## 4.1 SOIL SAMPLE COLLECTION AND STATISTICAL INFERENCE OF AVERAGE CONTAMINANT CONCENTRATIONS IN DECISION UNITS

In most cases, the goal of investigating hazardous substances in individual decision units (DU) is to determine representative average concentrations of targeted Chemicals of Potential Concern (COPCs) within the unit (see Section 3). Determining the maximum concentration of the contaminant within the DU is not usually necessary or relevant for the purposes of an Environmental Hazard Evaluation. A DU is an area where a decision is to be made regarding the extent and magnitude of contaminants with respect to the potential environmental hazards posed by the existing or anticipated future exposure to contaminants (Ramsey and Hewitt., 2005).

To properly infer a representative average contaminant concentration by collecting and analyzing only a small portion of soil within the DU, it is very important that the sample collection and analysis be both unbiased and precise. Unbiased sampling requires random increments to be collected using the appropriate sampling tool and sampling method. Collection of precise samples requires an adequate volume of soil as well as a sufficient number of random increments from across the DU. Precision and absence of bias are needed to meet the Data Quality Objectives (DQO) established for soil investigations during systematic planning. Representative samples are generally collected with a soil coring device or other equipment to collect core-like samples across the DU from a minimum of 30 systematic random or stratified random locations. The resulting data are used to estimate average contaminant concentrations within the DU as a whole. As discussed in the following subsections, estimating representative average contaminant concentrations within a DU is best accomplished using a *Multi-increment* sample collection approach rather than a discrete sample or a judgmental sample collection approach.

A *Multi-increment* sampling approach is preferable in most soil sampling situations. Sampling and Analysis Plans (SAPs) should clearly identify situations where a *Multi-increment* sampling approach is not selected, and provide a rationale for the alternate approach. The HEER Office may be consulted regarding the use of options other than *Multi-increment* sampling for specific circumstances.

For surface soils where the use of hand tools is feasible, *Multi-increment* soil sample collection is relatively simple to accomplish (typically for non-volatile contaminants). *Multi-increment* soil sampling is more time and cost intensive for subsurface soils because in many situations, soil-drilling equipment or soil excavation equipment must be used.

If only low numbers of increments (e.g., < 30) can be collected in a subsurface DU due to site constraints or cost constraints, data gained from the sampling may generally be expected to be limited (e.g., less representative of the average COPC concentrations in the subsurface DU). Under these circumstances, it is important that a judgment call be made prior to sampling as to whether collecting limited sampling data would meet the DQO of the investigation, or some other option should be pursued as an alternative (see Subsection 4.2.6).

*Multi-increment* sampling of subsurface soils contaminated with volatile chemicals involves similar challenges and warrants careful review of DQO, as well as options available for sampling. In addition, *Multi-increment* sampling for volatiles requires close coordination with the laboratory to implement appropriate modifications to the traditional “methanol method” for volatiles sampling in soils (see Subsection 4.2.7).

Without random selection of a sufficient number of soil sample increments across a DU, it is not appropriate to statistically infer average contaminant concentrations throughout the DU. As a result, the usefulness of any judgmental sampling (i.e., biased sampling) depends entirely on how well the sample contamination distribution is known by the sample collector (as well as how the samples are collected). Typically, this type of sampling would be limited to an easily observable decision unit such as an obvious spill area where the intent of the sample collection and analysis is to qualitatively confirm COPCs that were known or reported to be spilled.

Professional judgment is critical in reviewing relevant information and choosing DUs where COPCs will be representatively sampled. As discussed in Section 3, considerations in choosing DUs include:

- Present and potential future exposure scenarios
- The type of environmental hazard presented by the COPCs
- Knowledge of any large spill areas

- Site physical characteristics that could influence the distribution of COPCs
- Historical information on past site activities
- Evaluation of any existing screening or sampling data
- Other relevant factors

Based on a review of such information, judgment is used to define DUs that will best represent COPCs at the site. Once DUs are selected, representative sampling methods (e.g., *Multi-increment* sampling) are employed to sample and infer average contaminant concentrations across each DU. The average contaminant concentrations are compared to applicable HDOH Environmental Action Levels (EALs) to make decisions regarding the need for any subsequent response actions.