPA 2018).

Because ISM provides excellent spatial coverage within the DU, not information on the spatial distribution within the DU, it is critical that the project team first determine the minimum spatial concentration resolution needed to meet the DQOs and establish the size of DUs to reflect this resolution (DOD 2013). To assist in defining a DU or study area, the appropriate size is when knowledge of variability within the DU is no longer important relative to the DQOs. In most cases, DUs are applied in areas that are known or thought to be fairly homogeneous or when the characterization of exposure area takes precedent over variability.

At a typical small arms firing range, areas that are normally designated as separate DUs include impact berms, firing lanes, and areas with high density of shot and/or clay targets (see **Figure 2-3**). However, BLM-managed recreational shooting areas are often characterized by numerous poorly defined or undefined firing lanes, none to several natural or man-made impact berms, and target areas that may include household items that have been dumped or randomly placed (see **Figure 2-4**). Therefore, to identify DUs, it is important to document detailed site conditions, estimate debris density using a mesh screen, and collect preliminary XRF and/or laboratory grab samples during the site visit (see **Section 2.1.2**). If information on spatial concentration variability within a DU is needed, then a smaller DU should be used (DOD 2013).

The successful implementation of ISM consists of sample design, sample collection, and a laboratory processing component discussed in more detail in **Section 2.4**. To reduce the influence of compositional and distributional heterogeneity when estimating the mean concentration of an analyte within a DU, collecting 30 or more evenly spaced increments to build a sample has been recommended (Jenkins et al. 2004a, 2004b, 2005, 2006; Walsh et al. 2005; Hewitt et al. 2005, 2007). The U.S. Army Corps of Engineers (USACE) Engineering Research and Development Center (ERDC) TR-12-1 also states that at least 30 increments would likely be needed to obtain reliable estimates of mean metal concentrations from a small arms range (2012).

Owing to the large number of increments collected within a DU, ISM tends to result in better spatial coverage and larger (and therefore more representative) sample masses for laboratory analysis than conventional grab sampling designs, which typically entail a comparatively small number of grabs.

However, multi-increment field sampling is insufficient in of itself to overcome the distributional and compositional heterogeneity in soil. Also, **ISM is not appropriate for all sites**. The following list presents examples where the use of other types of sampling designs (e.g., judgmental) and sample collection methodologies (e.g., discrete samples) should be considered (DOD 2013):

- There is some knowledge of the distribution of contaminants at the site and the project team has determined that judgmental sampling will better meet project-specific DQOs.
- Investigations where delineation of specific boundaries or delineation of the horizontal and vertical extent of contamination is required (judgmental sampling designs).
- Acute exposure assumptions where the investigation needs to determine the maximum exposure point concentration based on exposure to a small volume of soil (discrete samples).
- For data that will be used for risk assessments, ISM sample results may not be representative of exposure point conditions as they exist in-situ, if grinding has been performed. This is due to the fact that grinding changes the particle size distribution of the soil, the bioavailability of contaminants, and, therefore, the true exposure point concentrations as well. In this case, ISM can still be used, with the grinding step omitted.
- Advice on selecting appropriate sample designs may be found in Chapter 2 of *Guidance for Choosing a Sampling Design for Environmental Data Collection* (EPA 2002a). For comprehensive guidance on the implementation of ISM, refer to *Incremental Sampling Methodology* (ITRC 2012).

Figure 2-3. Typical Firing Range DUs

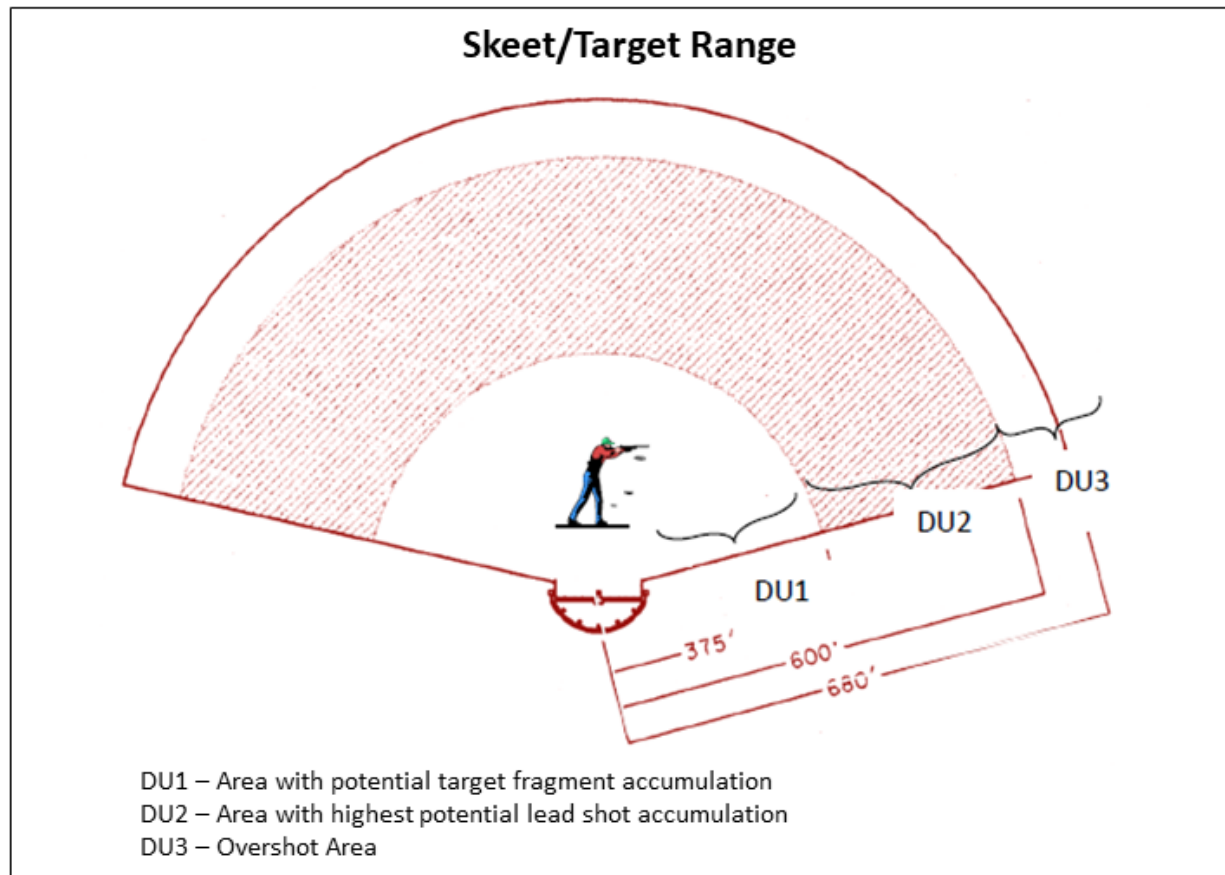
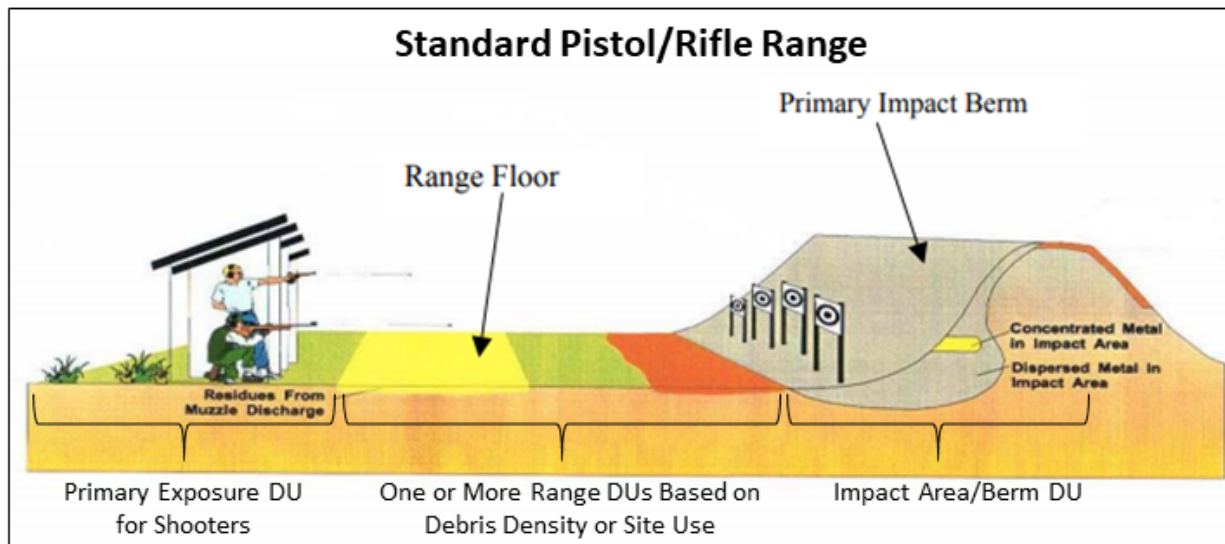
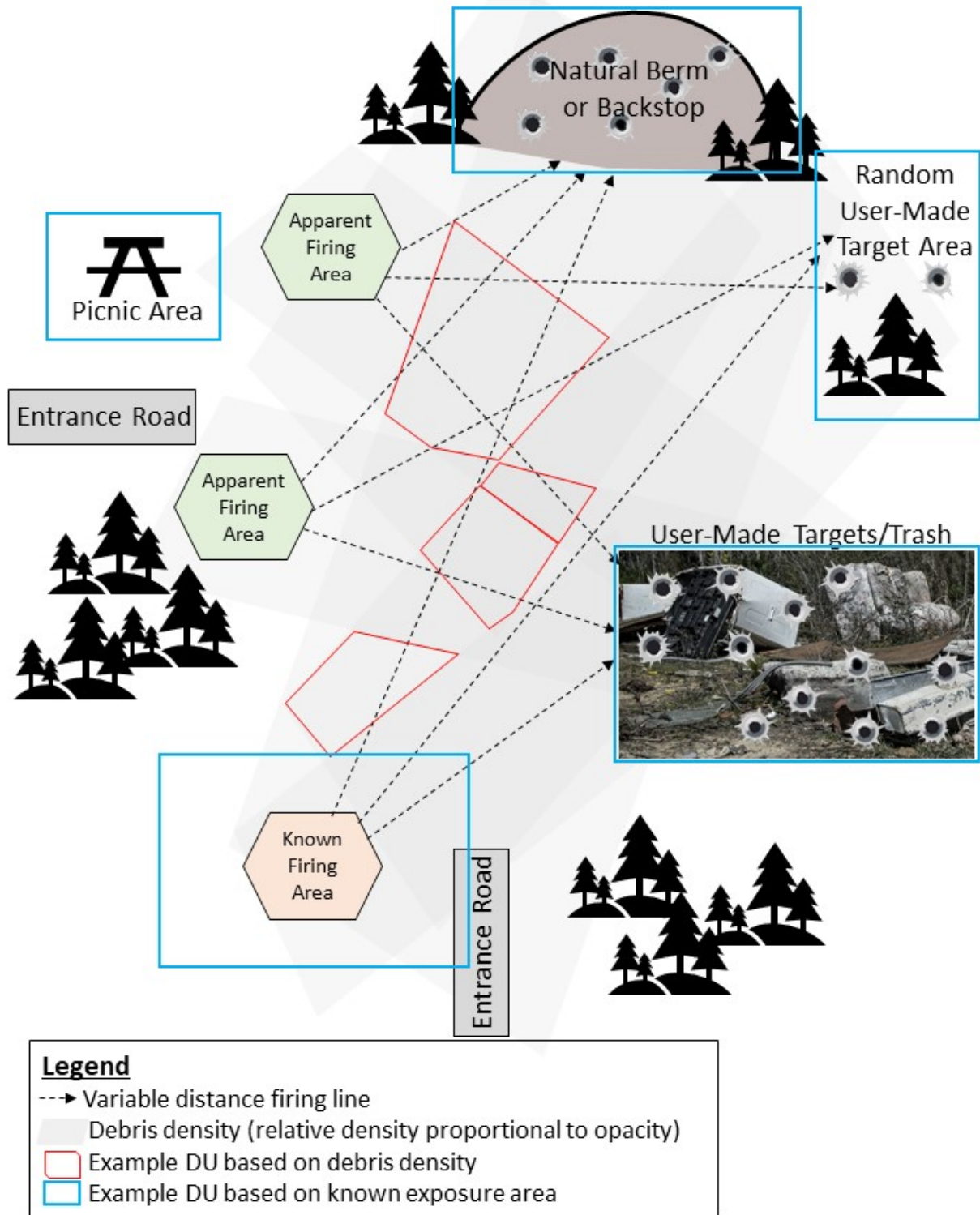


Figure 2-4. Generalized BLM Shooting Area and Example DUs



2.3.3 Sediment and Surface Water Sampling

At some sites, drainages or ecological habitat, such as riparian and forage areas, creeks, rivers, wetlands, ponds, lakes, etc. may be present, requiring sediment and/or surface water sampling. Multi-increment sampling is not used to sample these media. Discrete samples comprised of aliquots homogenized in the field or subsampled in the laboratory are collected at each sediment sample location. Surface water is collected as a grab sample by standing downstream (where appropriate) of the proposed sample location. Additional details on sediment and surface water sampling procedures are available from EPA and state-specific guidance. Please see your state's or EPA Regional website for more details. Additionally, the BLM Headquarters or National Operations Center risk assessment expert can be consulted for clarification and insight.

2.4 Analytical Methods

There are primarily two analytical methods that are used to evaluate sample results from shooting area sites. XRF, or EPA SW-846 Method 6200, is typically used in the field to assess soil and sediment concentrations with a hand-held instrument. Offsite laboratory analysis may use several methods depending on the analytes and medium of interest.

2.4.1 X-Ray Fluorescence (XRF)

XRF is a hand-held instrument that can analyze 26 metals, including each of the inorganic elements listed in **Table 1-1**. It is typically used with laboratory confirmation analyses (see **Section 2.4.2**). According to EPA, prior studies have shown that XRF measurements of lead in soil obtained using a hand-held in-situ detector closely correlate with laboratory measurements of lead in soil (EPA 2002a).

Considerations for using XRF are primarily related to precision. Generally, instrument precision is the least significant source of error. User- or application-related error is generally more significant and varies with each site and method used. It is, therefore, very important that field staff are experienced using the XRF and familiar with sources of error. The primary and controllable sources of error are summarized below (EPA 2007):

- Shorter source measurement times (30 seconds) result in decreased accuracy but may be used for initial screening and hot spot delineation; longer measurement times (up to 300 seconds) typically meet higher precision and accuracy requirements.
- Physical matrix effects result from variations in the physical character of the sample, such as particle size, uniformity, homogeneity, and surface condition. Samples may be ground, sieved, and/or homogenized to mitigate this error.
- Moisture content may affect the accuracy. When the moisture content is between 5 and 20 percent, the overall error from moisture is minimal. Error due to moisture can be minimized by drying the samples, which can be difficult and time-consuming in the field.
- Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases as the distance from the radioactive source increases. This error is minimized by maintaining the same distance between the window and each sample.
- Using a site-specific calibration standard (SSCS) is recommended to avoid interference from multiple elements that may be present at a site. The SSCS must be a well homogenized representative of the matrix and include a minimum of 10 samples spanning the concentration ranges of the analytes of

interest and relevant interfering elements. A sample size of 4 to 8 ounces in a glass sampling jar is recommended.

- Ambient temperature changes can affect the gain of the amplifiers producing instrument drift and should be accounted for if the unit does not have automatic gain control. It is standard to perform a gain check after every 10 to 20 sample measurements or once an hour, whichever is more frequent.

Additional details on instrument use, calibration, and sources of errors are detailed in Method 6200 – *Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment* (EPA 2007).

Depending on DQOs, XRF may be used to screen samples for subsequent laboratory analysis or follow EPA Method 6200 to achieve the necessary precision and accuracy to quantify metal concentrations for use in risk characterization and remedial decision making (ITRC 2003).

2.4.2 Laboratory Analytical Methods

This section briefly summarizes the laboratory analytical methods for analysis of total metals in solid or water samples, PAHs in soil, Synthetic Precipitation Leaching Procedure (SPLP) to assess leachability of metals, and Toxicity Characteristic Leaching Procedure (TCLP) for waste characterization. A summary of bioavailability analysis is also presented as this can be an important consideration for the risk assessment process, particularly where the action decision is uncertain, potentially costly, and risk-based toxicity is an important variable (e.g., a close call). Bioavailability studies usually involve special sampling and analytical techniques that should be considered at the planning stage before obligating to the decision rationale.

2.4.2.1 Metals Analysis

For metals analysis, there are two EPA SW-846-approved methods: Method 6010 – *Inductively Coupled Plasma – Optical Emission Spectrometry* and Method 6020 – *Inductively Coupled Plasma Mass Spectrometry*.

- **Method 6010** is often used for analyzing ground water, wastewater, soil, and solid waste measures contaminants for environmental safety assessment and elements with a higher regulatory limit.
- **Method 6020** is especially useful for analyzing samples with low regulatory limits. Although both methods can be used for high matrix samples, sample dilution is often necessary for use on Method 6020.

If data are planned for correlation with XRF analyses, because XRF measures the total concentration of an element, to achieve the greatest comparability of XRF to analytical methods (reduced bias) a total digestion procedure such as Method 3050B should be used for sample preparation (EPA 2007) regardless of the analytical method used.

Consideration also must be given for laboratory sample preparation methods as these methods differ for discrete and ISM samples. The use of ISM methodology also increases analytical costs. **Table 2-2** summarizes the different preparation methods.

Table 2-2. Salient Differences Between Laboratory Preparation Methods for Discrete and ISM Samples

Process	Prep Method 3050B Conventional Sampling	Prep Method 3050C Incremental Sampling Methodology
Field sampling	Not explicitly addressed in method. Typically, grab/discrete samples are collected.	An incremental sample consists of 30-100 “increments” collected randomly over the entire DU (e.g., using systematic sampling). For cohesive surface soils, an “increment” typically consists of a small cylindrical soil core (e.g., 2-5 centimeter [cm] in length) collected with a 2-4 cm diameter coring device.
Sampling mass and containers	Approximately 200 grams (g) of soil in 4-ounce, wide-mouth, amber glass jars with screw-top lids.	Typically, 1-2 kilograms of soil in clean large (e.g., 15x15 inches, 6 millimeters [mm] thick) polyethylene plastic bags sealed with Ty-wraps.
Sample drying	Sample drying is optional and not typically done.	Sample is air-dried at room temperature by spreading onto a tray to form a thin uniform slab.
Sieving	“...sieve, if appropriate and necessary, using a USS #10 sieve...” However, soil samples are typically not sieved.	Samples are passed through a #10 (2 mm) sieve. Both size fractions are weighed and < 2 mm fraction is additionally processed.
Milling	“[w]et samples may be dried, crushed, and ground to reduce sample variability,” however, milling is typically not performed.	Samples are milled using appropriate mechanical grinders such as puck or roller (ball) mills. Milling must result in finely ground material of uniform appearance and texture. Recommended 5 x 60 seconds with 1-minute cooling period for the puck mill when metals and energetics are desired. For metals only, a cooling period is not needed. Recommend 8 hours for ball mill for metals only.
Laboratory sub-sampling	“Mix the sample thoroughly to achieve homogeneity.” Soil is often stirred with a spatula or similar device (often in original container) and a single aliquot (e.g., scooped from the top of the container) collected as the subsample for digestion and analyses.	After milling, the soil is spread onto a large tray to form a thin slab of material of uniform thickness. At least 20 small aliquots are randomly collected over the entire slab with a flat-edged spatula with sides or similar device and combined to prepare a subsample for digestion and analysis.
Subsample mass	0.5-2 g wet weight or 1 g dry weight	2-10 g dry weight

Table modified from Table 23-2 of the Quality Assurance Project Plan Tool (DOD 2013).

2.4.2.2 Polycyclic Aromatic Hydrocarbons (PAHs) Analysis

Analytical methods for PAHs are generally limited to soil since PAHs are unlikely to partition to water. Methods for soil or sediment include SW-846 8310, high-performance liquid chromatography (HPLC), and SW-846 8270D Selected Ion Monitoring (SIM), which analyzes semivolatile organic compounds by gas chromatography/mass spectrometer (GCMS) SIM. PAHs may also be analyzed by Method 8100 GCMS, however, this technique is not commonly used, as HPLC and GCMS SIM can achieve lower detection limits. It is recommended that the method with the lowest detection limit is used.

2.4.2.3 Leaching Procedures

When selecting the appropriate leaching procedure, planners must decide how the data will be used. The TCLP is performed as a waste characterization method to support waste disposal efforts for

Resource Conservation and Recovery Act (RCRA)-listed compounds and elements. In the TCLP procedure the pH of the sample material is first established, and then leached with an acetic acid/sodium hydroxide solution at a 1:20 mix of sample to solvent.

The SPLP method is very similar to TCLP, but is generally specific to soil samples to evaluate the potential of contaminants in soil to leach into groundwater. SPLP simulates acid rain on soil waste materials (EPA Method 1312) to estimate the concentrations that will leach. Extraction fluid pH is a function of the region where the sample is located. Using SPLP testing provides a more realistic type of exposure for the deposited materials.

SPLP is used for site investigation areas with shallow groundwater or drainages/potential for offsite migration via runoff, and TCLP is used for waste characterization.

2.4.2.4 Bioavailability

Bioavailability is a measure of the extent of absorption of a chemical following exposure, and it can be an important consideration in the risk assessment process. Because this guidance is not designed to support a human health or ecological risk assessment, bioavailability analyses is not addressed directly. However, this may be considered when a more realistic assessment of potential risk from contamination at a site or a more accurate assessment of the need for remediation is required.

To incorporate these considerations into the risk assessment and resulting decision process, of most interest is the “relative bioavailability” (RBA), which is a measure of the bioavailability from site media (e.g., soil) relative to the bioavailability of that chemical in the toxicity study that formed the basis of the toxicity criterion. The special needs of bioavailability studies should be considered at the planning stage and typically require distinct sampling and analysis approaches as discussed in the *Draft Technical Report Incorporating Bioavailability Adjustments for Lead and Arsenic into Human Health Risk Assessments for BLM Projects* (BLM 2017a), which focuses on RBA procedures for lead and arsenic.

2.5 Quality Assurance (QA)/Quality Control (QC)

Data resulting from a sampling program can only be evaluated and interpreted with confidence when adequate QA methods and procedures have been incorporated into the sampling plan. This section summarizes recommended QC sample types. These samples are collected during field studies to evaluate field/laboratory variability.

Equipment Blank (EB). A sample of analyte-free media that has been used to rinse the sampling equipment. It is collected after completion of decontamination and prior to sampling at a location. One EB is typically collected per reusable sampling equipment per week.

Field Duplicate (FD). Useful in documenting the precision of the sampling process. FDs are used to assess improper homogenization of the samples in the field, reproducibility of sample preparation and analysis, and heterogeneity of the matrix. One FD is typically collected per 20 environmental samples per medium.

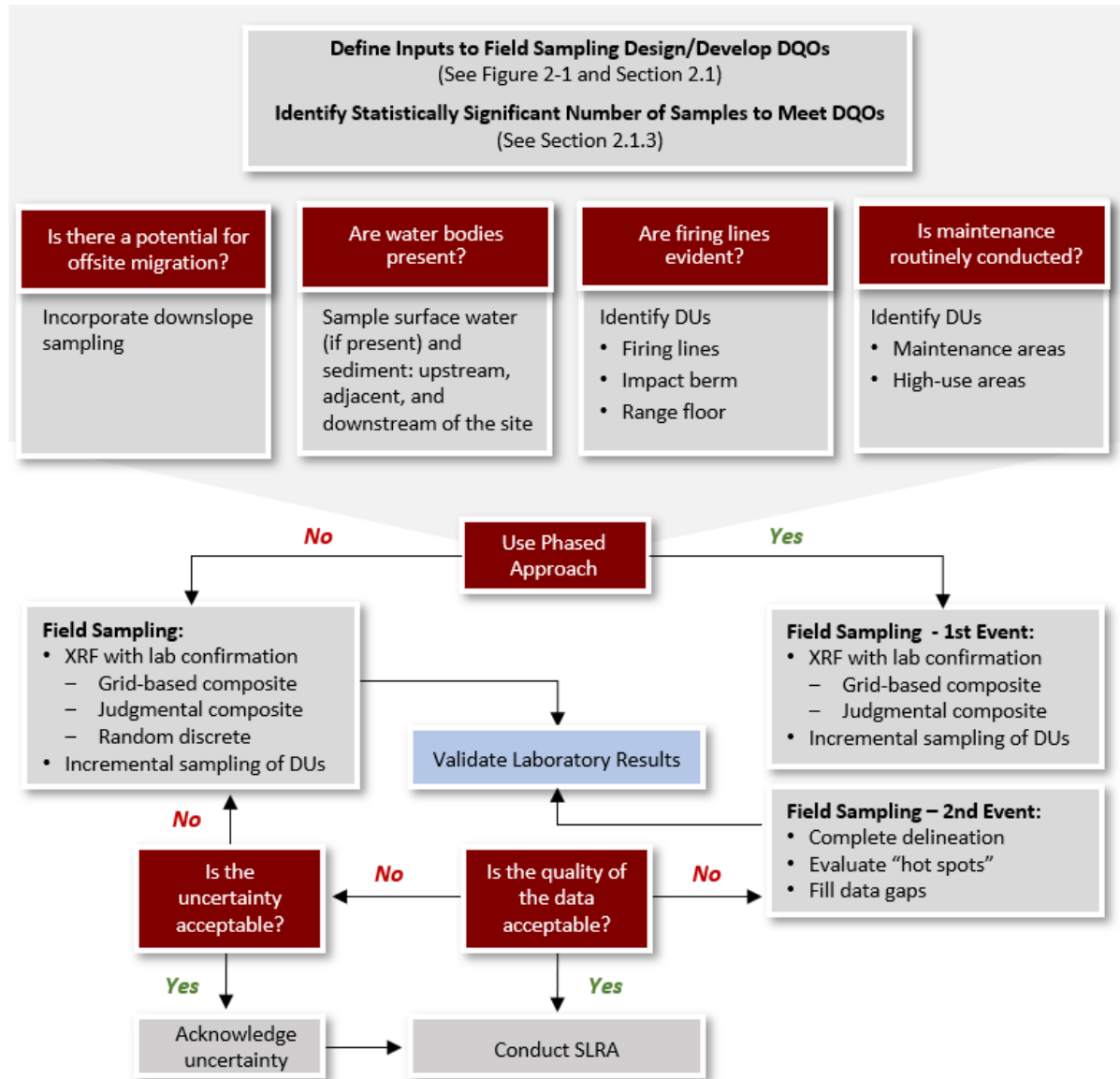
Matrix Spike (MS). An aliquot of an environmental sample to which known concentrations of target analytes have been added before sample preparation and analysis. Under ideal circumstances, the original, unspiked, field sample will be analyzed first to determine the concentration. This analysis is used to assess the performance of the method by measuring the effects of interferences caused by the sample matrix and reflects the bias of the method for the particular matrix in question. One MS is typically collected per 20 environmental samples per medium.

Matrix Spike Duplicate (MSD). Replicates of MS samples that are subjected to the same sample preparation and analytical scheme as the original sample. Analysis of spiked duplicate samples ensures a positive value, allowing for estimation of analytical precision. MSDs are used to document the precision and bias of a method in a given matrix. One MSD is typically collected per 20 environmental samples per medium.

3.0 NORMALIZING APPROACHES ACROSS SITES

This section summarizes how to apply the methods described in **Section 2** to support statistically significant data collection and evaluation. These processes can be used to support decision making as summarized in **Figure 3-1**.

Figure 3-1. Decision Tree for Site Studies



3.1 Statistical Planning/Defining Data Quality Objectives (DQOs)

This section provides additional details of the statistical planning process. Inputs (**Figure 2-1**) into this process are needed to set clear, measurable DQOs. The kick-off meeting questionnaire (**Attachment A**) should be completed to support development of project goals and identify site-specific concerns, site user issues, and known site conditions/past use. The results of the kick-off meeting should be carried into the site visit and sampling plan (checklist in **Attachment A**). The site visit should identify areas requiring clarification and confirm site conditions sufficiently to develop the CSM.

Data collected during the site visit and the steps defined in **Section 2.1.2** should be used to identify the project DQOs, in particular whether a human health or ecological risk assessment will be performed. Project DQOs impact not only sample type and location, but also quantity. Sufficient samples are needed to support a statistical evaluation of the data.

Once DQOs are defined and the initial data from the site visit are evaluated, the planning team should assess whether a single event or phased approach will be used to collect samples. Typically, phased approaches produce a more defensible dataset where iterations result in improved (more normal) data distribution, the identification of hot spots, and delineation of nature and extent. However, some sites may have conditions that limit access (physical or temporal) resulting in a short field season and the need to collect samples during one event.

Strategic sampling approaches should be used to improve certainty in identifying sources, fate and transport mechanisms, migration pathways, exposure routes and receptors, and early action opportunities to mitigate potential threats.

Key Concept: Critical Factors for Strategic Sampling

- Thorough scoping and planning to identify key factors
- Baseline or up-to-date CSM
- Maximum use of state-of-practice analytical tools and sampling approaches
- Well-planned communications, data management, and visualization

3.2 Initial Site Visit and Evaluation

Prior to preparing the SAP, site conditions are assessed during the site visit as described in **Section 2.1.2**. A checklist to ensure consistency across sites is provided in **Attachment A**. To conduct the site visit, field personnel should walk the perimeter of the site to assess the lateral extent of the study area, identify areas appropriate for background sampling, use a mesh screen to quantify debris/bullet density in one square foot areas, and evaluate soil concentrations using judgmental sampling as defined in **Section 2.3.1.1**. Soil samples should be screened using XRF, and a subset of the XRF samples may be submitted for laboratory analysis as defined in **Section 2.4.2**. Recommended sample areas include suspected berms, firing lanes, illegal dump sites, and areas with high density of shot and/or clay target debris. Photographs should be taken to document conditions. Also, aerial photographs of the site may be used to document observations and sample locations.

Soil concentrations (XRF and/or laboratory) and debris/bullet-density data from the site visit should be used to assess whether further investigation is needed. For example, data that are similar to historical concentrations and debris/bullet density indicate little change in site use over time or if background and site sample results are similar and consistent with published values, further investigation may not be warranted. Conversely, if site visit data indicate concentrations have increased over time or are one or more orders of magnitude greater than historical samples, RBSLs, or background, further investigation is warranted.

3.3 Preparing the Sampling and Analysis Plan (SAP)

This section summarizes the decisions that should be incorporated into the SAP to ensure defensible comparable data are collected across sites. The SAP is developed after site history is understood, the site visit is complete, the CSM has been developed, and DQOs defined.

The SAP should summarize the DQOs, known site conditions, approximate proposed sample number, media, location, depth, and analytical methods/laboratory requirements. Sampling objectives include, but are not limited to:

- Identifying affected environmental media.
- Delineating the vertical and horizontal extent of contamination.
- Estimating background concentrations of the COIs (i.e., the concentrations that would be present in the absence of the site).
- Defining areas where constituents of concern are concentrated (i.e., “hot spots”).
- Calculating exposure point concentrations for the assessment of human and/or environmental risk.

3.3.1 *Estimating Background Concentrations*

Nearly all shooting area investigations will evaluate constituents that are naturally occurring in soil, in particular, metals and/or PAHs. Therefore, identifying an appropriate background concentration to apply to site data is important for risk analysis and decision making. However, the number of samples needed may be impacted by the amount of historical data available, source of those data (i.e., site-specific or published¹), and the correlation of concentrations. Because background sampling will be necessary in almost all cases, the following bullets summarize considerations for the planning team:

- Sites with abundant historical data that calculate a statistically meaningful BTV may only need to include the site visit sample results to complete a background data set.
- Sites with some historical data that have a lower correlation factor will likely require additional background sampling to improve the data set.
- Direct correlation between background concentrations collected during the site visit and historical or published values may reduce the amount of additional background samples needed.
- If site-specific data were collected only during the site visit, a more robust background sampling plan is needed.

Use of the statistical tools summarized in **Table B-1, Attachment B**, or the support of a statistician can be used to estimate of the number of background samples needed to meet project DQOs.

Concentrations and their correlation factor will impact the quantity of additional samples needed. Where a robust background dataset exists from site-specific and/or published values, Figure 2-1 of *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* (EPA 2002b) may be consulted to assess whether the existing data may be used for decision making.

In drafting the sampling plan, first identify a background reference area with the same physical, chemical, geological, and biological characteristics as the site being investigated that have not been affected by site activities (EPA 2002b); this should occur during the site visit. Physical characteristics of soil may be available from the National Resources Conservation Service (NRCS) or the local county extension. Additional considerations for background sampling include:

- Choose a site with similar wildfire history to evaluate PAHs in soil.
- Select an area upstream (sediment/surface water), upgradient (groundwater), or upwind (soil).

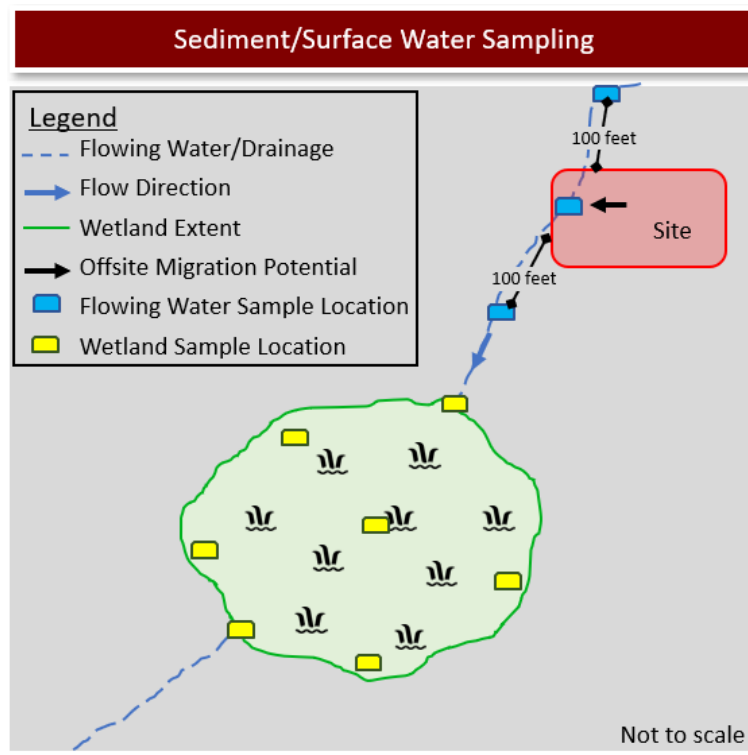
1. Public domain information such as *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States* (Shacklette and Boerngen 1984) or other sources cited in **Section 2** and **Appendix B** are good initial sources of screening information.

- Estimate the appropriate number of samples.
 - If a risk assessment is being conducted and BTVs are calculated, refer to EPA 2015.
 - The number of samples is influenced by the distribution of the data. One of the statistical tools in **Table B-1 (Attachment B)** may be used, or available guidance may be considered with the support of a statistician.
 - EPA recommends a minimum of 10 to 15 samples for each background dataset; more samples are preferred (EPA 2015).
- Consider the size of the background area to select sample number; larger areas require more samples (EPA 2015).

In some cases, a background concentration without anthropogenic influence may be impossible (next to a town, surrounded by mining-influenced land, etc.). The anthropogenic influences may now constitute the background and a pristine natural background environment should not be sought.

In instances where drainages, wetlands, or surface water channels/bodies are within, adjacent to, or downstream/downslope of a site, paired surface water (if present) and sediment samples should be collected upstream of the site. If a wetland is downslope of a site or no upstream area exists, surface water samples should be collected near the likely discharge area or confluence, distal end, and periphery of the wetland/drainage for comparison (**Figure 3-2**).

Figure 3-2. Schematic of Surface Water/Sediment Sampling Approach



3.3.2 Identifying Decision Units (DUs)

Depending on the results of the site visit and XRF or laboratory grab samples, historical review, and kick-off meeting, site-use-related DUs may or may not be identified. In particular, they are likely poorly defined at most of the shooting areas, which typically do not have backstops/berms, and are

characterized by one or more undefined firing lines or where there is no routine maintenance to identify or enforce common shooting areas (**Figure 2-4**). At these sites, the entire area may comprise one DU or DUs may be defined based on a combination of exposure areas (if known, such as a picnic area), bullet/debris density, and site visit or initial sampling results. In this case, sufficient discrete samples should be planned to meet project DQOs. If the site is operated as a shooting range, DUs are typically identified as shown in **Figure 2-3**.

DUs reflect, among other factors, site-specific knowledge (e.g., known shooting patterns, maintenance history), consideration of the receptor scenarios found in the companion RBSL document (e.g., shooters, BLM staff or volunteers performing trash and debris removal), site features (e.g., presence of one or more natural or man-made berms or backstops, household waste or other user targets, inaccessible areas, rock outcrops), or DQOs. For example, if a DQO is to define hot spots for remediation, ISM sampling of a DU will dilute hot spots within the larger group of samples. The only way ISM sampling could meet this objective is to reduce the size of the DU to the size of the hot spot. ISM is best used to address concerns of compliance with an action level or assess exposure risk, one of the discrete sampling methods defined in **Section 2.3.1** should be selected to define hot spots.

Since defined firing lines are typically not present at BLM recreational shooting areas, the site visit, initial XRF and laboratory grab sample results, and maintenance personnel records/interviews are useful resources for identifying DUs based on site usage or debris density (estimated during the site visit). If one of the DQOs is to conduct a human health risk assessment, specific location(s) where receptors might come into contact with a contaminated medium should be identified (see **Figure 2-4**). It is critically important to identify any reasonably anticipated future land use. Specific areas of the site where the potential for exposure may be higher for human activities (e.g. parking, picnic, or play areas) and/or habitat areas for ecological receptors (e.g. wetlands) should be identified (DOD 2013).

If developing a site cleanup plan is a DQO, DUs should be defined based on debris density or likely target areas (such as natural or man-made berms/backstops and household dump piles) should be identified.

If the field work must be completed in a single event, additional samples should be planned to allow for professional judgment to be used in the field as discussed in **Section 3.2.3**. In particular, when elevated XRF concentrations are identified in an unexpected area, a DU around the elevated reading is recommended, or if habitat or other reasons to evaluate impact to site ecology is identified, new DUs may need to be defined.

If a multi-phased event is planned, the site visit and first sampling event should use XRF or one of the discrete sampling methods defined in **Section 2.3.1** to help identify DUs. However, additional DUs may be defined based on the concentrations identified during the initial event.

Define DUs based on debris density, known or observed site use, land management and user considerations, drainages, and presence of ecological habitat. Ensure that each area of interest is defined by a DU.

3.3.3 Sampling and Analysis

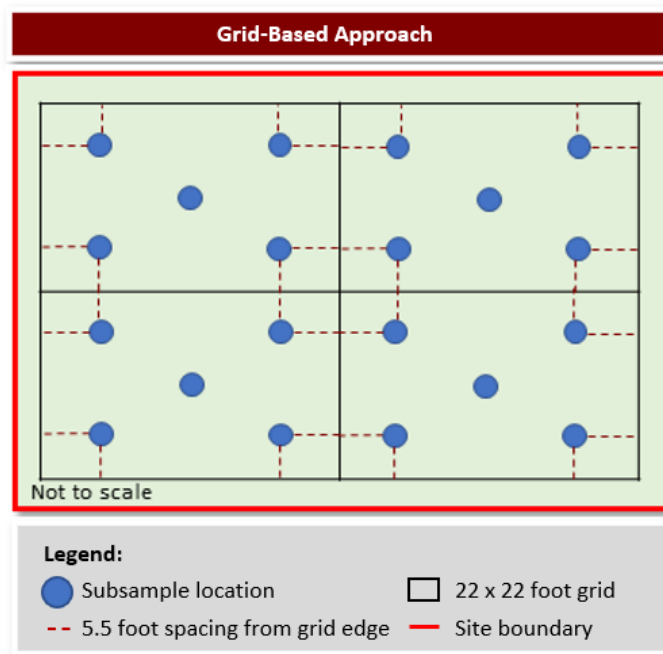
As discussed, the team may conduct a phased approach to the site investigation or collect all of the data in one field effort. The decision tree in **Figure 3-1** defines the steps recommended to inform the SAP depending on whether a phased approach or single event is selected.

3.3.3.1 Soil Sampling

A combination of discrete sampling and ISM should be included in the SAP for both single and phased events. The areas sampled for each sample type will be determined based on the DQOs. The number of samples needed may be determined using one of the statistical sampling tools described in **Section 2.1.3**. To support the selection of the appropriate number of samples, the team should first select one of the sampling approaches defined in **Section 2.3.1**.

Discrete Sampling. A commonly used methodology for collecting discrete samples at ranges since 1999 is a grid-based approach with the area of interest divided into grids measuring 22 x 22 feet (ITRC 2003). Samples are collected within the grid using a five-on-a-die pattern; each of the four corner subsamples are typically spaced 5.5 feet from the nearest grid edge and one subsample is collected from the center (Figure 3-4). Sampling intervals may vary but are usually 0–6, 6–12, 12–24, or 24–36 inches below ground surface (bgs), based on the location within the site and anticipated depth of penetration by projectiles. The subsamples are then composited. For berm areas, since particles are concentrated in bullet pockets at depths potentially exceeding several feet, the ITRC (2003) guidance proposes trenching through the berm and compositing samples from the trench walls.

Figure 3-4. Schematic of Grid-Based Approach



In addition to the predetermined sample number and location defined in the SAP, additional samples should be planned to allow flexibility in the field based on professional judgment. These samples may be used to evaluate new areas of interest since the inspection was completed or delineate potential hot spots indicated by elevated XRF readings. Although more may be planned, it is recommended that bottleware for an additional 10 percent of samples be included in the laboratory request.

In a phased approach, grid-based and biased XRF discrete samples with laboratory confirmation are proposed for the first visit. After the first visit, an R-squared (R^2) value for XRF to laboratory correlation should be calculated to determine how much the XRF should be relied on in supplemental field events. If

there is a good correlation, the XRF can effectively define the boundaries of the area affected by site activities, identify hot spots, and focus the scope of the investigation and subsequent sampling events.

Multi-Increment Sampling. Regardless of whether a single event or phased approach is proposed, the project teams needs to identify the number and mass of soil increments and number of replicates per DU. The number of increments required to ensure a representative sample and meet the required level of reproducibility specified in the DQOs (i.e., data precision), depends on the distributional heterogeneity of analytes within the DU (XRF data may be used to provide an estimate of heterogeneity). A larger DU potentially encompasses greater variability.

An unbiased sampling scheme must be developed and carefully followed to uniformly sample the volume of soil within the boundaries of the DU. The fundamental requirements for increment collection are:

- An unbiased pattern throughout the entire DU
- Complete and uniform sampling across the specified depth interval
- Uniform size/mass of increments

Coring devices that ensure a uniform diameter core through the entire sampled interval are preferred for increment collection. A variety of hand-operated coring devices designed for surface sampling (e.g., < 6 inches) are widely available from a variety of vendors (e.g., forestry supply catalogs). Where suitable, cohesive soils are present, a coring device greatly facilitates the rapid collection of uniform, representative increments from a consistent depth interval. For highly compacted or cemented soils, split-barrel samplers with a drive shoe can be driven manually using a slide hammer. Depending on the number if increments planned, the minimum number required to achieve good reproducibility (e.g., percent relative standard deviation < 30) is 30 or more (ERDC 2009; EPA 2003b). The diameter of the cores should be adjusted to obtain a total dry weight sample mass of at least 500 grams (preferably 1 kg to 2 kg) from the prescribed number of increments (**Table 3-1**).

Table 3-1. Increment Mass Table for Coring Devices

Corer Diameter (cm)	Desired Total Incremental Sample Mass* (g)				
	500	750	1,000	1,500	2,000
	Number of increments to reach desired total sample mass (g)				
1.00	170	255	340	509	679
1.25	109	163	217	326	435
1.50	75	113	151	226	302
1.75	55	83	111	166	222
2.00	42	64	85	127	170
2.25	34	50	67	101	134
2.50	27	41	54	81	109
2.75	22	34	45	67	90
3.00	19	28	38	57	75
3.25	16	24	32	48	64
3.50	14	21	28	42	55
3.75	12	18	24	36	48
4.00	11	16	21	32	42
4.25	9	14	19	28	38
4.50	8	13	17	25	34
4.75	8	11	15	23	30
5.00	7	10	14	20	27

Surface Water/Sediment Sampling Guidance. Regardless of whether a single event or phased approach is planned, if a waterbody or wetland is present, include paired sediment and surface water sample locations into the SAP. If the feature is a flowing water body, each sample set should include upstream (or background as discussed in **Sections 2.2 and 3.2.1**), one or more adjacent, and downstream samples. If the area is a wetland or there is no upstream/background area, include enough samples, depending on size, to allow a comparison of concentrations from samples collected where runoff enters the body/wetland to samples along the wetland's periphery, middle, and discharge area. Enough samples should be collected to assess whether concentrations within the wetland and at the discharge location are statistically elevated above upstream or influent samples (this also requires enough samples to understand the concentration distribution within the area of interest). One of the statistical tools described in **Section 2.1.3** may be used, or a statistician may be engaged to support SAP development. **Figure 3-3** presents a generalized schematic of the recommended surface water/sediment sampling approach.

Analytical Methods. A QA plan should be incorporated into the SAP to address both field-collected XRF and offsite laboratory analyses. If samples are shipped offsite, the laboratory should be notified so that the appropriate preparation methods are used for each sample. Considerations to ensure high-quality analytical results include:

- Identify COIs based on historical records (if available), meet with BLM, and perform the site visit and initial sampling activities. Although this guidance focuses on metals and PAHs, as these are most commonly present at shooting sites, additional chemicals may warrant investigation based on historical records review, BLM interviews/meetings, and the site visit. For example, when the following are present, other analytes may need to be considered:
 - Abandoned car(s)
 - Drum(s)
 - Old refrigerator(s)
 - General household waste (such as televisions, computers)
 - Industrial waste
 - Evidence of exploding targets (e.g., Tannerite or use of incendiary ammunition)
- Use SPLP to evaluate potential leaching where groundwater is present at or above 10 feet below ground surface or where drainages from the site runoff to surface water bodies or wetlands. If required, samples may need to be collected from different lithologies present at a site.
- Use TCLP for waste characterization.
- Ensure the proposed laboratory(ies) meet state and/or federal certification requirements and are prepared and experienced with ISM protocols (see **Table 2-4**).
- Compare laboratory method detection limits against BLM-recommended RBSLs documented in the BLM companion document, *Risk-Based Screening Levels for Recreational Shooting Sites on Bureau of Land Management Properties* (Herndon Solutions Group [HSG] 2021) and background values (if known, or available from literature).
- Collect appropriate QA/QC samples as described in **Section 2.5**.
- Ensure proper use and calibration of the XRF as described in **Section 2.4.1**.
- If it is a single event, calculate a statistically significant percent laboratory confirmation of XRF samples to allow for a correlation estimate.

- If using a phased approach, calculate R^2 correlation between XRF and laboratory samples to assess the appropriate percent confirmation samples needed and reliability of XRF results.

3.3.4 Health and Safety

The development of an appropriate health and safety plan depends entirely on site-specific factors and planned field procedures. To support consistent uniform health and safety procedures across sites and regions, the Health and Safety Plan Template developed for BLM is provided in **Attachment C** (HSG 2018). The template is intended to address the requirements of Occupational Safety and Health Administration 1910.120, *Hazardous Waste Operations and Emergency Response*, for performing work on hazardous waste sites or performing emergency response actions. **Note: the template covers more activities than anticipated but its use allows for consistency.**

In addition to the Health and Safety Plan Template, a job hazard analysis should be conducted prior to and during field implementation. In particular, physical conditions associated with the site are likely to drive hazards. The Occupational Safety and Health Administration Publication 3071 provided in **Attachment C** explains what a job hazard analysis is and offers guidelines to conduct a step-by-step analysis of each proposed job or activity.

3.3.5 Investigation-Derived Waste (IDW)

Materials that may become IDW include, but are not limited to:

- Personal protective equipment including disposable coveralls, gloves, booties, etc.
- Disposable equipment and items such as plastic ground and equipment covers, aluminum foil, broken or unused containers, sample container boxes, tape, etc.
- Soil cuttings from drilling, sampling, or hand augering.
- Cleaning fluids such as spent solvents and wash water.
- Packing and shipping materials.

If non-hazardous waste is from an active facility, permission should be sought from the operator to place the IDW into the facility's dumpsters. If necessary, these materials may be placed into municipal dumpsters with the permission of the owner. The IDW may also be taken to a nearby permitted landfill. On larger studies, waste-hauling services may be obtained and a dumpster located at the study site.

Hazardous IDW must be disposed as specified in EPA regulations. If appropriate, these wastes may be disposed in the source area from which they originated if doing so does not endanger human health or the environment. If onsite disposal is not feasible and if the wastes are suspected to be hazardous, appropriate tests must be conducted to make that determination. If they are determined to be hazardous wastes, they must be properly contained and labeled. They may be stored on the site for a maximum of 90 days before they must be manifested and shipped to a permitted treatment or disposal facility. Generation of hazardous IDW must be anticipated, if possible, to allow arrangements for proper containerization, labeling, transportation, and disposal/treatment in accordance with EPA regulations (EPA 2020).

4.0 DATA EVALUATION

Data evaluation is a stepwise approach where results are evaluated to assess whether the data are statistically significant and can meet DQOs. If data are of sufficient quality and quantity, results are compared to background values, where applicable, and RBSLs based on identified receptors at the site. Each potential receptor present should be evaluated independently for potential risk. At sites where background values or RBSLs are exceeded, a simplified ranking will assist in determining whether further action is required. Data may be compared to the background mean, median, or upper percentile. **Table 4-1** presents criteria that support and contradict the use of the mean, upper percentile, and median.

Table 4-1. Criteria to Support Usage of the Mean, Upper Percentile, or Median

Parameter	Points to Consider
Mean	1) Easy to calculate and estimate a confidence interval. 2) Requires fewer samples than other parameters to achieve similar confidence. 3) Useful when the cleanup standard has been based on consideration of carcinogenic or chronic health effects or long-term average exposure. 4) Useful when the soil is uniform with little spread in the sample data. 5) Not as useful when contamination exists in small areas within a larger area that is being sampled because the mean can be “diluted” or reduced by the inclusion of clean areas in the sample area. 6) Not very representative of highly variable soils because the most heavily contaminated areas are not characterized by a mean. 7) Not useful when there are a large proportion of less-than-detection-limit values.
Upper Proportion/Percentile	1) Can be expressed in terms that have more meaning than tests of the mean. Volumes or areas can be expressed relative to the total volume or area of concern, and this can be a proportion of importance. For example, if no more than 10,000 cubic meters (m³) in a total volume of 1,000,000 m³ can exceed a cleanup standard, then this becomes a test to verify with reasonable confidence that no less than 99 percent of the site is below the cleanup standard. 2) Will provide the best control of extreme values when data are highly variable. 3) Some methods are unaffected by less-than-detection-limit values, as long as the detection limit is less than the cleanup standard. 4) If the health effects of the contaminant are acute or worst-case effects, extreme concentrations are of concern and are best evaluated by ensuring that a large proportion of the site is below a cleanup standard. 5) Similar to the mean if contamination exists within a small area, but if the sampling program is conducted to include a much larger surrounding area with little contamination, the proportion will be affected or “diluted” 6) The proportion of the size that must be below the cleanup standard must be chosen. 7) When statistical methods are used that require few assumptions, then a larger sample size will be required for tests based on the mean.
Median	1) Has benefits over the mean because it is not as heavily influenced by outliers and highly variable data and can be used with a large number of less-than-detection-limit values. 2) Has many of the positive features of the mean, in particular its usefulness for evaluating cleanup standards based on carcinogenic or chronic health effects and long-term average exposure. 3) Has positive features of the proportion, including its reliance on fewer assumptions.

Table 4-1. Criteria to Support Usage of the Mean, Upper Percentile, or Median

Parameter	Points to Consider
	4) Retains some negative features of the mean in that the median will not control extreme values.

4.1 Evaluating Background Concentrations

As indicated in BLM guidance, *Technical Memorandum Screening Assessment Approaches for Metals in Soil at BLM HazMat/AML Sites* (2017b), remediation to concentrations below background values is not feasible or necessary. Most of the constituents found at shooting areas are metals or PAHs, which are naturally occurring. Once an appropriate range of background values are determined (**Table 2-2, Section 2.1**), results should be compared to these values as part of the preliminary screening.

The distribution of the background dataset along with parametric or nonparametric statistical methods may be used to compute BTVs. A review of the environmental literature reveals that one or more of the following statistical limits are used to calculate background statistics; that is to determine and estimate background concentrations. Collectively, these statistics represent estimates of the BTVs. The BTVs are estimated by statistics representing values in the upper tail (e.g., 95 percent upper percentile, 95 percent upper prediction limit) of the background data distribution. For datasets with non-detects, the BTVs can be estimated using upper limits based on Kaplan Meier estimates (EPA 2015).

Several statistical methods may be used to compare data to background:

- A common method of developing a background exceedance gauge is calculating a BTV (this can be done using EPA's ProUCL software).
- Methods such as inferential statistics (e.g., students-t tests or analysis of variance [ANOVA]) may be more appropriate depending on the problem/decision statement.
- A null hypothesis could be used to assess whether there is a difference between the mean constituent concentration at the site (or DU) and the background area.
- Many parametric and nonparametric statistical procedures exist to compare background data with site-specific or DU-specific results.

A variety of such procedures are reviewed in EPA's *Risk Assessment Guidance for Superfund, Volume 1* (EPA 1989) and *Guidance for Data Quality Assessment* (EPA 2000). Also, please review state guidance where available (**Table 2-2**).

4.2 Considerations in Managing Sites

If neither background nor human health or ecological RBSLs are exceeded, no further action is necessary. However, when background or RBSLs are exceeded, further evaluation should be conducted. This evaluation should consider secondary data (e.g., historical records, maintenance logs, use history) to weigh the analytical results to potential alternatives. Risk management considerations should include:

- Magnitude of the exceedances (How similar are the values relative to background or RBSLs?)
- Exceedance locations (Are the exceedances clustered in a small area or spread across the site?)
- Impact on DQOs (Are the data of sufficiently quality and quantity to meet project objectives?)
- Evidence that elevated concentrations are migrating offsite or have the potential to migrate offsite, such as:

- Drainage running through or adjacent to the site
- Highest concentrations identified at the top of a sloped area
- Sensitive receptors identified downwind of the site

These data are used to assess whether additional characterization is needed to meet project DQOs or if remedial decisions can be made.

5.0 CONCLUSIONS

The most important step in collecting meaningful data is the planning process. Of particular importance is defining clear DQOs. This is accomplished once the CSM is developed and the end goal is determined. Once the goals are established, available state-specific guidance should be reviewed to ensure the work is done to meet relevant requirements that may not be defined in this document. Understanding how the data will be used should be clear and either statistical tools, as summarized in **Section 2.1.3 (Table 2-1)**, or support from a statistician should be incorporated into the planning process.

Sample number, type, and location should be determined depending on:

- Results of the site visit
- Single event or phased approach planned
- Quantity and size of DUs
- Site extent
- Knowledge of sensitive receptors
- Planned use of ISM and/or discrete sampling procedures
- Applicability and use of XRF
- Presence of offsite migration potential
- Other site uses (such as camping, waste dumping)
- Frequency and type of ongoing maintenance, if applicable
- Presence of surface water or wetlands
- Evidence of potential habitat

The SAP should clearly define DQOs; summarize the CSM; and define sample locations, quantities, media, analytes of interests, and laboratory requirements (including potential field analyses such as XRF for soil or pH for surface water). Best practices should be defined and appropriate guidance referenced to ensure field processes result in quality data. QA procedures should be part of the planning and implementation process.

5.1 Assumptions

Assumptions incorporated into this guidance include:

- Primary medium of concern is soil; sediment and surface water sampling will only be included to address a wetland, surface water body, or drainage where identified.
- Heavy metals (lead in particular) and PAHs are the COIs.
- User will have knowledge or have access to the CERCLA/RCRA regulatory process including data quality planning and sampling and analysis planning.
- Data will be compared to background values and RBSLs to evaluate whether additional investigation or remedial action is warranted.
- SPLP analysis will be required when shallow groundwater is present (< 10 feet bgs) or when water may runoff to nearby surface water bodies/wetlands.
- TCLP analysis will be required for waste characterization if offsite disposal is needed.

5.2 Limitations

As stated in **Section 1**, this document does not provide a one-size-fits-all guidance. The following are a list of limitations in applying the technical guidance.

- The process will only be successful if clear, meaningful DQOs are identified.
- This guidance does not address every condition that may be present at a site; professional judgment is needed to apply the approaches and principles defined herein.
- There may not be a statistical correlation between XRF and laboratory results, which can decrease data quality and the ability to make decisions using the data.
- This guidance was developed to perform a screening of the data and does not include provisions/rigors necessary to support a SLRA; however, the decision to conduct a risk assessment should be a part of the DQOs and statistically significant data should be collected to meet project objectives.
- Field operating procedures are not defined; federal or state-specific procedures should be consulted in developing and implementing the SAP.
- Groundwater is not included as a medium of concern.

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ATTACHMENT A: KICK-OFF QUESTIONNAIRE AND SITE VISIT CHECKLIST

Kick-Off Questionnaire Cover Page

Site Name:

Site Address or Location:

BLM Project Manager:

Latitude/Longitude:

Kick-Off Questionnaire

Planning Team	
BLM Field or District Office:	
BLM Project Manager(s):	
Additional Participants:	
Site Background	
1. Dates of known operations:	
2. Is the Site currently active? (Yes/No)	
3. What is the Site history of use?	
4. Has any sampling been completed at the site? (Yes/No)	
<i>If yes, what are the prime constituents of interest?</i>	
5. Are there drawings/maps of the Site available?	
6. Are there any other recreational activities present in the area?	
7. Are there communities surrounding the Site?	
<i>If so, what is their location relative to the site?</i>	
8. Is wildlife present in the area?	
<i>If yes, have any wildlife or bird kills been recorded at the site? (Describe)</i>	
Site Description	
Is debris present?	
Type:	Volume:
1. Are there defined firing lines with back stops? (Describe)	
2. Is surface erosion present?	

Maintenance				
1. Are the spent casings periodically collected and removed from the shooting area? (Yes/No)				
2. Is target/shot debris periodically removed? (Yes/No)				
3. What type and volume of debris is present at the Site?				
4. Have any wildland fires occurred at or near the Site? (Yes/No)				
Site Geography and Soil Information				
1. What is the soil type in the area?				
Clay (%):	Sand (%):	Lime (%):	Other (specify, %):	
2. Are there defined backstops?				
3. Has the soil/accumulated lead or debris ever been removed from the Site?				
<i>If yes, what was done with the soil?</i>				
4. Are there any wetlands or surface water bodies nearby the facility?				
5. What is the depth to groundwater from the surface in the vicinity of the ranges?				
6. Is shooting taking place over or into water or wetlands?				
7. Where do the local communities and/or nearby residents obtain drinking water:				
Public groundwater wells				
Private groundwater wells				
Surface water sources				
8. Are local surface water bodies used for commercial or recreational fishing or other recreational activities? (Yes/No)				
Describe distance, direction, and activities:				
9. Have nearby surface waters, groundwater wells, or drinking water wells ever been chemically analyzed for lead or other metals? (Yes/No)				
10. Location(s) Township: Range: Section: Latitude: Longitude:				
Additional Maps				

Site Visit Checklist

Site Name:

Site Address or Location:

BLM Project Manager:

Latitude/Longitude:

General Site Information

Site Usage			
1. Describe site usage.			
2. Identify size of affected area.			
3. What are the general conditions of the site?			
4. Are there visible firing lines or preferred shooting angles?			
5. Are there targets or debris remnants present? If so, describe.			
a. Estimate debris density			
6. Identify whether there are site access restrictions.			
a. Describe any limitations that may impact sample design and planning.			
7. Are there obvious backstops?			
a. What is the soil type in the backstop/berm?			
Clay (%):	Sand (%):	Lime (%):	Other (specify, %):
b. Estimate debris density.			
c. General backstop size and dimensions:			
<i>Length:</i>	<i>Width:</i>	<i>Height:</i>	
d. Document sample results on field sampling form.			
e. Latitude:		Longitude:	
8. Describe evidence of munitions type or trap skeet use.			

Environmental Conditions and Habitat	
1. Describe the general surrounding habitat.	
2. Are there signs of wildlife? If yes, describe.	
3. Identify a representative background location.	
Latitude:	Longitude:
4. Describe adjacent land used.	
5. Is there evidence of campfires?	
6. Is there evidence of site usage other than shooting (e.g., off-road vehicle use, homeless encampment, waste dumping)?	
a. Estimate debris density.	
b. Document sample results on field sampling form.	
C. Latitude:	Longitude:
7. Is there evidence of offsite transport (actual or potential)?	
8. Are there any wetlands or surface water bodies nearby?	
9. If observed, what is the condition and migration extent with respect to any wetlands or surface water bodies?	
10. What is the depth to groundwater in the vicinity of the site?	
11. Are the firing lines oriented to avoid shooting over or into water or wetlands?	
Sketch the area on a site map or recent aerial photograph. Include debris density, backstops, sample locations, waste or dump areas, etc., as applicable.	

ATTACHMENT B: AVAILABLE GUIDANCE FOR STATISTICAL EVALUATION AND BACKGROUND SOURCES

Table B-1. Summary of Available Sampling Design/Analysis Tools

Link	Owner	Capabilities
Visual Sampling Plan (publicly available)		
https://vsp.pnnl.gov/	U.S. Department of Energy (DOE)	- Integrated sample planning. - Can use site-specific spatial files and maps. - Applicable to two-dimensional sampling plans. - Includes modules for soil, sediment, surface water, groundwater, and other media. - Includes random, systematic, sequential, adaptive cluster, collaborative, stratified, transect, multi-increment, combined judgment/probabilistic, and rank set sampling designs. - Supports EPA's DQO process.
Spatial Analysis and Decision Assistance (publicly available)		
https://www.sadaproject.net/index.html	Oak Ridge National Labs	- Integrated sample planning. - Can use site-specific spatial files and maps to locate samples. - Includes modules for visualization, geospatial analysis, statistical analysis, human health risk assessment, ecological risk assessment, cost/benefit analysis, sampling design, and decision analysis.
ProUCL (publicly available)		
https://www.epa.gov/land-research/proucl-software	U.E. Environmental Protection Agency (EPA)	- Used after data are collected. - Standard tool for computing background levels. - Determines data outliers. - Compares background and site sample data for evaluation and risk assessment. - Uses datasets with and without non-detects.
Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Power (publicly available)		
http://www.marssim.com/Tools.htm	DOE, EPA, National Resource Council, U.S. Department of Defense	- Fast, easy-to-use tool to get sample sizes for comparing to risk-based screening levels (RBSLs). - MARSSIM uses multiple programs such as Spatial Analysis and Decision Assistance, Visual Sample Plan, and Compass to improve the MARSSIM process and calculations.
PASS (for purchase)		
https://www.ncss.com/	Commercial	- Provides sample size tools for a high number of statistical tests and confidence interval scenarios. - Sample size results and corresponding plots are displayed in a ready to use output window.
Statgraphics (for purchase)		
https://www.statgraphics.com/	Commercial	- Product performs statistical analysis, data visualization, and predictive analytics. - Includes StatAdvisor, which explains the results of statistical analyses in a non-statistical manner.
SPSS (for purchase)		

Table B-1. Summary of Available Sampling Design/Analysis Tools

Link	Owner	Capabilities
https://www.ibm.com/products/spss-statistics	Commercial	▪ Runs powerful analyses of advanced and descriptive statistics, regression, and more. Allows for easy development of visualizations and reports without the need for coding experience. ▪ Allows for use of R and Python programming extensions to integrate with open-source software.

Table B-2. Available Background Guidance Documents for States

State	Document Title	Hyperlink	Author and Year	Summary
Alaska	Element Concentrations in Soils and Other Surficial Materials of Alaska	https://pubs.usgs.gov/pp/1458/pdf/pp1458.pdf	U.S. Geological Survey, 1988	Provides background values for soil and other surficial materials from 266 locations throughout Alaska.
	Guidance for Evaluating Metals at Contaminated Sites	https://dec.alaska.gov/media/8788/evaluating-naturally-occurring-metals-at-sites-2018.pdf	Alaska Department of Environmental Conservation Division of Spill Prevention and Response Contaminated Sites Program, 2018	- Guidance on how to select locations for background sampling. - EPA's Guidance can be used for assistance in choosing the appropriate number of samples. - Provides guidance on establishing statistical background concentrations and comparing with site data.
Arizona	Evaluation of Background Metals Concentrations in Arizona Soil	https://repository.asu.edu/attachments/181316/content/Evaluation_of_Background_Metals_Concentration_of_Arizona_Soils.PDF	The Earth Technology Corporation, 1991	1991 document Provides values in Section 3 using USGS and Arizona Department of Environmental Quality (ADEQ) data. Results are summarized in Table 3-1.
	Site Investigation Guidance Manual	https://static.azdeq.gov/vrp/site_investigation_guidance.pdf	ADEQ Waste Programs Division, 2014	- Provides information in Section 5.2.2 on what background concentrations are. - Recommends EPA 2002b as guidance for comparing background concentrations to investigation area.
California	Background Concentrations of Trace and Major Elements in California Soils	https://ucanr.edu/sites/poultry/files/297094.pdf	Kearney Foundation of Soil Science University of California, 1996	- Database on background concentrations of California soils. - Provides total concentrations in Table 2 and concentration ranges and statistical summary in Table 3.
	Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Site and Permitted Facilities	https://dtsc.ca.gov/wp-content/uploads/sites/31/2016/01/backgrnd.pdf	Department of Toxic Substances Control, 1997	Policy that promotes the use of graphic techniques and describes various statistical tests to distinguish background chemicals from site-related constituents of interest.

Table B-2. Available Background Guidance Documents for States

State	Document Title	Hyperlink	Author and Year	Summary
Colorado	Geochemical Data for Colorado Soils: Results from the 2006 State-Scale Geochemical Survey Table 3: Complete geochemical data on 0-15-cm soils from Colorado	https://pubs.usgs.gov/ds/520/ https://pubs.usgs.gov/ds/520/downloads/table3.pdf	USGS, 2006	▪ Presents data collected from 960 sites in 2006 throughout Colorado. ▪ Statistical summary on geochemical data of 0-15 centimeters summarized in Table 2. ▪ Table 3 provides complete geochemical data collected with land use types for each sample location.
Idaho	Idaho Risk Evaluation Manual	https://www.deq.idaho.gov/media/967298-risk_evaluation_manual_2004.pdf	Idaho Department of Environmental Quality, 2004	▪ Section 4.10 discusses background soil concentrations and references EPA background guidance.
Kansas	Determining Background Level for Chemicals of Concern	https://www.kdheks.gov/ber/policies/BER_RS_038.pdf	Kansas Department of Health and Environment, Bureau of Environmental Remediation, 2010	▪ Provides state-specific guidance on developing a background sampling plan. ▪ Recommends EPA background guidance for relevant statistical tools.
Montana	Project Report Background Concentrations of Inorganic Constituents in Montana Surface Soils	https://deg.mt.gov/Portals/112/Land/StateSuperfund/Documents/InorganicBackground/BkgdInorganicsReport.pdf	Hydrometrics, Inc., 2013	▪ Report presents the results of background concentrations from 2012-2013 investigation. ▪ Provides a soil sampling procedure outline and suggests using EPA's ProUCL statistical software.
Nevada	Background Shallow Soil Summary Report BMI Complex and Common Areas Vicinity Guidelines for Discovery Events	https://ndep.nv.gov/uploads/documents/background-shallow-soil-report.pdf https://ndep.nv.gov/uploads/env-sitecleanup-guidance-docs/NDEP_Guidelines_for_discovery_events.pdf	Basic Remediation Company Titanium Metals Corporation, 2007	▪ Background samples and results for the Basic Management, Inc., Complex and Common Area in Clark County, Nevada. ▪ If releases are suspected, site-specific background samples should be collected.
New Mexico	Risk Assessment Guidance for Site Investigations and Remediation Volume I Soil Screening Guidance for	https://www.env.nm.gov/wp-content/uploads/sites/12/2016/11/NMED_SSG_VOL-I_-March_2017_revised.pdf	New Mexico Environment Department (NMED), 2017	▪ Site-specific background study must be approved by NMED. ▪ Suggests using the ProUCL software and guidance for determination of

Table B-2. Available Background Guidance Documents for States

State	Document Title	Hyperlink	Author and Year	Summary
	Human Health Risk Assessments			BTVs.
North Dakota	Naturally elevated metal contents of soils in northeastern North Dakota, USA, with a focus on cadmium	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6054461/pdf/nihms936671.pdf	Vijaya Jyoti, Bernhardt Saini-Eidukat, David Hopkins, and Thomas DeSutt, 2015	- Soils in Cavalier County in the northeastern part of North Dakota were sampled. - Recommends EPA background guidance.
Oklahoma	Background Metal Concentrations in Oklahoma Soils	http://dasnr22.dasnr.okstate.edu/docushare/dsweb/Get/Document-9403/PSS-2276web2018.pdf	Oklahoma State University	Fact sheet establishing background values for 28 benchmark soils in the Oklahoma region.
Oregon	Development of Oregon Background Metals Concentrations in Soil	https://www.oregon.gov/deq/FilterDocs/DeBORbackgroundMetal.pdf	State of Oregon Department of Environmental Quality, 2013	- Technical report with state-wide and regional concentrations for 16 metals. - Data available in Table 2.
Texas	Figure 30 TAC of Texas-Specific Soil Background Concentrations	https://www.tceq.texas.gov/assets/public/legis/rules/rules/pdflib/350c.pdf	Texas Commission on Environmental Quality, 2007	- Figure located on page 5. - Uses numbers found in the Background Geochemistry of Stone Rocks, Soils, Plants, and Vegetables in the Conterminous United States report done by USGS in 1975.
Washington	Background Concentrations of Metal in Soils from Selected Regions in the State of Washington	https://pubs.usgs.gov/wri/1995/4018/report.pdf	USGS, 1995	Provides soil samples from 60 sites throughout the State of Washington.
Wyoming	Establishing Site-Specific Background Metals Concentrations in Soil	http://deq.wyoming.gov/media/attachments/Solid%20%26%20Hazardous%20Waste/Voluntary%20Remediation%20Program/Fact%20Sheets/SHWD_VRP_FACTSHEET-24-Establishing-Site-Specific-Background-Metal-Concentrations-in-Soil_2014-1202.pdf	Wyoming Department of Environmental Quality, 2000	- Fact sheet on how to establish background levels. - Recommends EPA's ProUCL statistical program to evaluate background datasets and calculate background concentration-based cleanup levels.

Table B-2. Available Background Guidance Documents for States

State	Document Title	Hyperlink	Author and Year	Summary
Continental United States	USGS Background Soil-Lead Survey: State Data	https://www.epa.gov/superfund/usgs-background-soil-lead-survey-state-data	EPA, 2018	State-specific soil-lead concentrations compiled by EPA for the 48 contiguous states.
	National Geochemical Database: Soil	https://mrdata.usgs.gov/ngdb/soil/	USGS	Interactive map with a compilation of multiple USGS studies going back to 1964.

**ATTACHMENT C: BLM HEALTH AND SAFETY PLAN TEMPLATE WITH ACTIVITY
HAZARD ANALYSIS**



Bureau of Land Management (BLM) Health and Safety Plan (HASP) Template

PREFACE

This Health And Safety Plan (HASP) template (Template) is intended to support the implementation of the Bureau of Land Management (BLM) Safety and Occupational Health Management Program (Program) as set forth in BLM Manual Handbook 1112-1, Safety and Health Management, and in BLM Manual Handbook 1112-2, Safety and Health for Field Operations. Additionally, the Template is intended to address the requirements of Occupational Safety and Health Administration (OSHA) 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER), for performing work on hazardous waste sites or performing emergency response actions.

The Template is to be completed by staff who have completed basic 40-hour HAZWOPER training, prior to beginning work onsite, in consultation with safety and health staff, and who are authorized by BLM management to complete the Template. The Template is formatted as a checklist tool addressing most of the topics anticipated at BLM Sites. The Template cannot anticipate all plausible hazards at all BLM sites. However, it does address many of the most likely anticipated hazards at BLM sites. Users are encouraged to seek help from subject matter experts (SMEs) as necessary.

The Template supports a graded or tiered approach that is intended to accommodate a variety of BLM staff activities ranging from straightforward site visits to more complex operations where staff are conducting or participating in intrusive work.

This Template is intended to be flexible so that authorized personnel can tailor site-specific HASPs to their needs. HASP developers are encouraged to expand beyond the checklist responses as necessary. The Template is particularly relevant to BLM's medium- to long-term or complex environmental cleanup, natural resource restoration, and physical safety hazard remediation projects, and is anticipated to help ensure that they are completed in an efficient and cost-effective manner and comply with all appropriate laws, regulations, and policies. Not all sections will apply in all cases. Additionally, the section on Emergency Response Planning and Site Control, may apply only on a case-by-case basis.



SECTION 1 – PROJECT IDENTIFICATION, EMERGENCY CONTACTS, OVERALL RISK ASSESSMENT, and PERSONNEL

BLM Project Identification:		
Project Start/End Dates:	Start:	Complete:
Project Location:		
Scope of Work for this HASP:		
Yes ☐ No ☐ Site Map(s) and Directions to Nearest Emergency Medical Resource (Attachment A)		
Risk Assessment Tiers are developed in Section 2	Tier 1 ☐ _____	
	Tier 2 ☐ _____	
	Tier 3 ☐ _____	
	Basis:	

FOR ALL EMERGENCIES CALL

Emergency Contact Numbers:

For all incidents, injuries, property damage, near-misses, work-induced illness or chemical over-exposures, the following personnel should be immediately contacted upon scene stabilization.

PROJECT PERSONNEL (IF APPLICABLE) CONTACT INFORMATION

BLM Project Manager	Name:	Phone:
	Email:	
BLM Project EHS Point of Contact	Name:	Phone:
	Email:	
Contractor Site Manager	Name:	Phone:
	Email:	
Other	Name:	Phone:
	Email:	

OTHER CONTACT INFORMATION (if applicable)

Subcontractor Project Manager	Name:	Phone:
	Email:	
Subcontractor Site Superintendent	Name:	Phone:
	Email:	
Subcontractor Health & Safety Representative	Name:	Phone:
	Email:	

HASP REVIEW and APPROVAL

Reviewed & Approved by:	Title:	Date
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3



SECTION 2 BLM WORKER HASP RISK ASSESSMENT

The HASP Risk Assessment can normally be addressed after completing Sections 2 and 3. Use of this risk assessment requires understanding of the nature and extent of contamination, the activities to be conducted, and the physical features of the site. **Note medical clearance and training are normally necessary for any onsite activity.**

Yes ☐ No ☐ Medical clearance current?

Yes ☐ No ☐ Basic HAZWOPER Training (40 hr) and annual Refresher Training (8 hr) current?

Yes ☐ No ☐ Completed hazard identification (Section 3)

Yes ☐ No ☐ Enter an exclusion zone?

Yes ☐ No ☐ Perform work involving contact with hazardous substances?

Yes ☐ No ☐ Personal Protective Equipment (PPE) other than Level D?

Yes ☐ No ☐ Use respiratory protection?

Yes ☐ No ☐ Unprotected physical walking working surface hazards?

Yes ☐ No ☐ Unprotected mechanical hazards

Yes ☐ No ☐ Any OSHA Health Protection Standards (e.g., lead) engaged?

☐ **Tier 1 – Low Risk.** If there is a low probability of exposure to hazardous and/or physical site features and moving equipment, the activities covered by the HASP can be regarded a low risk. Low risk HASPs would typically address site visits, reconnaissance surveys, observation of contractors performing work and similar observational-like activities.

☐ **Tier 2 – Moderate Risk.** If there is a reasonable chance for exposure to concentrations of hazardous substances, but at concentrations below the range of their permissible exposure limits and/or physical site features and moving equipment, the activities covered by the HASP can be regarded a moderate risk. Moderate risk HASP would address activities such as entering an exclusion zone and donning PPE (excluding respiratory protection) to support contractors performing work or executing moderately intrusive work (collecting groundwater or soil samples).

☐ **Tier 3 – High Risk.** If there is a realistic opportunity for exposure to concentrations of hazardous substances in the range of permissible exposure limits and/or significant opportunity to encounter physical site features and moving equipment, the activities covered by the HASP can be regarded a high risk. Activities requiring the use of respiratory protection, entering an exclusion zone and donning Level C or higher PPE to support contractors performing work or executing intrusive work in the presence of hazardous materials would be regarded a high risk work. Large scale (e.g., tanker) spill response with unknown concentrations of hazardous materials would be Tier 3.

Discuss Rationale for Tier Risk Selection:



SECTION 3
SITE CHARACTERIZATION, ACTIVITY, HAZARD AND RISK IDENTIFICATION

3a Site Characterization

3b Site Hazards and Conditions that this HASP Must Address

Yes ☐ No ☐ **Chemical Contamination**

Describe:

Yes ☐ No ☐ **Physical Safety Including Working and Working Surface Hazards**

Describe:

Yes ☐ No ☐ **Radiological Contamination**

Describe:

Yes ☐ No ☐ **Biological Contamination**

Describe:

Yes ☐ No ☐ **Biota Investigation**

Describe:

Yes ☐ No ☐ **Geophysical Investigation**

Describe:

Yes ☐ No ☐ **Monitoring**

Describe:

Yes ☐ No ☐ **Construction/Demolition**

Describe:



Yes ☐ No ☐ **Post Closure Activities**

Describe:

Yes ☐ No ☐ **Other**

Describe:

3c Identify and Describe the Activities BLM Personnel Will Be Doing

Yes	No	Activity	Description
☐	☐	Site Visit	
☐	☐	Site Reconnaissance	
☐	☐	Subsurface Investigation, Describe:	
☐	☐	Excavation, Describe:	
☐	☐	Sampling and Handling Potentially Contaminated Media, Describe:	
☐	☐	Construction, Describe:	
☐	☐	Demolition, Describe:	
☐	☐	Other, Describe:	
☐	☐	Is an Activity Hazard Assessment (AHA) Appropriate? See Attachment B	
☐	☐	Fall Protection Equipment	
☐	☐	Forklift Operation/Powered Industrial Truck Use	
☐	☐	Heavy Equipment Operation List Equipment:	



Yes	No	
	☐	Ladder Use
—	☐	Lock-Out/Tag-Out
	☐	Noisy Operations requiring Hearing Conservation Training
	☐	Scaffolding Erection, Use
—	☐	Respirator use
	☐	Powdered Actuated Tool (PAT)
3d Hazard and Risk Identification		
Yes	No	Will BLM workers potentially be exposed to:
	☐	Chemical, Radiological, Biological, Media Describe the chemicals, concentration, and duration of exposure:
	☐	Working Surface and Elevated Workstation Hazards
—	☐	Local Biologic Species (Insects, Snakes)
—	☐	Mechanical/Moving Equipment Hazards
	☐	Heat and Cold Hazards
—	☐	Electrical Hazards
	☐	Chemical Process Hazards (Pressure, Heat, Flammability)
	☐	Powdered Actuated Tools (PAT)
—	☐	Noisy Operations
Other:		



SECTION 4 ENGINEERING AND WORKPRACTICE CONTROLS

Activity Engineering and Work Practices

Yes ☐ No ☐ ☐ Ventilation to control hazardous exposures to acceptable levels.

Yes ☐ No ☐ ☐ Physical access controls (barriers) necessary.

Yes ☐ No ☐ ☐ Pressurized cabs or control booths.

Yes ☐ No ☐ ☐ Remotely operated equipment.

Yes ☐ No ☐ ☐ Activity-specific operating procedures.

Yes ☐ No ☐ ☐ Removing all non-essential work from potential exposure.

Yes ☐ No ☐ ☐ Wet-down operations

Yes ☐ No ☐ ☐ Working upwind.

Others (Describe):



SECTION 5 PERSONAL PROTECTIVE EQUIPMENT (PPE)					
PPE	List Activity				
Level D, general work clothes coveralls, hard hat, safety glasses, and work shoes boot					
Level D – modified to include chemical resistant glove					
Level C chemical-resistant clothing with air purifying respirator					
Level B chemical resistant clothing with SCBA					
Level A totally-encapsulating chemical protective suit with self-contained breathing apparatus (SCBA)					
Expand description as necessary (e.g., hearing protection) special PPE requirements.					



SECTION 6 ONSITE ACTIVITY MONITORING

Activity Monitoring Provisions

Yes ☐ No ☐ Is IDLH monitoring necessary. If yes, what constituents _____

Yes ☐ No ☐ Lower Explosion Limit (LEL). Describe method:

Yes ☐ No ☐ Oxygen deficiency (e.g. confined space entry). Describe method:

Yes ☐ No ☐ Volatile organic constituents (VOCs). Describe method:

Yes ☐ No ☐ Personal exposure. Describe method:

Yes ☐ No ☐ Area monitoring. Describe method:

Yes ☐ No ☐ Heat/Cold. Describe method:

Yes ☐ No ☐ Other real time monitoring. Describe method(s):

Yes ☐ No ☐ Radiological. Describe method(s):

Describe the activities (Section 3c) where monitoring will be provided:

Other (Describe):

Identify monitoring instrument/equipment calibration and operability verifications, as appropriate:



SECTION 7 MEDICAL SURVEILLANCE

Is medical surveillance provided for BLM workers engaged in onsite activities?

Will there be BLM workers covered under this HASP who:

Yes ☐ **No** ☐ Require medical clearance; **Yes** ☐ **No** ☐ Is it current?

Yes ☐ **No** ☐ Are exposed or potentially exposed to hazardous substances or health hazards above permissible exposure limits (PELs) (or above published exposure levels if there is no PEL) for more than 30 days per year.

Yes ☐ **No** ☐ Wear a respirator for 30 days or more per year on site or as required to use respirators (See OSHA 1910.134).

Yes ☐ **No** ☐ Are exposed to unexpected or emergency releases of hazardous wastes above exposure limits (without wearing appropriate protective equipment) or who show signs, symptoms, or illness that may have resulted from exposure to hazardous substance

Yes ☐ **No** ☐ Are subject to OSHA expanded health standards (e.g., lead) with applicable medical monitoring requirements.

Yes ☐ **No** ☐ Responsible for responding to onsite hazardous materials (HAZMAT) releases (i.e., onsite HAZMAT team).

Yes ☐ **No** ☐ Are subject to other potential exposures or physical conditions of the site or work (e.g., strenuous work or heat stress) that indicate the need for medical consultation?

Discuss:



SECTION 8 TRAINING

General Worker Training

For each worker who may be exposed to hazardous substance, the following level of training is required:

Yes ☐ No ☐ 40 hours initial training, or
Yes ☐ No ☐ 24 hours supervised field experience
Yes ☐ No ☐ 8 hours annual refresher

Discussion:

For workers occasionally onsite for a limited task (e.g., groundwater monitoring, land surveying) with minimal exposure, the following level of training is required:

Yes ☐ No ☐ 24 hours initial training, or
Yes ☐ No ☐ 8 hours supervised field experience
Yes ☐ No ☐ 8 hours annual refresher

Discussion:

Supervisors/Managers

For each supervisor/manager who may be exposed to hazardous substance and/or who manage workers who may be exposed to hazardous substances, the following level of training is required:

Yes ☐ No ☐ 40 hours initial training
Yes ☐ No ☐ 24 hours supervised field experience
Yes ☐ No ☐ 8 hours annual refresher
Yes ☐ No ☐ 8 hours specialized training in employer's safety and health-related programs

Discussion:

Supervisors of employees occasionally onsite for a limited task (e.g., groundwater monitoring 8 hours supervised field experience monitoring, land surveying) or who supervise employees regularly onsite who are not exposed to health hazards, the following level of training is required:

Yes ☐ No ☐ 8 hours initial training
Yes ☐ No ☐ 8 hours supervised field experience
Yes ☐ No ☐ 8 hours annual refresher
Yes ☐ No ☐ 8 hours specialized training in employer's safety and health-related programs

Discussion:



SECTION 9 DECONTAMINATION

Some BLM sites and site activities may require personnel and /or equipment contamination.

Decontamination can vary from simple personal hygiene to complex decontamination zone protocols.

Yes ☐ **No** ☐ Will BLM personnel encounter an exclusion zone?

Describe:

Yes ☐ **No** ☐ Will decontamination of equipment and personnel be necessary?

Describe:

Yes ☐ **No** ☐ Will BLM personnel use a contractor's decontamination arrangement?

Describe:

Yes ☐ **No** ☐ Will BLM activities require spill control and containment provisions?

Describe:

Yes ☐ **No** ☐ Will BLM personnel apply PPE that will require decontamination?

Describe:

Yes ☐ **No** ☐ Can PPE requiring decontamination be disposed of and left onsite?

Describe:

Yes ☐ **No** ☐ Can PPE that requiring decontamination be bagged and returned to the office?

Describe:

Yes ☐ **No** ☐ Will on-site showers and/or change rooms be required?

Discuss additional decontamination issues:



SECTION 10 EMERGENCY RESPONSE PLANNING (ERP)

Some BLM sites and sites and/or spills may require BLM workers to function as emergency response personnel

ERP may need to address some or all of the following, depending on the situation. Only BLM personnel who are capable and competent should take on ERP responsibilities.

Yes ☐ No ☐ Provisions for pre-emergency planning (State/Local Emergency Planning On-Scene Coordinator/Commander, Hazardous Materials Team, Ambulance, Medical Treatment Facility (MTF), Regional Poison Control Center).

Describe:

Yes ☐ No ☐ Identification of personnel roles, lines of authority, and communication procedures?

Describe:

Yes ☐ No ☐ Criteria and procedures for emergency situation recognition and methods for prevention?

Describe:

Yes ☐ No ☐ Identification of safe distances and places of refuge?

Describe:

Yes ☐ No ☐ Site security and control?

Describe:

Yes ☐ No ☐ Evacuation procedures and routes, route to emergency medical treatment facility, emergency responder phone numbers?

Describe:

Yes ☐ No ☐ Decontamination procedures, including decontaminating injured employees (not covered in other sections of the HASP)?

Describe:

Yes ☐ No ☐ Emergency alerting and response procedures and criteria for alerting emergency responders?

Describe:

Yes ☐ No ☐ PPE and emergency equipment identification?

Describe:



Yes ☐ No ☐ Exposure monitoring required?

Describe:

Discuss additional decontamination issues:



SECTION 11 SITE CONTROL

Some BLM sites and/or spill response actions may require BLM workers to establish site control

If contractors or lead agencies in the case of spill responses have not established site control, BLM workers establishing site control may need to address the following.

Yes ☐ No ☐ A site map attached? If yes, insert Map in Attachment A.

Yes ☐ No ☐ Establishment of work zones, a clearly defined Exclusion Zone (EZ), Secure Zone (SZ), and a Contaminant Reduction Zone (CRZ) as a transition between EZ and SZ?

Describe – Show on Map in Attachment A:

Yes ☐ No ☐ Use of the “buddy” system?

Describe:

Yes ☐ No ☐ Site communications, including alerting employees of emergencies?

Describe:

Yes ☐ No ☐ Site security and control?

Describe:

Yes ☐ No ☐ Standard operating procedures and safe work practices, including site rules and prohibitions?

Describe:

Yes ☐ No ☐ Decontamination procedures, including decontaminating injured employees (not covered in other sections of the HASP)?

Describe:

Yes ☐ No ☐ Emergency alerting and response procedures and criteria for alerting emergency responders?

Describe:

Yes ☐ No ☐ Standard operating procedures and safe work practices, including site rules and prohibitions?

Describe:

Yes ☐ No ☐ Work permits and task/equipment-specific safety standard operating procedures?

Describe:



ATTACHMENT A: SITE MAP AND DIRECTIONS TO EMERGENCY RESPONSE RESOURCES



ATTACHMENT B: ACTIVITY HAZARD ASSESSMENT

Activity/Work Task:			
Project Location:			
Contract Number:			
Date Prepared:		Date Accepted:	
Prepared by (Name/Title):			
Reviewed by (Name/Title):			
Notes:			

Overall Risk Assessment Code (RAC) (Use highest code [letter/color])					M
Risk Assessment Code (RAC) Matrix					
Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each “Hazard” with identified safety “Controls” and determine RAC (See above)

Probability: is the likelihood of the activity to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.	RAC Chart
Severity: is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, or Negligible.	E = Extremely High Risk
Step 2: Identify the RAC (Probability vs. Severity) as E, H, M, or L for each “Hazard” on AHA. Annotate the overall highest RAC at the top of AHA.	H = High Risk
	M = Moderate Risk
	L = Low Risk

Job Hazard Analysis



**Occupational
Safety and Health
Administration**

U.S. Department of Labor

Job Hazard Analysis



U.S. Department of Labor
Occupational Safety and Health Administration
OSHA 3071
2002 (Revised)

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Who needs to read this booklet?

This booklet is for employers, foremen, and supervisors, but we encourage employees to use the information as well to analyze their own jobs and recognize workplace hazards so they can report them to you. It explains what a job hazard analysis is and offers guidelines to help you conduct your own step-by-step analysis.

What is a hazard?

A hazard is the potential for harm. In practical terms, a hazard often is associated with a condition or activity that, if left uncontrolled, can result in an injury or illness. See Appendix 2 for a list of common hazards and descriptions. Identifying hazards and eliminating or controlling them as early as possible will help prevent injuries and illnesses.

What is a job hazard analysis?

A job hazard analysis is a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment. Ideally, after you identify uncontrolled hazards, you will take steps to eliminate or reduce them to an acceptable risk level.

Why is job hazard analysis important?

Many workers are injured and killed at the workplace every day in the United States. Safety and health can add value to your business, your job, and your life. You can help prevent workplace injuries and illnesses by looking at your workplace operations, establishing proper job procedures, and ensuring that all employees are trained properly.

One of the best ways to determine and establish proper work procedures is to conduct a job hazard analysis. A job hazard analysis is one component of the larger commitment of a safety and health management system. (See page 15 for more information on safety and health management systems.)

What is the value of a job hazard analysis?

Supervisors can use the findings of a job hazard analysis to eliminate and prevent hazards in their workplaces. This is likely to result in fewer worker injuries and illnesses; safer, more effective work methods; reduced workers' compensation costs; and increased worker productivity. The analysis also can be a valuable tool for training new employees in the steps required to perform their jobs safely.

For a job hazard analysis to be effective, management must demonstrate its commitment to safety and health and follow through to correct any uncontrolled hazards identified. Otherwise, management will lose credibility and employees may hesitate to go to management when dangerous conditions threaten them.

What jobs are appropriate for a job hazard analysis?

A job hazard analysis can be conducted on many jobs in your workplace. Priority should go to the following types of jobs:

- Jobs with the highest injury or illness rates;
- Jobs with the potential to cause severe or disabling injuries or illness, even if there is no history of previous accidents;
- Jobs in which one simple human error could lead to a severe accident or injury;
- Jobs that are new to your operation or have undergone changes in processes and procedures; and
- Jobs complex enough to require written instructions.

Where do I begin?

1. **Involve your employees.** It is very important to involve your employees in the hazard analysis process. They have a unique understanding of the job, and this knowledge is invaluable for finding hazards. Involving employees will help minimize oversights, ensure a quality analysis, and get workers to “buy in” to the solutions because they will share ownership in their safety and health program.
2. **Review your accident history.** Review with your employees your worksite’s history of accidents and occupational illnesses that needed treatment, losses that required repair or replacement, and any “near misses” — events in which an accident or loss did not occur, but could have. These events are indicators that the existing hazard controls (if any) may not be adequate and deserve more scrutiny.
3. **Conduct a preliminary job review.** Discuss with your employees the hazards they know exist in their current work and surroundings. Brainstorm with them for ideas to eliminate or control those hazards.

If any hazards exist that pose an immediate danger to an employee’s life or health, take immediate action to protect the worker. Any problems that can be corrected easily should be corrected as soon as possible. Do not wait to complete your job hazard analysis. This will demonstrate your commitment to safety and health and enable you to focus on the hazards and jobs that need more study because of their complexity. For those hazards determined to present unacceptable risks, evaluate types of hazard controls. More information about hazard controls is found in Appendix 1.

4. **List, rank, and set priorities for hazardous jobs.**

List jobs with hazards that present unacceptable risks, based on those most likely to occur and with the most severe consequences. These jobs should be your first priority for analysis.

5. **Outline the steps or tasks.** Nearly every job can be broken down into job tasks or steps. When beginning a job hazard analysis, watch the employee perform the job and list each step as the worker takes it. Be sure to record enough information to describe each job action without getting overly detailed. Avoid making the breakdown of steps so detailed that it becomes unnecessarily long or so broad that it does not include basic steps. You may find it valuable to get input from other workers who have performed the same job. Later, review the job steps with the employee to make sure you have not omitted something. Point out that you are evaluating the job itself, not the employee's job performance. Include the employee in all phases of the analysis—from reviewing the job steps and procedures to discussing uncontrolled hazards and recommended solutions.

Sometimes, in conducting a job hazard analysis, it may be helpful to photograph or videotape the worker performing the job. These visual records can be handy references when doing a more detailed analysis of the work.

How do I identify workplace hazards?

A job hazard analysis is an exercise in detective work. Your goal is to discover the following:

- What can go wrong?
- What are the consequences?
- How could it arise?
- What are other contributing factors?
- How likely is it that the hazard will occur?

To make your job hazard analysis useful, document the answers to these questions in a consistent manner. Describing a hazard in this way helps to ensure that your efforts to eliminate the hazard and implement hazard controls help target the most important contributors to the hazard.

Good hazard scenarios describe:

- Where it is happening (environment),
- Who or what it is happening to (exposure),
- What precipitates the hazard (trigger),
- The outcome that would occur should it happen (consequence), and
- Any other contributing factors.

A sample form found in Appendix 3 helps you organize your information to provide these details.

Rarely is a hazard a simple case of one singular cause resulting in one singular effect. More frequently, many

contributing factors tend to line up in a certain way to create the hazard. Here is an example of a hazard scenario:

In the metal shop (environment), while clearing a snag (trigger), a worker's hand (exposure) comes into contact with a rotating pulley. It pulls his hand into the machine and severs his fingers (consequences) quickly.

To perform a job hazard analysis, you would ask:

- **What can go wrong?** The worker's hand could come into contact with a rotating object that "catches" it and pulls it into the machine.
- **What are the consequences?** The worker could receive a severe injury and lose fingers and hands.
- **How could it happen?** The accident could happen as a result of the worker trying to clear a snag during operations or as part of a maintenance activity while the pulley is operating. Obviously, this hazard scenario could not occur if the pulley is not rotating.
- **What are other contributing factors?** This hazard occurs very quickly. It does not give the worker much opportunity to recover or prevent it once his hand comes into contact with the pulley. This is an important factor, because it helps you determine the severity and likelihood of an accident when selecting appropriate hazard controls. Unfortunately, experience has shown that training is not very effective in hazard control when triggering events happen quickly because humans can react only so quickly.

- **How likely is it that the hazard will occur?** This determination requires some judgment. If there have been “near-misses” or actual cases, then the likelihood of a recurrence would be considered high. If the pulley is exposed and easily accessible, that also is a consideration. In the example, the likelihood that the hazard will occur is high because there is no guard preventing contact, and the operation is performed while the machine is running. By following the steps in this example, you can organize your hazard analysis activities.

The examples that follow show how a job hazard analysis can be used to identify the existing or potential hazards for each basic step involved in grinding iron castings.



Grinding Iron Castings: Job Steps

- Step 1.** Reach into metal box to right of machine, grasp casting, and carry to wheel.
- Step 2.** Push casting against wheel to grind off burr.
- Step 3.** Place finished casting in box to left of machine.

Example Job Hazard Analysis Form

<i>Job Location:</i> Metal Shop	<i>Analyst:</i> Joe Safety	<i>Date:</i>
<i>Task Description:</i> Worker reaches into metal box to the right of the machine, grasps a 15-pound casting and carries it to grinding wheel. Worker grinds 20 to 30 castings per hour.		
<i>Hazard Description:</i> Picking up a casting, the employee could drop it onto his foot. The casting's weight and height could seriously injure the worker's foot or toes.		
<i>Hazard Controls:</i> 1. Remove castings from the box and place them on a table next to the grinder. 2. Wear steel-toe shoes with arch protection. 3. Change protective gloves that allow a better grip. 4. Use a device to pick up castings.		

Job Location: Metal Shop	Analyst: Joe Safety	Date:
Task Description: Worker reaches into metal box to the right of the machine, grasps a 15-pound casting and carries it to grinding wheel. Worker grinds 20 to 30 castings per hour.		
Hazard Description: Castings have sharp burrs and edges that can cause severe lacerations.		
Hazard Controls: 1. Use a device such as a clamp to pick up castings. 2. Wear cut-resistant gloves that allow a good grip and fit tightly to minimize the chance that they will get caught in grinding wheel.		

<i>Job Location:</i> Metal Shop	<i>Analyst:</i> Joe Safety	<i>Date:</i>
<i>Task Description:</i> Worker reaches into metal box to the right of the machine, grasps a 15-pound casting and carries it to grinding wheel. Worker grinds 20 to 30 castings per hour.		
<i>Hazard Description:</i> Reaching, twisting, and lifting 15-pound castings from the floor could result in a muscle strain to the lower back.		
<i>Hazard Controls:</i> 1. Move castings from the ground and place them closer to the work zone to minimize lifting. Ideally, place them at waist height or on an adjustable platform or pallet. 2. Train workers not to twist while lifting and reconfigure work stations to minimize twisting during lifts.		

***Repeat similar forms
for each job step.***

How do I correct or prevent hazards?

After reviewing your list of hazards with the employee, consider what control methods will eliminate or reduce them. For more information on hazard control measures, see Appendix 1. The most effective controls are engineering controls that physically change a machine or work environment to prevent employee exposure to the hazard. The more reliable or less likely a hazard control can be circumvented, the better. If this is not feasible, administrative controls may be appropriate. This may involve changing how employees do their jobs.

Discuss your recommendations with all employees who perform the job and consider their responses carefully. If you plan to introduce new or modified job procedures, be sure they understand what they are required to do and the reasons for the changes.

What else do I need to know before starting a job hazard analysis?

The job procedures discussed in this booklet are for illustration only and do not necessarily include all the steps, hazards, and protections that apply to your industry. When conducting your own job safety analysis, be sure to consult the Occupational Safety and Health Administration standards for your industry. Compliance with these standards is mandatory, and by incorporating their requirements in your job hazard analysis, you can be sure that your health and safety program meets federal standards. OSHA standards, regulations, and technical information are available online at www.osha.gov.

Twenty-four states and two territories operate their own OSHA-approved safety and health programs and may have standards that differ slightly from federal requirements. Employers in those states should check with the appropriate state agency for more information. A list of applicable states and territories and contact information is provided on page 32.

Why should I review my job hazard analysis?

Periodically reviewing your job hazard analysis ensures that it remains current and continues to help reduce workplace accidents and injuries. Even if the job has not changed, it is possible that during the review process you will identify hazards that were not identified in the initial analysis.

It is particularly important to review your job hazard analysis if an illness or injury occurs on a specific job. Based on the circumstances, you may determine that you need to change the job procedure to prevent similar incidents in the future. If an employee's failure to follow proper job procedures results in a "close call," discuss the situation with all employees who perform the job and remind them of proper procedures. Any time you revise a job hazard analysis, it is important to train all employees affected by the changes in the new job methods, procedures, or protective measures adopted.

When is it appropriate to hire a professional to conduct a job hazard analysis?

If your employees are involved in many different or complex processes, you need professional help conducting your job hazard analyses. Sources of help include your insurance company, the local fire department, and private consultants with safety and health expertise. In addition, OSHA offers assistance through its regional and area offices and consultation services. Contact numbers are listed at the back of this publication.

Even when you receive outside help, it is important that you and your employees remain involved in the process of identifying and correcting hazards because you are on the worksite every day and most likely to encounter these hazards. New circumstances and a recombination of existing circumstances may cause old hazards to reappear and new hazards to appear. In addition, you and your employees must be ready and able to implement whatever hazard elimination or control measures a professional consultant recommends.

OSHA Assistance, Services, and Programs

How can OSHA help me?

OSHA can provide extensive help through a variety of programs, including assistance about safety and health programs, state plans, workplace consultations, Voluntary Protection Programs, strategic partnerships, training and education, and more.

How does safety and health program management assistance help employers and employees?

Effective management of worker safety and health protection is a decisive factor in reducing the extent and severity of work-related injuries and illnesses and their related costs. In fact, an effective safety and health program forms the basis of good worker protection and can save time and money—about \$4 for every dollar spent—and increase productivity.

To assist employers and employees in developing effective safety and health systems, OSHA published recommended *Safety and Health Program Management Guidelines*, (*Federal Register* 54(18):3908–3916, January 26, 1989). These voluntary guidelines can be applied to all worksites covered by OSHA.

The guidelines identify four general elements that are critical to the development of a successful safety and health management program:

- Management leadership and employee involvement;
- Worksite analysis;
- Hazard prevention and control; and
- Safety and health training.

The guidelines recommend specific actions under each of these general elements to achieve an effective safety and health program. The *Federal Register* notice is available online at www.osha.gov.

What are state plans?

State plans are OSHA-approved job safety and health programs operated by individual states or territories instead of Federal OSHA. The *Occupational Safety and Health Act of 1970 (OSH Act)* encourages states to develop and operate their own job safety and health plans and permits state enforcement of OSHA standards if the state has an approved plan. Once OSHA approves a state plan, it funds 50 percent of the program's operating costs. State plans must provide standards and enforcement programs, as well as voluntary compliance activities, that are at least as effective as those of Federal OSHA.

There are 26 state plans: 23 cover both private and public (state and local government) employment, and 3 (Connecticut, New Jersey, and New York) cover only the public sector. For more information on state plans, see the listing at the end of this publication, or visit OSHA's website at www.osha.gov.

How can consultation assistance help employers?

In addition to helping employers identify and correct specific hazards, OSHA's consultation service provides free, onsite assistance in developing and implementing effective workplace safety and health management systems that emphasize the prevention of worker injuries and illnesses.

Comprehensive consultation assistance provided by OSHA includes a hazard survey of the worksite and an appraisal of all aspects of the employer's existing safety and health management system. In addition, the service offers assistance to employers in developing and implementing an effective safety and health management system. Employers also may receive training and education services, as well as limited assistance away from the worksite.

Who can get consultation assistance and what does it cost?

Consultation assistance is available to small employers (with fewer than 250 employees at a fixed site and no more than 500 corporatewide) who want help in establishing and maintaining a safe and healthful workplace.

Funded largely by OSHA, the service is provided at no cost to the employer. Primarily developed for smaller employers with more hazardous operations, the consultation service is delivered by state governments employing professional safety and health consultants. No penalties are proposed or citations issued for hazards identified by the consultant. The employer's only obligation is to correct all identified serious hazards within the agreed-upon correction time frame.

Can OSHA assure privacy to an employer who asks for consultation assistance?

OSHA provides consultation assistance to the employer with the assurance that his or her name and firm and any information about the workplace will not be routinely reported to OSHA enforcement staff.

Can an employer be cited for violations after receiving consultation assistance?

If an employer fails to eliminate or control a serious hazard within the agreed-upon time frame, the Consultation Project Manager must refer the situation to the OSHA enforcement office for appropriate action. This is a rare occurrence, however, since employers request the service for the expressed purpose of identifying and fixing hazards in their workplaces.

Does OSHA provide any incentives for seeking consultation assistance?

Yes. Under the consultation program, certain exemplary employers may request participation in OSHA's Safety and Health Achievement Recognition Program (SHARP). Eligibility for participation in SHARP includes, but is not limited to, receiving a full-service, comprehensive consultation visit, correcting all identified hazards, and developing an effective safety and health management system.

Employers accepted into SHARP may receive an exemption from programmed inspections (not complaint or accident investigation inspections) for a period of 1 year initially, or 2 years upon renewal.

For more information concerning consultation assistance, see the list of consultation offices beginning on page 36, contact your regional or area OSHA office, or visit OSHA's website at www.osha.gov.

What are the Voluntary Protection Programs?

Voluntary Protection Programs (VPPs) represent one part of OSHA's effort to extend worker protection beyond the minimum required by OSHA standards. VPP—along with onsite consultation services, full-service area offices,

and OSHA's Strategic Partnership Program (OSPP)—represents a cooperative approach which, when coupled with an effective enforcement program, expands worker protection to help meet the goals of the *OSH Act*.

How does VPP work?

There are three levels of VPP recognition: Star, Merit, and Demonstration. All are designed to do the following:

- Recognize employers who have successfully developed and implemented effective and comprehensive safety and health management systems;
- Encourage these employers to continuously improve their safety and health management systems;
- Motivate other employers to achieve excellent safety and health results in the same outstanding way; and
- Establish a relationship between employers, employees, and OSHA that is based on cooperation.

How does VPP help employers and employees?

VPP participation can mean the following:

- Reduced numbers of worker fatalities, injuries, and illnesses;
- Lost-workday case rates generally 50 percent below industry averages;
- Lower workers' compensation and other injury- and illness-related costs;
- Improved employee motivation to work safely, leading to a better quality of life at work;
- Positive community recognition and interaction;

- Further improvement and revitalization of already-good safety and health programs; and a
- Positive relationship with OSHA.

How does OSHA monitor VPP sites?

OSHA reviews an employer's VPP application and conducts a VPP Onsite Evaluation to verify that the safety and health management systems described are operating effectively at the site. OSHA conducts Onsite Evaluations on a regular basis, annually for participants at the Demonstration level, every 18 months for Merit, and every 3 to 5 years for Star. Each February, all participants must send a copy of their most recent Annual Evaluation to their OSHA regional office. This evaluation must include the worksite's record of injuries and illnesses for the past year.

Can OSHA inspect an employer who is participating in the VPP?

Sites participating in VPP are not scheduled for regular, programmed inspections. OSHA handles any employee complaints, serious accidents, or significant chemical releases that may occur at VPP sites according to routine enforcement procedures.

Additional information on VPP is available from OSHA national, regional, and area offices, listed beginning on page 27. Also, see **Outreach** at OSHA's website at www.osha.gov.

How can a partnership with OSHA improve worker safety and health?

OSHA has learned firsthand that voluntary, cooperative partnerships with employers, employees, and unions can be a useful alternative to traditional enforcement and an effective way to reduce worker deaths, injuries, and illnesses. This is especially true when a partnership leads to the development and implementation of a comprehensive workplace safety and health management system.

What is OSHA's Strategic Partnership Program (OSPP)?

OSHA Strategic Partnerships are alliances among labor, management, and government to foster improvements in workplace safety and health. These partnerships are voluntary, cooperative relationships between OSHA, employers, employee representatives, and others such as trade unions, trade and professional associations, universities, and other government agencies. OSPPs are the newest member of OSHA's family of cooperative programs.

What do OSPPs do?

These partnerships encourage, assist, and recognize the efforts of the partners to eliminate serious workplace hazards and achieve a high level of worker safety and health. Whereas OSHA's Consultation Program and VPP entail one-on-one relationships between OSHA and individual worksites, most strategic partnerships seek to have a broader impact by building cooperative relationships with groups of employers and employees.

What are the different kinds of OSPPs?

There are two major types:

- Comprehensive, which focuses on establishing comprehensive safety and health management systems at partnering worksites; and
- Limited, which helps identify and eliminate hazards associated with worker deaths, injuries, and illnesses, or have goals other than establishing comprehensive worksite safety and health programs.

OSHA is interested in creating new OSPPs at the national, regional, and local levels. OSHA also has found limited partnerships to be valuable. Limited partnerships might address the elimination or control of a specific industry hazard.

What are the benefits of participation in the OSPP?

Like VPP, OSPP can mean the following:

- Fewer worker fatalities, injuries, and illnesses;
- Lower workers' compensation and other injury- and illness-related costs;
- Improved employee motivation to work safely, leading to a better quality of life at work and enhanced productivity;

- Positive community recognition and interaction;
- Development of or improvement in safety and health management systems; and
- Positive interaction with OSHA.

For more information about this program, contact your nearest OSHA office or go to the agency website at www.osha.gov.

Does OSHA have occupational safety and health training for employers and employees?

Yes. The OSHA Training Institute in Des Plaines, IL, provides basic and advanced training and education in safety and health for federal and state compliance officers, state consultants, other federal agency personnel, and private-sector employers, employees, and their representatives.

Institute courses cover diverse safety and health topics including electrical hazards, machine guarding, personal protective equipment, ventilation, and ergonomics. The facility includes classrooms, laboratories, a library, and an audiovisual unit. The laboratories contain various demonstrations and equipment, such as power presses, woodworking and welding shops, a complete industrial ventilation unit, and a sound demonstration laboratory. More than 57 courses dealing with subjects such as safety and health in the construction industry and methods of compliance with OSHA standards are available for personnel in the private sector.

In addition, OSHA's 73 area offices are full-service centers offering a variety of informational services such as personnel for speaking engagements, publications, audiovisual aids on workplace hazards, and technical advice.

Does OSHA give money to organizations for training and education?

OSHA awards grants through its Susan Harwood Training Grant Program to nonprofit organizations to provide safety and health training and education to employers and workers in the workplace. The grants focus on programs that will educate workers and employers in small business (fewer than 250 employees), train workers and employers about new OSHA standards or high-risk activities or hazards. Grants are awarded for 1 year and may be renewed for an additional 12 months depending on whether the grantee has performed satisfactorily.

OSHA expects each organization awarded a grant to develop a training and/or education program that addresses a safety and health topic named by OSHA, recruit workers and employers for the training, and conduct the training. Grantees are also expected to follow-up with people who have been trained to find out what changes were made to reduce the hazards in their workplaces as a result of the training.

Each year OSHA has a national competition that is announced in the *Federal Register* and on the Internet at www.osha-slc.gov/Training/sharwood/sharwood.html. If you do not have access to the Internet, you can contact the OSHA Office of Training and Education, 1555 Times Drive, Des Plaines, IL 60018, (847) 297-4810, for more information.

Does OSHA have other assistance materials available?

Yes. OSHA has a variety of materials and tools available on its website at www.osha.gov. These include eTools, Expert Advisors, Electronic Compliance Assistance Tools (e-CATs), Technical Links, regulations, directives, publications, videos, and other information for employers and employees. OSHA's software programs and compliance assistance tools walk you through challenging safety and health issues and common problems to find the best solutions for your workplace. OSHA's comprehensive publications program includes more than 100 titles to help you understand OSHA requirements and programs.

OSHA's CD-ROM includes standards, interpretations, directives, and more and can be purchased on CD-ROM from the U.S. Government Printing Office. To order, write to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, or phone (202) 512-1800. Specify *OSHA Regulations, Documents and Technical Information on CD-ROM (ORDT)*, GPO Order No. S/N 729-013-00000-5.

What other publications does OSHA offer?

OSHA offers more than 100 documents, including brochures, fact sheets, posters, pocket cards, flyers, technical documents, and a quarterly magazine. These documents are available online at www.osha.gov or by calling (202) 693-1888.

What do I do in case of an emergency or if I need to file a complaint?

To report an emergency, file a complaint, or seek OSHA advice, assistance, or products, call (800) 321-OSHA or contact your nearest OSHA regional or area office listed beginning on page 27. The teletypewriter (TTY) number is (877) 889-5627.

You can also file a complaint online and obtain more information on OSHA federal and state programs by visiting OSHA's website at www.osha.gov.

For more information on grants, training, and education, write: OSHA Training Institute, Office of Training and Education, 1555 Times Drive, Des Plaines, IL 60018; call (847) 297-4810; or see Outreach on OSHA's website at www.osha.gov.

OSHA Regional and Area Offices

OSHA Regional Offices

Region I

(CT,* ME, MA, NH, RI, VT*)
JFK Federal Building, Room E340
Boston, MA 02203
(617) 565-9860

Region II

(NJ,* NY,* PR,* VI*)
201 Varick Street, Room 670
New York, NY 10014
(212) 337-2378

Region III

(DE, DC, MD,* PA,* VA,* WV)
The Curtis Center
170 S. Independence Mall West
Suite 740 West
Philadelphia, PA 19106-3309
(215) 861-4900

Region IV

(AL, FL, GA, KY,* MS, NC,* SC,* TN*)
Atlanta Federal Center
61 Forsyth Street, SW, Room 6T50
Atlanta, GA 30303
(404) 562-2300

Region V

(IL, IN,* MI,* MN,* OH, WI)
230 South Dearborn Street
Room 3244
Chicago, IL 60604
(312) 353-2220

Region VI

(AR, LA, NM,* OK, TX)
525 Griffin Street, Room 602
Dallas, TX 75202
(214) 767-4731 or 4736 x224

Region VII

(IA,* KS, MO, NE)
City Center Square
1100 Main Street, Suite 800
Kansas City, MO 64105
(816) 426-5861

Region VIII

(CO, MT, ND, SD, UT,* WY*)
1999 Broadway, Suite 1690
Denver, CO 80202-5716
(303) 844-1600

Region IX

(American Samoa, AZ,* CA,* HI, NV,* Northern Mariana Islands)
71 Stevenson Street, Room 420
San Francisco, CA 94105
(415) 975-4310

Region X

(AK,* ID, OR,* WA*)
1111 Third Avenue, Suite 715
Seattle, WA 98101-3212
(206) 553-5930

*These states and territories operate their own OSHA-approved job safety and health programs (Connecticut, New Jersey and New York plans cover public employees only). States with approved programs must have a standard that is identical to, or at least as effective as, the federal standard.

OSHA Area Offices

Birmingham, AL
(205) 731-1534

Mobile, AL
(251) 441-6131

Anchorage, AK
(907) 271-5152

Little Rock, AR
(501) 324-6291(5818)

Phoenix, AZ
(602) 640-2348

San Diego, CA
(619) 557-5909

Sacramento, CA
(916) 566-7471

Denver, CO
(303) 844-5285

Greenwood Village, CO
(303) 843-4500

Bridgeport, CT
(203) 579-5581

Hartford, CT
(860) 240-3152

Wilmington, DE
(302) 573-6518

Fort Lauderdale, FL
(954) 424-0242

Jacksonville, FL
(904) 232-2895

Tampa, FL
(813) 626-1177

Savannah, GA
(912) 652-4393

Smyrna, GA
(770) 984-8700

Tucker, GA
(770) 493-6644/6742/8419

Des Moines, IA
(515) 284-4794

Boise, ID
(208) 321-2960

Calumet City, IL
(708) 891-3800

Des Plaines, IL
(847) 803-4800

Fairview Heights, IL
(618) 632-8612

North Aurora, IL
(630) 896-8700

Peoria, IL
(309) 671-7033

Indianapolis, IN
(317) 226-7290

Wichita, KS
(316) 269-6644

Frankfort, KY
(502) 227-7024

Baton Rouge, LA
(225) 389-0474 (0431)

Braintree, MA
(617) 565-6924

Methuen, MA
(617) 565-8110

Springfield, MA
(413) 785-0123

Linthicum, MD
(410) 865-2055/2056

Bangor, ME
(207) 941-8177

Portland, ME
(207) 780-3178

August, ME
(207) 622-8417

Lansing, MI
(517) 327-0904

Minneapolis, MN
(612) 664-5460

Kansas City, MO
(816) 483-9531

St. Louis, MO
(314) 425-4249

Jackson, MS
(601) 965-4606

Billings, MT
(406) 247-7494

Raleigh, NC
(919) 856-4770

Omaha, NE
(402) 221-3182

Bismark, ND
(701) 250-4521

Concord, NH
(603) 225-1629

Avenel, NJ
(732) 750-3270

Hasbrouck Heights, NJ
(201) 288-1700

Marlton, NJ
(856) 757-5181

Parsippany, NJ
(973) 263-1003

Carson City, NV
(775) 885-6963

Albany, NY
(518) 464-4338

Bayside, NY
(718) 279-9060

Bowmansville, NY
(716) 684-3891

New York, NY
(212) 337-2636

North Syracuse, NY
(315) 451-0808

Tarrytown, NY
(914) 524-7510

Westbury, NY
(516) 334-3344

Cincinnati, OH
(513) 841-4132

Cleveland, OH
(216) 522-3818

Columbus, OH
(614) 469-5582

Toledo, OH
(419) 259-7542

Oklahoma City, OK
(405) 278-9560

Portland, OR
(503) 326-2251

Allentown, PA
(610) 776-0592

Erie, PA
(814) 833-5758

Harrisburg, PA
(717) 782-3902

Philadelphia, PA
(215) 597-4955

Pittsburgh, PA
(412) 395-4903

Wilkes-Barre, PA
(570) 826-6538

Guaynabo, PR
(787) 277-1560

Providence, RI
(401) 528-4669

Columbia, SC
(803) 765-5904

Nashville, TN
(615) 781-5423

Austin, TX
(512) 916-5783 (5788)

Corpus Christi, TX
(361) 888-3420

Dallas, TX
(214) 320-2400 (2558)

El Paso, TX
(915) 534-6251

Fort Worth, TX
(817) 428-2470 (485-7647)

Houston, TX
(281) 591-2438 (2787)

Houston, TX
(281) 286-0583/0584 (5922)

Lubbock, TX
(806) 472-7681 (7685)

Salt Lake City, UT
(801) 530-6901

Norfolk, VA
(757) 441-3820

Bellevue, WA
(206) 553-7520

Appleton, WI
(920) 734-4521

Eau Claire, WI
(715) 832-9019

Madison, WI
(608) 264-5388

Milwaukee, WI
(414) 297-3315

Charleston, WV
(304) 347-5937

OSHA-Approved Safety and Health Plans

Alaska

Alaska Department of Labor
and Workforce Development

Commissioner
(907) 465-2700
FAX: (907) 465-2784

Program Director
(907) 269-4904
FAX: (907) 269-4915

Arizona

Industrial Commission
of Arizona

Director, ICA
(602) 542-4411
FAX: (602) 542-1614

Program Director
(602) 542-5795
FAX: (602) 542-1614

California

California Department of
Industrial Relations

Director
(415) 703-5050
FAX: (415) 703-5114

Chief
(415) 703-5100
FAX: (415) 703-5114

Manager, Cal/OSHA
Program Office
(415) 703-5177
FAX: (415) 703-5114

Connecticut

Connecticut Department
of Labor

Commissioner
(860) 566-5123
FAX: (860) 566-1520

Conn-OSHA Director
(860) 566-4550
FAX: (860) 566-6916

Hawaii

Hawaii Department of Labor
and Industrial Relations

Director
(808) 586-8844
FAX: (808) 586-9099

Administrator
(808) 586-9116
FAX: (808) 586-9104

Indiana

Indiana Department of Labor

Commissioner
(317) 232-2378
FAX: (317) 233-3790

Deputy Commissioner
(317) 232-3325
FAX: (317) 233-3790

Iowa

Iowa Division of Labor
Commissioner
(515) 281-6432
FAX: (515) 281-4698
Administrator
(515) 281-3469
FAX: (515) 281-7995

Kentucky

Kentucky Labor Cabinet
Secretary (502) 564-3070
FAX: (502) 564-5387
Federal/State Coordinator
(502) 564-3070 ext.240
FAX: (502) 564-1682

Maryland

Maryland Division of Labor
and Industry
Commissioner
(410) 767-2999
FAX: (410) 767-2300
Deputy Commissioner
(410) 767-2992
FAX: (410) 767-2003
Assistant Commissioner, MOSH
(410) 767-2215
FAX: (410) 767-2003

Michigan

Michigan Department of
Consumer and Industry Services
Director
(517) 322-1814
FAX: (517) 322-1775

Minnesota

Minnesota Department of
Labor and Industry
Commissioner
(651) 296-2342
FAX: (651) 282-5405
Assistant Commissioner
(651) 296-6529
FAX: (651) 282-5293
Administrative Director,
OSHA Management Team
(651) 282-5772
FAX: (651) 297-2527

Nevada

Nevada Division of
Industrial Relations
Administrator
(775) 687-3032
FAX: (775) 687-6305
Chief Administrative Officer
(702) 486-9044
FAX: (702) 990-0358
[Las Vegas (702) 687-5240]

New Jersey

New Jersey Department of Labor
Commissioner
(609) 292-2975
FAX: (609) 633-9271
Assistant Commissioner
(609) 292-2313
FAX: (609) 292-1314
Program Director, PEOSH
(609) 292-3923
FAX: (609) 292-4409

New Mexico

New Mexico Environment
Department

Secretary
(505) 827-2850
FAX: (505) 827-2836

Chief
(505) 827-4230
FAX: (505) 827-4422

New York

New York Department of Labor

Acting Commissioner
(518) 457-2741
FAX: (518) 457-6908

Division Director
(518) 457-3518
FAX: (518) 457-6908

North Carolina

North Carolina Department
of Labor

Commissioner
(919) 807-2900
FAX: (919) 807-2855

Deputy Commissioner,
OSH Director
(919) 807-2861
FAX: (919) 807-2855

OSH Assistant Director
(919) 807-2863
FAX: (919) 807-2856

Oregon

Oregon Occupational Safety
and Health Division

Administrator
(503) 378-3272
FAX: (503) 947-7461

Deputy Administrator for Policy
(503) 378-3272
FAX: (503) 947-7461

Deputy Administrator
for Operations
(503) 378-3272
FAX: (503) 947-7461

Puerto Rico

Puerto Rico Department of
Labor and Human Resources

Secretary
(787) 754-2119
FAX: (787) 753-9550

Assistant Secretary for
Occupational Safety and Health
(787) 756-1100,
1106 / 754-2171
FAX: (787) 767-6051

Deputy Director for
Occupational Safety and Health
(787) 756-1100/1106,
754-2188
FAX: (787) 767-6051

South Carolina

South Carolina Department of
Labor, Licensing, and
Regulation

Director
(803) 896-4300
FAX: (803) 896-4393

Program Director
(803) 734-9644
FAX: (803) 734-9772

Tennessee

Tennessee Department of Labor

Commissioner

(615) 741-2582

FAX: (615) 741-5078

Acting Program Director

(615) 741-2793

FAX: (615) 741-3325

Utah

Utah Labor Commission

Commissioner

(801) 530-6901

FAX: (801) 530-7906

Administrator

(801) 530-6898

FAX: (801) 530-6390

Vermont

Vermont Department of
Labor and Industry

Commissioner

(802) 828-2288

FAX: (802) 828-2748

Project Manager

(802) 828-2765

FAX: (802) 828-2195

Virgin Islands

Virgin Islands Department
of Labor

Acting Commissioner

(340) 773-1990

FAX: (340) 773-1858

Program Director

(340) 772-1315

FAX: (340) 772-4323

Virginia

Virginia Department of Labor
and Industry

Commissioner

(804) 786-2377

FAX: (804) 371-6524

Director, Office of Legal Support

(804) 786-9873

FAX: (804) 786-8418

Washington

Washington Department of
Labor and Industries

Director

(360) 902-4200

FAX: (360) 902-4202

Assistant Director

(360) 902-5495

FAX: (360) 902-5529

Program Manager,
Federal-State Operations

(360) 902-5430

FAX: (360) 902-5529

Wyoming

Wyoming Department of
Employment

Safety Administrator

(307) 777-7786

FAX: (307) 777-3646

OSHA Consultation Projects

Anchorage, AK
(907) 269-4957

Tuscaloosa, AL
(205) 348-3033

Little Rock, AR
(501) 682-4522

Phoenix, AZ
(602) 542-1695

Sacramento, CA
(916) 263-2856

Fort Collins, CO
(970) 491-6151

Wethersfield, CT
(860) 566-4550

Washington, DC
(202) 541-3727

Wilmington, DE
(302) 761-8219

Tampa, FL
(813) 974-9962

Atlanta, GA
(404) 894-2643

Tiyam, GU
9-1-(671) 475-1101

Honolulu, HI
(808) 586-9100

Des Moines, IA
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Appendices

Appendix 1

Hazard Control Measures

Information obtained from a job hazard analysis is useless unless hazard control measures recommended in the analysis are incorporated into the tasks. Managers should recognize that not all hazard controls are equal. Some are more effective than others at reducing the risk.

The order of precedence and effectiveness of hazard control is the following:

1. Engineering controls.
2. Administrative controls.
3. Personal protective equipment.

Engineering controls include the following:

- Elimination/minimization of the hazard—Designing the facility, equipment, or process to remove the hazard, or substituting processes, equipment, materials, or other factors to lessen the hazard;
- Enclosure of the hazard using enclosed cabs, enclosures for noisy equipment, or other means;
- Isolation of the hazard with interlocks, machine guards, blast shields, welding curtains, or other means; and
- Removal or redirection of the hazard such as with local and exhaust ventilation.

Administrative controls include the following:

- Written operating procedures, work permits, and safe work practices;
- Exposure time limitations (used most commonly to control temperature extremes and ergonomic hazards);
- Monitoring the use of highly hazardous materials;
- Alarms, signs, and warnings;
- Buddy system; and
- Training.

Personal Protective Equipment—such as respirators, hearing protection, protective clothing, safety glasses, and hardhats—is acceptable as a control method in the following circumstances:

- When engineering controls are not feasible or do not totally eliminate the hazard;
- While engineering controls are being developed;
- When safe work practices do not provide sufficient additional protection; and
- During emergencies when engineering controls may not be feasible.

Use of one hazard control method over another higher in the control precedence may be appropriate for providing interim protection until the hazard is abated permanently. In reality, if the hazard cannot be eliminated entirely, the adopted control measures will likely be a combination of all three items instituted simultaneously.

Appendix 2

Common Hazards and Descriptions

Hazards	Hazard Descriptions
Chemical (Toxic)	A chemical that exposes a person by absorption through the skin, inhalation, or through the blood stream that causes illness, disease, or death. The amount of chemical exposure is critical in determining hazardous effects. Check Material Safety Data Sheets (MSDS), and/or OSHA 1910.1000 for chemical hazard information.
Chemical (Flammable)	A chemical that, when exposed to a heat ignition source, results in combustion. Typically, the lower a chemical's flash point and boiling point, the more flammable the chemical. Check MSDS for flammability information.
Chemical (Corrosive)	A chemical that, when it comes into contact with skin, metal, or other materials, damages the materials. Acids and bases are examples of corrosives.
Explosion (Chemical Reaction)	Self explanatory.
Explosion (Over Pressurization)	Sudden and violent release of a large amount of gas/energy due to a significant pressure difference such as rupture in a boiler or compressed gas cylinder.
Electrical (Shock/ Short Circuit)	Contact with exposed conductors or a device that is incorrectly or inadvertently grounded, such as when a metal ladder comes into contact with power lines. 60Hz alternating current (common house current) is very dangerous because it can stop the heart.

Hazards	Hazard Descriptions
Electrical (Fire)	Use of electrical power that results in electrical overheating or arcing to the point of combustion or ignition of flammables, or electrical component damage.
Electrical (Static/ESD)	The moving or rubbing of wool, nylon, other synthetic fibers, and even flowing liquids can generate static electricity. This creates an excess or deficiency of electrons on the surface of material that discharges (spark) to the ground resulting in the ignition of flammables or damage to electronics or the body's nervous system.
Electrical (Loss of Power)	Safety-critical equipment failure as a result of loss of power.
Ergonomics (Strain)	Damage of tissue due to overexertion (sprains and strains) or repetitive motion.
Ergonomics (Human Error)	A system design, procedure, or equipment that is error-provocative. (A switch goes up to turn something off).
Excavation (Collapse)	Soil collapse in a trench or excavation as a result of improper or inadequate shoring. Soil type is critical in determining the hazard likelihood.
Fall (Slip, Trip)	Conditions that result in falls (impacts) from height or traditional walking surfaces (such as slippery floors, poor housekeeping, uneven walking surfaces, exposed ledges, etc.)
Fire/Heat	Temperatures that can cause burns to the skin or damage to other organs. Fires require a heat source, fuel, and oxygen.
Mechanical/ Vibration (Chaffing/ Fatigue)	Vibration that can cause damage to nerve endings, or material fatigue that results in a safety-critical failure. (Examples are abraded slings and ropes, weakened hoses and belts.)

Hazards	Hazard Descriptions
Mechanical Failure	Self explanatory; typically occurs when devices exceed designed capacity or are inadequately maintained.
Mechanical	Skin, muscle, or body part exposed to crushing, caught-between, cutting, tearing, shearing items or equipment.
Noise	Noise levels (>85 dBA 8 hr TWA) that result in hearing damage or inability to communicate safety-critical information.
Radiation (Ionizing)	Alpha, Beta, Gamma, neutral particles, and X-rays that cause injury (tissue damage) by ionization of cellular components.
Radiation (Non-Ionizing)	Ultraviolet, visible light, infrared, and microwaves that cause injury to tissue by thermal or photochemical means.
Struck By (Mass Acceleration)	Accelerated mass that strikes the body causing injury or death. (Examples are falling objects and projectiles.)
Struck Against	Injury to a body part as a result of coming into contact of a surface in which action was initiated by the person. (An example is when a screwdriver slips.)
Temperature Extreme (Heat/Cold)	Temperatures that result in heat stress, exhaustion, or metabolic slow down such as hypothermia.
Visibility	Lack of lighting or obstructed vision that results in an error or other hazard.
Weather Phenomena (Snow/Rain/Wind/Ice)	Self explanatory.

Appendix 3
Sample Job Hazard Analysis Form

<i>Job Title:</i>	<i>Job Location:</i>	<i>Analyst</i>	<i>Date</i>
<i>Task #</i>	<i>Task Description:</i>		
<i>Hazard Type:</i>	<i>Hazard Description:</i>		
<i>Consequence:</i>	<i>Hazard Controls:</i>		
<i>Rational or Comment:</i>			



**Occupational Safety
and Health Administration**

U.S. Department of Labor