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System Description for DART (Decision Analysis for Remediation Technologies)

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LOCKHEED MARTIN

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ABSTRACT

DART is a computer aided system populated with influence models to determine quantitative benefits derived by matching requirements and technologies. The DART database is populated with data from over 900 DOE sites from 10 Field Offices. These sites are either source terms, such as buried waste pits, or soil or groundwater contaminated plumes. The data, traceable to published documents, consists of site-specific data (contaminants, area, volume, depth, size, remedial action dates, site preferred remedial option), problems (e.g., offsite contaminant plume), and Site Technology Coordinating Group (STCG) need statements (also contained in the Ten-Year Plan). DART uses this data to calculate and derive site priorities, risk rankings, and site specific technology requirements. DART is also populated with over 900 industry and DOE SCFA technologies. Technology capabilities can be used to "match" technologies to waste sites based on the technology's capability to meet site requirements and constraints. Queries may be used to access, sort, roll-up, and rank site data. Data roll-ups may be graphically displayed.

EXECUTIVE SUMMARY

Responding to suggestions from the National Research Council and the U.S. House of Representatives Committee of Commerce to establish formal and quantitative performance criteria for technology funding decisions, the Department of Energy's Subsurface Contaminants Focus Area (SCFA) funded a proposal to develop a decision analysis tool to support technology funding decisions. The tool (Decision Analysis for Remediation Technologies—DART) uses a systems engineering approach to provide the analysis necessary to defensibly support technology development investment decisions.

Waste sites are defined by the site-specific requirements and constraints that must be met in order to achieve cleanup. Remediation technologies, either proposed or existing, have specific capabilities that allow comparison to the site-specific requirements and constraints. The DART decision tool supports these comparisons either on a site-by-site, grouping of sites, or national basis. DART also assesses the benefit of a particular funding decision relative to a technology's projected cost and performance at DOE waste sites.

Defining the Problem

Three sources of requirements define the waste sites: Regulatory Drivers, Site Characteristics, and Other Constraints. Combined, these requirements define the nature of the problem posed by remediation of each individual waste site. Technology solutions can not be developed efficiently without a clear understanding of the requirements that must be addressed.

The source of many requirements may be traced to regulatory drivers. The primary regulations that serve as a source for remediation technology requirements come from 10 CFR Part 61, 40 CFR Part 241 and 264, and DOE Order 5820.2A.

Site characteristics also drive requirements. When seeking technology solutions, contaminants, concentrations, geology, and waste site boundaries are all examples of the site characteristic that become requirements. However, requirements for the DOE complex can be different than requirements for a single site. For example, each "retrieval" site must retrieve waste at different depths. Requirements are expressed as value ranges for all sites, such as retrieve waste from the surface to 100 feet. This "roll-up" of requirements is critical when making decisions on specific technology proposals. Technology performance objectives can be managed to optimize technology development to obtain maximum utilization throughout the complex.

Other site constraints impact the technology solutions. These constraints often change, requiring technology developers and managers to periodically reassess their goals. An example of a site constraint is the negotiated cleanup schedule for a specific waste site. Record of Decisions (RODs) are key dates for selection of a technology remedy. Technology development schedules that don't support the site's schedules should be modified or technology development activity re-directed. DART also uses a site-preferred solution (configuration option) as a constraint. This constraint enables development of a lower tier of technology/system-based requirements. Thirteen (13) configuration options from "Walk Away" to "In Situ Treatment" were developed to form the functions and requirements, and assign technology categories associated with site preferred remedial options.

Matching Technologies to Site Requirements

DART matches technologies with the site requirements through 1 of 28 technology categories that cover all 931 industrial and DOE SCFA portfolio technologies. The technology attributes entered into DART are compared to the site data within DART in accordance with design rules determining technology gaps (requirements are not met by available technology).

Influence Models

Figure ES-1 provides an example of how benefits of proposed technology solutions can be measured by analyzing the quantifiable impact on relative risk, cost, schedule, total volume, number of sites remaining, and total area to be cleaned up. One can quickly visualize the volume problem at the Idaho Field Office. From the 19 sites reporting volume, 4 have greater than 50,000 cubic yards of contaminated waste and 15 have less than 50,000 cubic yards. One could decide to remediate 90 percent of the source term waste at the Idaho Field Office by cleaning up 4 sites. Alternatively, one might decide to remediate 75 percent of the sites by cleaning up those sites with less than 50,000 cubic yards.

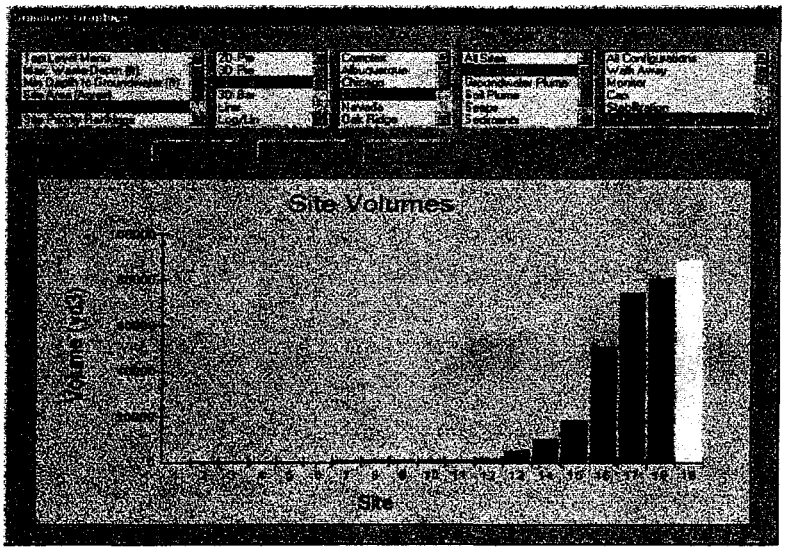

Figure ES-1. Sample of quantifiable impacts.

Risk—It is difficult to use one risk model universally across the DOE complex to calculate health and safety risk. For the purposes of DART, a relative risk assessment was desired that does not replace or compete with the remedial investigation/feasibility study. The DART risk data can be used to rank the sites relative to the contaminants and volume at the site. The equation used for the DART risk ranking is R = I * T * M * D where:

- I = Quantity of contaminants in the waste type
- T = Specific EPA toxicity of radionuclides and/or specific hazardous chemical toxicity
- M = Mobility, ease with which the contaminants could escape confinement

- D = Decay factor for radionuclides, actinides and nonactinides.

Cost Benefit—The DART cost models were developed to compare competing technologies, in remediating user selected waste sites, with a specific technology. The costs are calculated on a site-by-site basis for each of 18 technology categories, such as excavation, cap, stabilization, etc. DART cost models were developed to use existing site data. Hence, these models are high level with many simplifying assumptions but they provide a relative assessment of costs. The DART cost models are limited to comparing technologies within a technology category. Costs between different technology categories cannot be compared because of the simplifying assumptions necessary to use available site data.

Effectiveness and Implementability Models—There are six models derived from EPA guidelines for implementing balancing criteria for technology decisions. The models are:

- *Reliability* is the likelihood that technical problems associated with implementation will lead to schedule delays. Score = P * 1/9(10-x) where P is an evenly distributed probability associated with seven DOE identified technology gates ranging from Implementation to Basic Research and x is the number of years before start of remediation

- *Effective benefit* is the degree to which opposing technologies clean up sites faster

- *Residual risk* is the risk remaining at a site after a remediation activity is completed

- *Volume Reduction* is the ratio of resultant total volume to initial total volume

- *Toxicity Reduction* is a measure of harmful effects to a human if a dose of a contaminant is ingested

- *Irreversibility* indicates the degree to which toxic material is changed permanently or physically removed. Irreversibility is associated with treatment/retrieval.

Prioritization

Site priority is based upon the site-specific information contained in the data baseline. The quantitative factors are generated using a paired comparison analysis on 22 elements. Each element is compared to other elements as to its relative importance and receives a corresponding score. For example, the importance of a plume outside the site boundary is compared to the volume of waste at a site. The importance scores are added for each element, providing weights for each prioritization element. This analysis is subjective to allow the decision-maker(s) an opportunity to weight the factors influencing site priority. Once criteria and weights are agreed upon by the decision-maker(s) and stakeholders, DART will automatically use the site data to prioritize sites. Site prioritization enables the Focus Area to ensure technology development issues at priority sites are being addressed.

DART User Interface

Figure ES-2 shows the initial operator screen display where each button allows access to specific DART data. For example, if the operator selects site data, a site data template, Figure ES-3, will appear for the user to input the site criteria which DART should sort on.

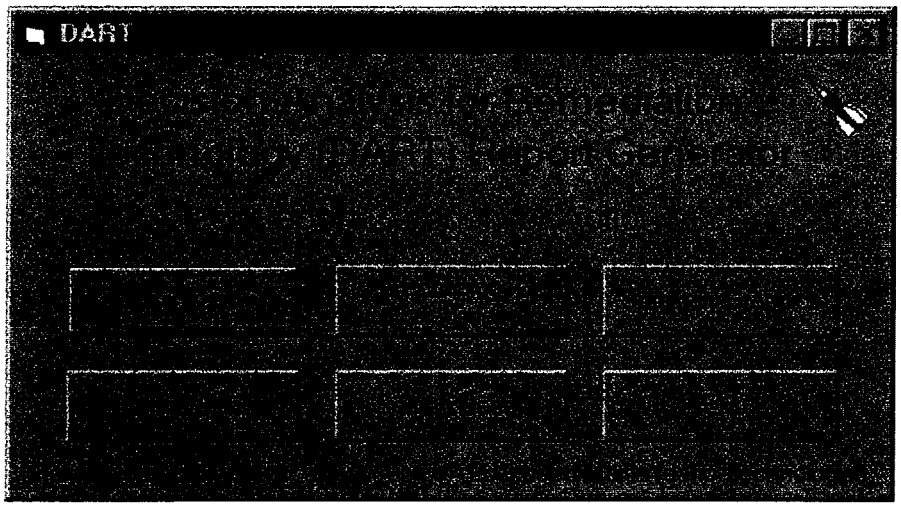

Figure ES-2. The initial DART screen allows the user to select site data, technology categories, graphics or search on site needs.

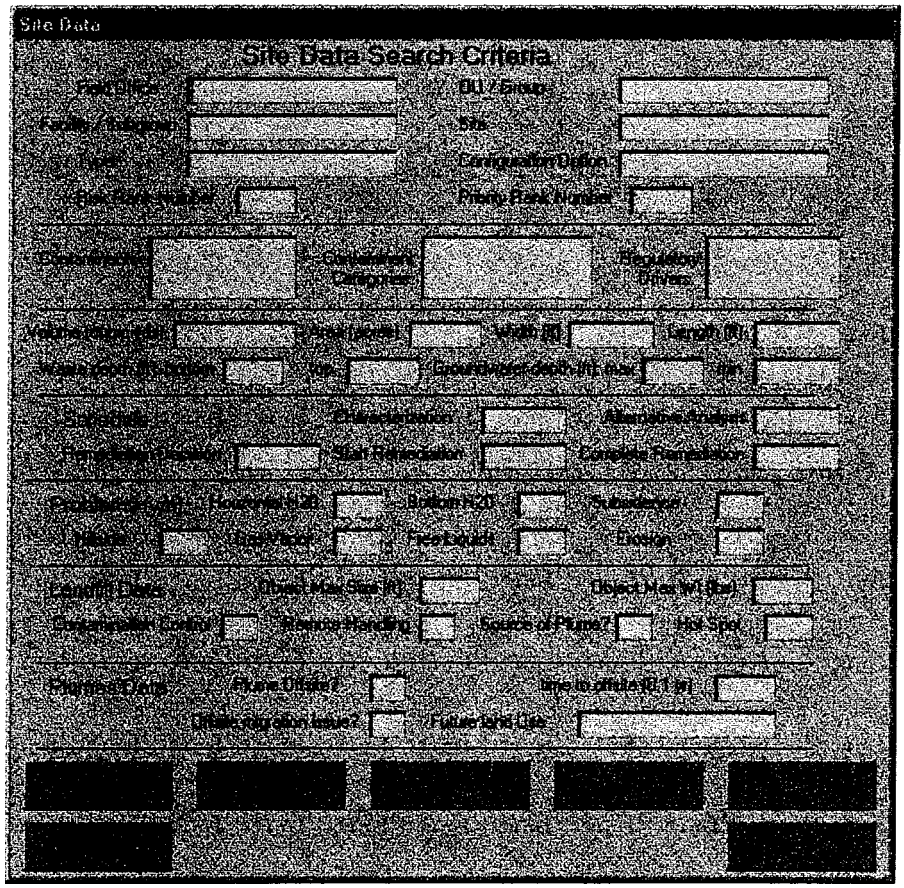

Figure ES-3. A DART data input screen allows the user to select the data for sorting. Any one or all of the data windows may be filled in to initiate the sort.

Summary

Department of Energy technology investment decisions need to shift to a requirements-driven paradigm from a perceived need paradigm. Department of Energy resources can be used to gain higher returns on an investment if funding decisions are defensible and the benefits quantifiable. A requirements-based decision tool like DART will support these analyses.

DART contains an integrated database of site characteristics: Site Technology Coordination Group (STCG) need statements, industrial technology data, technology research portfolio, and site technology requirements. These characteristics assist the SCFA in making technology investment decisions with quantifiable, traceable, and verifiable data from over 900 subsurface waste sites throughout the DOE complex. Site specific information can be grouped, needs assigned, and benefits analyzed to help prioritize technology investment proposals. Prioritizing proposals based upon site-specific data is supportable and defensible.

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DEFINITIONS

Configuration Option	Top level diagram of a cradle-to-grave remediation whose overall performance is specified by systems requirements.
Contamination Control	A site is considered to require contamination control if it is a retrieve and dispose site and contains any alpha emitter, except uranium, in its contaminants list. Unspecified TRU is assumed to be alpha emitting.
DART	Decision Analysis for Remediation Technology
Desirable (vs requirement)	Specifications or performance metrics whose effect is cost savings, but are not otherwise necessary to meet site remediation objectives. Desirables can be considered goals, which, if satisfied, provide a better product. Desirables do not require proof.
Landfill Site	One or more pits, trenches, tanks, cribs, french drains, ponds, seepage basins, landfills grouped for one remediation decision such as risk investigation/feasibility study or record of decision.
Need	Something required or desired, such as technology development, to solve a contaminated site problem.
Plume	Chemical and/or radiological contaminants exceeding background concentrations in ground water or soil that have migrated or are migrating outside an intended source term.
Plume Site	One or more plumes grouped for one remediation decision process such as risk investigation/feasibility study or record of decision.
Problem	General statement of concern relating to a contaminate which lends itself to further investigation by way of a risk investigation or feasibility study.
Remote Handling	A site is considered to require remote handling if it is a retrieve and dispose site and contains RH-TRU (remote handled TRU), high explosives, or pyrophoric material, e.g., material that spontaneously ignites in air.
Requirement	Performance based metric that must be satisfied by a technology or system. Satisfying a requirement requires proof/ verification.
SCFA	Subsurface Contaminant Focus Area
Source	Origin of a contaminant in a plume.
STCG	Site Technology Coordinating Group – the focal group at the field office who generate the need statements and interface with the operating unit/site managers.

Subsite	A location or area containing waste within or administered by a facility for which a specific remediation decision is made. (Note: a subsite may contain multiple areas if these areas are treated as a single unit relative to the decision process.)
Trade Study	An alternatives analysis. Trade studies must show that the alternatives satisfy the technical requirements and meet schedule. Performance and schedule variances often disqualify an alternative. Given that performance and schedule requirements are met, life cycle cost influences the decision.
Treatment	1. Change in the waste's treatment, and 2. Purpose: To transport, store or dispose; amenable for recovery, amenable for storage or reduced in volume (40 CFR 260.10 Subpart B).
Risk Driver	One or more contaminants that show increased risk, above a baseline number, when processed through a relative risk model that drives the remedy selection decision process.
Site	One or more pits, trenches, tanks, cribs, french drains, ponds, seepage basins, and/or plumes grouped for one remedial decision process such as risk investigation/feasibility study or record of decision.
Waste Stream	A term relating to the mixed waste focus area that marries a contaminant and waste matrix, e.g., fly ash, debris, ..., with a treatment process.

System Description for DART (Decision Analysis for Remediation Technologies)

1. INTRODUCTION

Ad Hoc prioritization of technologies, needs, or waste sites can result in decisions that are not supportable. The National Research Council in their review of the Department of Energy (DOE) Environmental Management Program, April, 1996, and the U.S. House of Representatives Committee of Commerce letter to Mr. Alm, November 19, 1996 stated that formal and quantitative performance criteria should be the basis of technology funding decisions.

The systems engineering effort for the Subsurface Contaminants Focus Area (SCFA) has focused on quantitative performance criteria while developing the Decision Analysis for Remediation Technologies (DART) tool to assist the DOE to make management decisions regarding technology development investments for waste remediation. DART is developed by the Idaho National Engineering and Environmental Laboratory (INEEL), it contains both technology information and DOE contaminated site information. The system provides a capability to assess, select, and evaluate technology alternatives based on a site's requirements and constraints. DART is populated with data from over 900 DOE waste sites from 10 Field Offices. These sites are either source terms, such as buried waste pits, or contaminant plumes, including both groundwater and soil plumes. Data consists of site specific data (contaminants, area, volume, depth, dates for remedial actions), site preferred remedial option, problems (e.g., plume offsite), site priorities, risk calculation/ranking, site specific technology requirements, and Site Technology Coordinating Group (STCG) need statements (also contained in the Ten Year Plan) associated with specific sites. Data provides for technology matching with the need statements (both DOE development and 931 industrial technologies from an Industrial Database prepared for the SCFA by Scientec), plus cost, implementability and effectiveness models to support benefit analysis information. Each site's needs, associated technical requirements, regulatory constraints, and site data are presented within this tool. Queries are used to access, sort, roll-up, and rank site data. DOE Complex-wide roll-ups or site-specific requirements are easily obtained.

DART is a flexible system that provides analysis from either the technology or the problem direction. For example, DART can provide information applicable to the following situations:

- Showing technology investors the greatest impact or most significant areas to focus resources on
- Showing DOE sites where a technology may be applicable
- Establishing performance objectives (any level of performance capability)
- Ranking or prioritizing problems
- Identifying applicable solutions for problem owners
- Computing relative risk or cost associated with applicable technologies.

Figure 1 is a DART process flow diagram. The DART uses available site summary information, algorithms and influence models to provide the following:

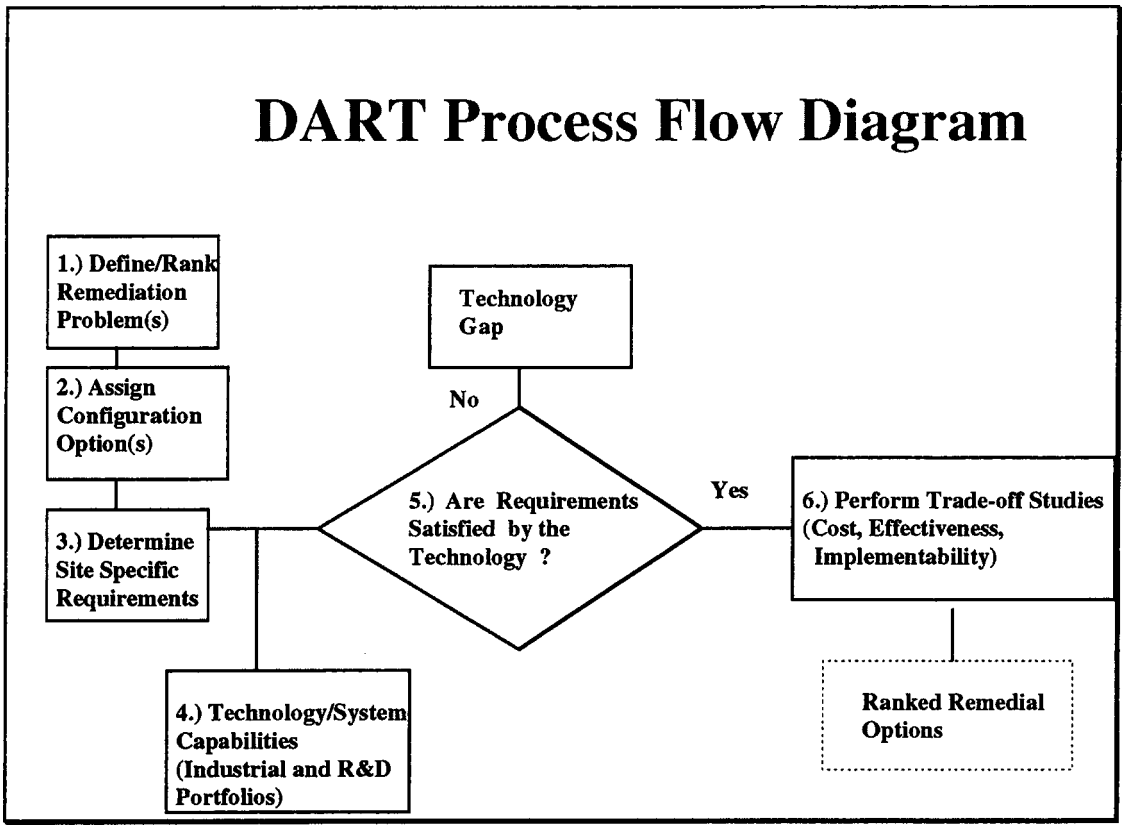

Figure 1. The DART process flow depicts the process. Objectives can be completed in any order.

- **Summary information on waste site data**, for example, the number of sites, location(s), cumulative sizes, cumulative contents including separating and accumulating the types of chemicals and/or types of weapons, and accumulating similar classifications. Summary information also includes a roll-up of schedules, problems, and other site characteristics.

- **Calculation of site risk** based upon the radiological, chemical, and explosive hazards. Health and safety risk can be used for determining priority or rank.

- **Calculation of site priority** based upon established criteria and agreed upon importance of each criterion.

- **List of site specific technical (technology) requirements** based upon the preferred method for remediation and site characteristics.

- **Site specific clean-up criteria** based upon the Environmental Protection Agency (EPA) clean-up standards.

- **List of industrial technologies and/or government development technologies** which satisfy the site-specific requirements. This provides a decision-maker with specific technologies and points of contact to discuss application of the technology to a specific problem. It also identifies technology gaps which require technology development to satisfy a problem.

- **Relative cost** of using one technology versus another in the same technology category for specific selected sites.

- **Measures of effectiveness and implementability** derived for implementing balancing criteria for technology decisions.

DART uses site data from over 900 source term or plume contaminated sites, algorithms to role up the data, remedial alternatives and associated functions to develop site specific requirements for remediation, techniques to rank risk and prioritize sites, industrial and development technologies to determine technology gaps, and influence models such as relative cost, implementability, and effectiveness to assist in the decision process. The software resides on a desktop or laptop computer.

1.1 Elements of System Integration

A complex problem of many elements requires computer aided solutions.

The remediation of over 900 subsurface waste sites in the DOE is more complex than just picking a site and cleaning it up to some standard. There are technical and regulatory requirements; technology alternatives; safety, stakeholder, and site constraints; and, risks, cost, priorities, implementability, and effectiveness influences. Figure 2 shows the numbers of things to consider are multiples of the possibilities in each category. For example, 900 sites times 13 remediation options times 6 functions times the numbers in the other categories. In addition to technologies developed by the DOE, the system uses an Industrial Data Base with over 900 industry technologies to match with site requirements.

The DOE has hazard and radiological contaminated sites which cause some concern. Concerns include the location, type of contaminant, type of container or weapon, depth, remediation alternatives, regulatory concerns, stakeholder interest, and safety of personnel and the community. Environmental concerns include contamination of the surrounding environment, air, soil, and water. Through remediation, DOE does not want to create secondary contamination or additional risk. For example, hazards associated with disturbing the subsurface could cause contamination of the surrounding

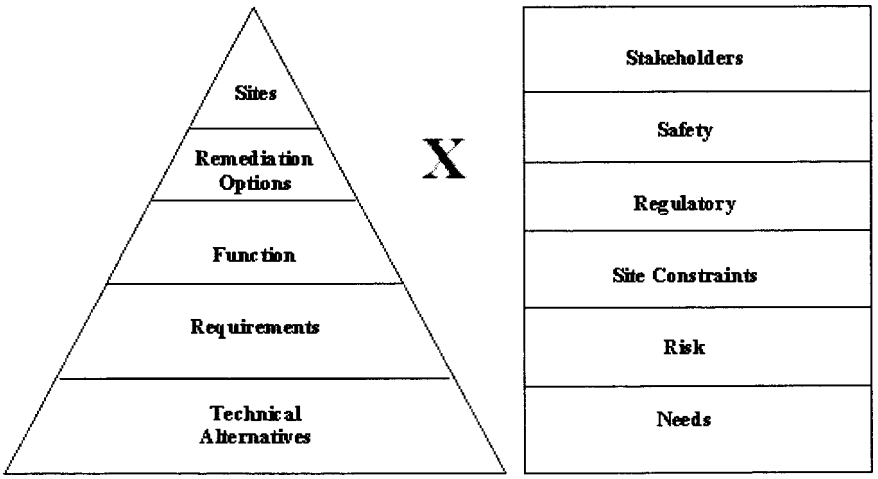

Figure 2. The Problem is multiplicative and leads to a numerically large database.

environment or an explosion. The DOE waste sites have a wide variety of objects, sizes, shapes, and contaminants. Remediation of a site requires a system, a group of individual elements operating in series or in parallel as one system.

Remediation can be accomplished in situ or ex situ. One or all of the functional elements which must be performed for remediation of a waste site are to locate, characterize, classify, identify, excavate, store, treat, and dispose. Location implies that we determine where the contaminant(s) are physically located, and their shape, orientation, and depth. Characterization determines the type of buried item, such as a barrel or debris and if it is ruptured or leaking. Classification determines the specific type of item. Identification specifies the contaminant. Excavate, store, treat, and dispose are self explanatory.

The SCFA has a limited charter relative to remediating a waste site. The charter consists of working with the subsurface contaminants. The a priori, characterization, and a posteriori, post extraction treatment and disposal, technologies are developed or demonstrated in other DOE focus areas. The SCFA is concerned with the deployment of the total system to remediate the site. An automated system is necessary to integrate the multiple factors involved in optimizing technology investment decisions. Figure 2 illustrates the multiple factors. When we consider over 900 waste sites, at least 15 remedial options, and hundreds of functions associated with each option, the problem explodes into millions of possible waste remediation paths. A computerized system seems necessary to track the data and assist the decision maker to sort through the paths to determine the maximum benefit from limited resources to invest in clean-up technologies. The Decision Analysis for Remediation Technologies (DART) tool is system engineered to provide this analysis capability.

DART is a computer aided system populated with influence models including health and safety risk, site priority, regulatory requirements, technical requirements, implementability, effectiveness, and cost. The quantitative benefits of inserting a new technology against the baseline (what is used now) are derived by matching the requirements and the technologies. The outputs of the models are considered individually to set priorities for site cleanup. In this way, the DOE meets the following objectives:

1. Provide a traceable process for selection and prioritization of technology development and demonstration activities responsive to specific requirements

2. Define and measure quantitative performance objectives and requirements for individual technical projects

3. Quantify ultimate benefits of all proposed technology development and demonstration activities

4. Provide and regularly update an overall metric of benefit to the program, i.e., metrics for progress.

2. DART SYSTEM ELEMENTS

The DART system consists of a site specific characteristics database, technology database (industrial and SCFA development portfolio), user interface, influence models, and graphics generator. A list of database tables, table definitions, queries, and functions is contained in Appendix A. DART models are described in Section 3. The user interface is discussed in Section 4.

2.1 Site Specific Characteristics Database

The database is implemented in Microsoft Access, Version 7.0. The data incorporated into the database is applicable to ten Field Offices: Albuquerque, Chicago, Hanford, Idaho, Nevada, Oak Ridge, Oakland, Ohio, Rocky Flats, and Savannah River. From the Field Office level, Operable Units and subsites are identified. A point of contact for each site contained in the DART database is available to the user through queries.

To efficiently manage the data resources, the data gathering effort was divided into two phases. Phase 1 consisted of inputting data extracted from the Landfill Stabilization Focus Area Site Visit Reports and Plume data reports from the Plume Focus Area site visits. Phase 2 consisted of data gathering from the INTERNET, Public Reading Rooms, and site Administrative Records. Site needs within the scope (defined by the SCPA Technical Team) of the Subsurface Contaminants Focus Area (combined Landfill and Plume Focus Areas) were extracted from Site Technology Coordinating Group (STCG) April 1997 inputs to the DOE Ten Year Plan.

- **Phase 1**—The DART data base was originally populated with information extracted from the 1995 and 1996 Landfill Stabilization Focus Area Site Visit Reports. Site visit reports were prepared by EnviroIssues, an independent contractor, to provide a problem data baseline set for use in the Focus Area. The types of information extracted from the reports were site dimensions, waste volumes, waste streams, waste areas, contaminants, dates, and site problems, such as plume offsite.

  The DART team requested additional clarification and definition of some specific data. EnviroIssues contacted site representatives and provided additional information in the form of data sheets. This information was used in the database.

  The Plumes Focus Area was separate from the Landfill Focus Area and data was collected separately. EnviroIssues was the focal point for both sets of data. When the two focus areas were combined in March 1996, plumes data was obtained from EnviroIssues and input into the database. There was no opportunity to revisit the site points of contact to clarify the plumes data.

The accuracy of information in the database was reviewed and verified by comparing the data input into DART to data within the LSFA and Plume reports. Data fields were sparsely populated which limited the usefulness and capability of the decision tool. To acquire more data, the DART team initiated phase 2 data collection.

- **Phase 2**—Phase 2 consisted of collecting site specific information from the INTERNET. The main INTERNET reports included the Baseline Environmental Management Report (BEMR), Management Action Plans (MAP), and various site specific documents. Most of the INTERNET information was high level information, and not very site specific.

Therefore, members of the DART team visited the DOE public reading rooms and reviewed documents and administrative records at four of the largest DOE field offices, Hanford, Idaho, Oak Ridge, and Savannah River. The sources of documentation included Record of Decisions (ROD), Characterization Reports, Remedial Investigation and Feasibility Study Reports, Track 1, and Track 2 documentation. Some site data was extracted from the STCG Need Statements prepared in April 1997.

The Phase 2 data collection process included gathering the documents, maintaining a hardcopy of the documents, extracting the data material, documenting the data source, and inputting the data into the DART database.

2.1.1 Guidelines for Gathering Data

General guidelines were developed for the data gathering effort to provide consistency for data extraction and database input. The data sources have been highlighted, documented, and filed. Guidelines are as follows:

1. Data input into DART from Phase 1 is assumed accurate unless proven otherwise by updated and approved site records. Use of additional site records include only records released to the public.

2. Data records that list values such as area, volume, length, width, and depth, which are unclear as to the associated specific location or waste stream, are not input into the DART database. Areas and volumes input into the data base are those interpreted to be the contaminated areas or volumes.

3. Data information resources applicable to each site are documented and maintained in a document file.

4. Records more recent than LSFA site data reports and which better define specific subsites within a particular OU are incorporated. On a case by case basis, subsites and facilities were further broken out individually from a grouping of a particular OU group.

5. Individual site records often conflict with other records, sometimes within the same document. When conflicts are obvious, a judgement is made to determine which data set seemed most correct. The data was referenced to the data source used.

6. If conflicting data existed between the DART data and newly acquired data, the newly acquired data was assumed to be more accurate if it had a more recent date and had been approved for public release.

Interpretation of data exists within the data gathering and extraction process. The data contained in DART is not validated by the individual Field Offices. When the product from DART is used to support technology investment decisions, it is imperative that the site characteristic data be validated.

Many sites have not been characterized and have incomplete contaminant listings, contaminant levels, remediation dates, volumes, and technology baselines.

Likely, more data exists than is included within DART. Additional data can be added as it becomes available or when the data validation process is initiated.

Many site data sources which list volumes and areas do not distinguish between contaminated areas and volumes versus total site areas and volumes. If it was unclear, the data was not included in DART. At some sites, the contaminated area was irregularly shaped. When this appeared to be the case, and the area was not given, length and width were not multiplied to get the area (area is left blank).

Sites report data in a number of units such as kilograms, liters, pounds, feet, yards, and meters, etc. DART uses the conversion table in Appendix B to normalize units. The conversion tables are used in all model calculations and are automatic in DART.

2.2 Technology (Industrial) Database

The technology (industrial) database was developed by Scientech using software called FileMaker Pro. The database description was provided by Scientech on May 7, 1997.

"Available technologies were identified from cognizant professionals, professional experience, industry publications (e.g., Environmental Technology, Environment Today, Pollution Equipment News, etc.), previously published volumes listing vendors and services (e.g., Industry Available Technology, Gale Environmental), the EPA programs Superfund Innovative Technology Evaluations (SITE) and Vendor Information System for Innovative Treatment Technologies (VISITT), previous technology identification efforts (e.g., TechCon, Rust, IIT), and various other sources (e.g., Internet Search). Information provided by the indicated sources vary in detail and vintage. With all relevant technologies, services, and vendors identified in the indicated sources, SCIENTECH, Inc. has sought and continues to seek current and comprehensive vendor data through direct contact with the vendors as the ultimate resource. Vendor data collected by interview and/or vendor data file is then used to profile the technology in the matrix. The latest version of the Technology Database contains 931 records, of which 483 were developed from vendor data. The breakdown of sources of technology record information is as follows:

- Vendor Data 483
- Public Domain (Trade Journals, Industry Publications, Internet) 227
- EPA SITE 52
- EPA VISITT 91
- Previous Technology Identification Efforts 85
- Vendor Lists 5

All of the Technology Vendors identified by record in the database have been contacted and vendor data requested. For the records not supported by Vendor data the response for requested vendor data was not provided. The record remained in the database based on the availability and reliability of alternative data available."

Figure 3 is a DART screen display of an industry technology for in situ thermal treatment. To display this screen, select "Technology Categories" (see Figure 7) and select "In situ Thermal." The

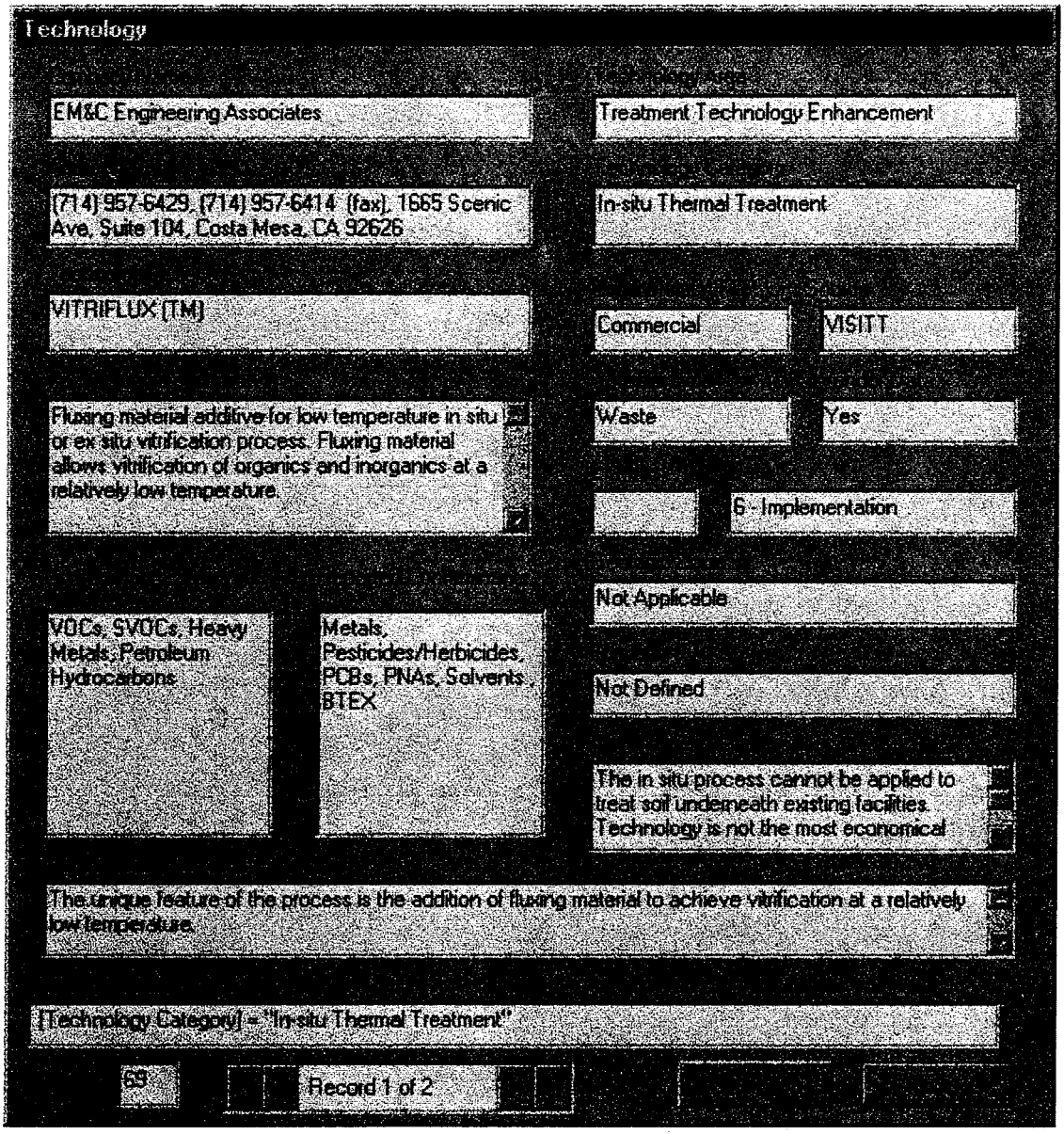

Figure 3. DART Screen Display for Industrial Technology. A technology template for each of 931 industrial technologies in the Industrial Database is available in DART. Each technology is associated with a technology category, specific waste sites, and specific STCG need statements in the DART database.

name of the company with the technology, and information about the technology is displayed. Typically there is no performance information to measure adequacy of the technology to satisfy the specific site(s) need(s). Performance criteria are necessary to match the technology to specific site needs. Performance criteria should be added in the future.

2.3 SCFA Technology Portfolio Used In DART

The FY 97 Technical Task Plans (TTP) funded by the SCFA are contained in DART using the same technology template as used for industrial technologies. The template, the same as Figure 3, is filled out using information from Part 2 and Part 3 of the TTP. TTPs are integrated with the industrial technologies but can be separated by the category "Company" which will always be "SCFA" or by "Source" which will always be the TTP number. Each TTP is identified by a TTP number that associates it with a field office developing the technology. There are 55 FY 97 TTPs in the DART database. Management TTPs are not included in the database.

2.4 Graphics

DART is equipped with a graphing capability to illustrate site specific data relating to Field Offices, Operable Units, or subsites. The DART graphics use Graphics Server 5.0 software, published by Pinnacle Publishing 1996. Graphics Server is a graphing kit used as a basic graphing tool with Visual Basic. Graphics Server consists of a set of graphics routines accessed through Visual Basic custom control (or OCX) version of the Graph Control used with version 4.0 of Visual Basic with languages that support Visual Basic custom controls.

DART provides graphs as a visual reference to summary site specific data. Any data that can be summarized can be graphed. The user may use select buttons to choose the desired graph for immediate display.

Figure 4 shows a selected data summary graph. The user selected site volume as the data to display in a 2 dimensional bar graph. The Field Office is Idaho and the waste sites are source terms or landfills. The configuration option, site preferred remedial action, is retrieve and dispose. DART summarizes the data from the 900+ sites in the database that satisfy the user selected criteria and displays the graph.

One can quickly visualize the volume problem at the Idaho Field Office. From the 19 sites reporting volume, 4 have greater than 50,000 cubic yards of contaminated waste and 15 have less than 50,000 cubic yards. One could make the decision to remediate 90 percent of the source term waste at the Idaho Field Office by cleaning up 4 sites. On the other hand, one might decide to remediate 75 percent of the sites by cleaning up those sites with less than 50,000 cubic yards. In either case the decision is defensible; the decision is supported by site data and traceable to published documents.

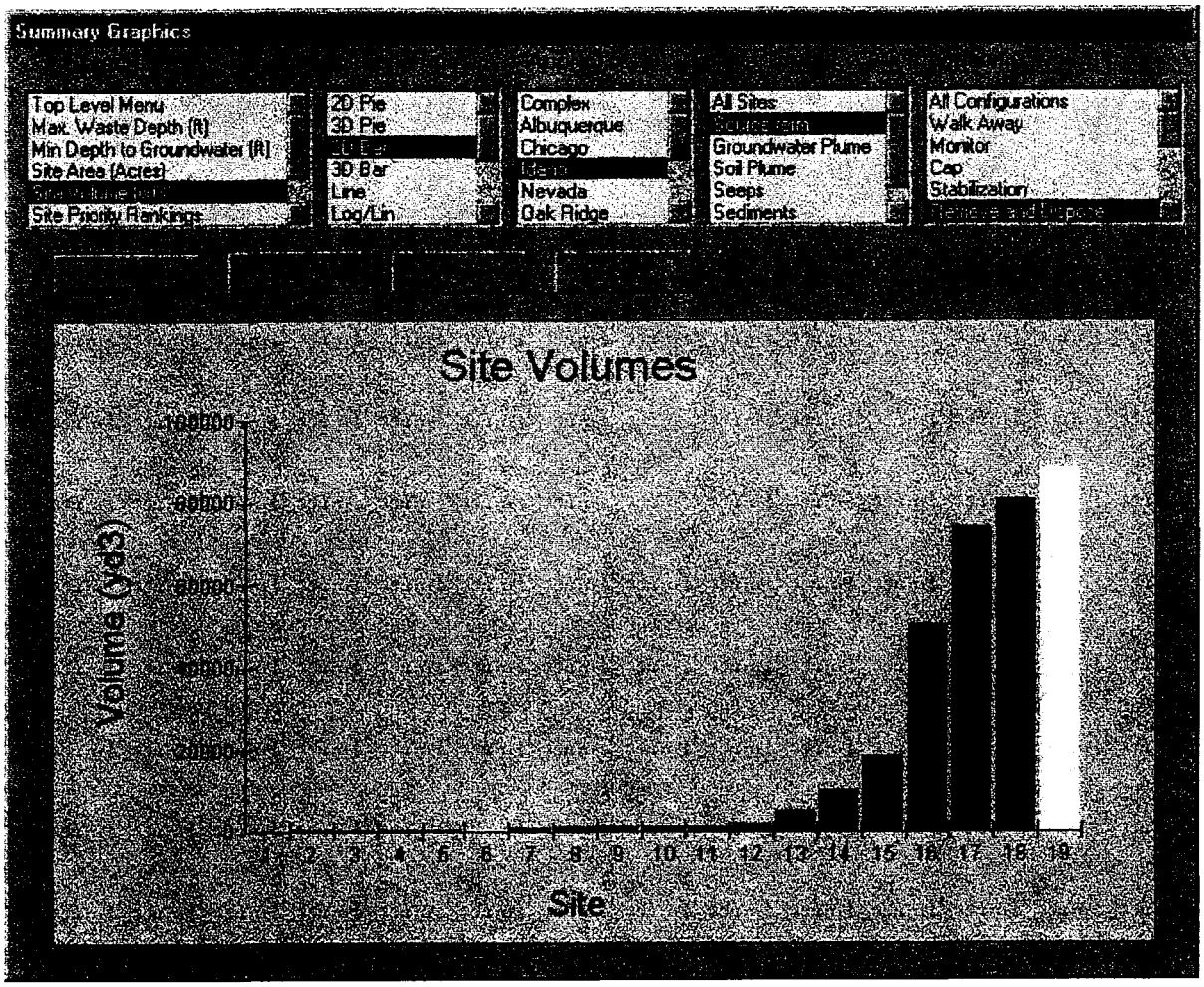

Figure 4. DART display of source term site volumes at the Idaho Field Office reveals that by cleaning up 4 of the 19 sites reporting volume, 90 % of the waste can be eliminated.

3. INFLUENCE MODELS USED IN DART

3.1 Site Priority Model

Site priority is based upon the site-specific information contained in the data baseline. The quantitative factors are generated using a paired comparison analysis on 22 elements. Figure 5 is an example template containing 20 of the 22 elements used for the paired comparison analysis. The example template was size constrained to 20 elements to be readable in this report; Table 1 includes all 22 elements. As depicted in Figure 5, the paired comparison analysis rates one element against every other element on a scale of 1 to 5, such as comparing a plume outside the boundary to the volume of waste at a site.

One might say that a plume outside the boundary is more important than the volume, independent of how high the volume may be. Using a scale of 1 to 5, choose the importance: if extremely more important, use the number 5; if much more important, use the number 4; and so forth.

Some elements have subelements, such as, land use varies from unrestricted to restricted with 7 subelements in between such as recreational, industrial, and so forth. Unrestricted is the most stringent and restricted the least stringent, therefore, unrestricted receives the highest score of the land use category. If industrial use compared to unrestricted is rated equal in importance, it receives the same score. If industrial use is less important than unrestricted, it receives a lesser score, for example, if unrestricted land use received a score of 16, industrial land use would be compared to the other elements (of the 22 initial elements) with scores less than 16. We could say that industrial land use would be of equal importance to gas vapor, and gas vapor received a score of 15; so industrial land use also receives a score of 15. The scores are added for each element selected as more important in the paired comparison analysis. Table 1 contains a list of the DART team scores for the paired comparison analysis in highest to lowest order. Subelements have scores equal to or less than the scores of the primary element.

This analysis is subjective to allow the decision-maker an opportunity to weight the factors influencing the site priority. Weights given in this report illustrate the technique. Categories, problems, and weights should be determined by the decision-maker.

The paired comparison analysis scores separate the elements into four categories: high, intermediate, medium, and low. High scores range from 111 to 88, intermediate scores range from 69 to 46, medium scores range from 34 to 27, and low scores range from 16 to 12. The sum of two intermediate scores equals or exceeds the high scores; the sum of two medium scores equals or exceeds an intermediate score; and, the sum of two low scores nearly equals or exceeds a medium score.

All elements used in the analysis are in the data baseline, but not all are currently populated for each site. If unpopulated, the default value is zero. Site priorities are the sum of the scores assigned to each site based on reported data values. The sum is calculated by running the query Priority within Access. The values determined are stored in the PRTable together with priority rankings, for example, ranking 1 is the highest priority according to problem scoring (22 elements) at each site.

For completeness, Table 2 lists the elements included in the categories that DART automatically uses from the site data.

A Paired Comparison Analysis for Measuring Site Priority

Criteria	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	Sum	Ranking 1 to 20
Area	A																					
Land use		B																				
Volume			C																			
Schedule				D																		
Plume or landfill					E																	
Rate of travel						F																
Outside boundary							G															
Arid or humid								H														
Erosion (wind, wtr)									I													
Horizontal water										J												
Bottom water											K											
Gas/Vapor												L										
Potential Subsidence													M									
Free Liquids														N								
Hillside slope															O							
DNAPLs																P						
High Explosives																	Q					
Rads Soluble in water																		R				
Landfill source of plume																			S			
Depth-waste to grndwtr																				T		

Preference weightings

0=No difference
1=Very slightly more imp
2=Slightly more imp
3=Reasonably more imp
4=Much more important
5=Extremely more important

In each box be sure to write both the letter representing the criteria and the numeral representing the weighting for the choice you feel is most important.

Figure 5. A template can be used for the paired comparison analysis to aid in the bookkeeping. Note: this example template does not include all 22 criteria due to page size constraints.

Table 1. The resulting scores from the pairwise comparison of 22 problems indicate that a plume offsite is the problem of most concern.

No.	Element/Subelement	Score
1	Plume or waste is outside boundary	111
2	Rate of travel	
2a	Reaches groundwater or reaches boundary by 2006	88
2b	Economic impact (cost more to clean up as plume spreads; score as it relates to original plume/landfill)	16
3	TRU waste	69
4	Horizontal water	63
5	Rads soluble in water	63
6	Landfill the source of a plume	62
7	Depth to the groundwater	
7a	0 to 10 feet	58
7b	10 to 50 feet (score as it relates to free liquids)	34
7c	50 to 100 feet (score as it relates to Arid or humid)	27
7d	100 to 200 feet (score as it relates to erosion)	15
7e	Greater than 200 feet (is not a concern)	0
8	DNAPLs	56
9	Volume	
9a	Greater than 252,000 yd^3 (sites with this volume have 90 percent of the waste in landfills)	52
9b	Less than 252,000 yd^3 (score as it relates to area)	33
10	Alpha	48
11	Bottom water	50
12	Schedule	
12a	Greater than or equal to 10 years	46
12b	Less than or equal to 10 years (score as it relates to plume or landfill)	16
13	Free Liquids	34
14	EPA Toxic Metals	33
15	Area	
15a	Greater than 25,200 yd^2 (volume divided by 10 because where depth was not given, depth was assumed to be 10 feet)	33
15b	Less than 252,00 yd^2 (score relative to land use)	16

Table 1. (continued).

No.	Element/Subelement	Score
16	Arid or Humid	
16a	Humid	27
16b	Arid (score higher than land use)	21
17	Land Use	
17a	Unrestricted	16
17b	Recreational	16
17c	Industrial (score relative to gas vapor)	15
17d	Industrial/commercial	15
17e	Economic development (score same as industrial)	15
17f	Test site (score relative to hillside)	15
17g	Ecological reserve (score relative to high explosives)	13
17h	Forest reserve (score same as ecological reserve)	13
17i	Trout pond (score same as ecological reserve)	13
17j	Restricted (not of interest)	0
18	Gas Vapor	15
19	Hillside	15
20	Erosion	15
21	High Explosives	13
22	Subsidence	12

Table 2. Elements in site priority categories that add to the site priority ranking.

Contaminants Included as Type Alpha			
Alpha	Americum (Am)	Europium (Eu)	Iodine (I-29)
Plutonium (Pu)	Radium (Ra)	Thorium (Th)	

Radionuclides Soluble In Water					
Cs	Sr	Tc	Ru	Sb	Eu

DNAPLs			
TCE	PCE	TCA	Carbon Tet

EPA Toxic Metals					
Ag	As	Ba	Be	Cr	Cu
Hg	Pb	Se	Tl (Thallium)	V	

Transuranic (TRU)			
Np	Am	Cm	Cf
Pu	RH-TRU	CH-TRU	Pu

3.2 Risk Model

Discussion of the Risk Model includes the Comparative Risk Model, Maximum Contaminant Levels (MCL), and the Clean Air Act.

3.2.1 Health and Safety Risk Model

Calculating health and safety risk to the population or the environment or both is a long (sometimes duration is measured in years to complete the risk assessment) and painful (sometimes there is much controversy relative to the process and assumptions) process. It is difficult to use one risk model throughout the DOE complex. For purposes of DART, a relative risk assessment was desired that does not take the place of nor compete with the remedial investigation/feasibility study. For DART, the relative risk assessment can be done quickly using the information from the site characteristic data contained in the database. The risk data can be used to rank the sites, in risk importance, relative to the output of the DART risk model. The highest rank indicates that site contains the most toxic and/or the highest quantity of toxic contaminants.

Dr. James Wilson, INEEL, developed the DART simplified risk model and provided major input to the expanded discussion, assumptions, and toxicity tables. The technical basis for the model and the values and decision points are contained in a reference document.[a]

The product of this simplified risk assessment method is a unitless number (R) that has meaning only when compared with other numbers calculated using the same simplified risk model. The numerical results are useful for ranking and screening purposes and should not be compared to absolute risk numerical results such as those calculated for CERCLA baseline risk assessments or Safety Analysis Reports.

The equation used for the DART health and safety risk assessment is $R = I * T * M * D$,

Where:

R = Unitless risk metric.

I = The sum of all contaminates reported at a site (curies of radioactivity and/or kilograms of hazardous chemicals).

T = Either the specific toxicity of radionuclides (per curie) or the specific chemical toxicity (per kilogram) of hazardous chemicals or both.

M = The ease of contaminants in the waste type to escape confinement, as a result of events or conditions that cause controls to fail and become mobile in environmental transport to the receptors. M = 0.1 for groundwater plumes, and 0.0003 for soil plumes and source terms.

D = The decay factor for radionuclides, actinides and non actinides. D = 1.4 for actinides and 0.015 for non actinides. Non radioactive elements have D = 1.

The equation is a rough approximation of the risk of the hazardous and radioactive materials at a site. The risk may be viewed as a local source term risk, since risk reduction along air and groundwater pathways to the workers and to the public are ignored. Thus, a site possessing twice the volume of the same contaminants of another site ought to be twice the concern of that other site in the uncontrolled future.

The adjustment factors for radioactive decay (D) for actinides and for nonactinides are extracted from Table 2-1 and Table 2-2,[a] relative to a 50 year time for low level waste.

The toxicity values for non radioactive materials assume the dominant route of exposure is ingestion. Ingestion route values are assigned based upon EPA toxicity measures (EPA 1994) for carcinogenic (oral slope factor [SF]) and non carcinogenic (oral reference dose [RfD]) effects using the following approach:

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a. Smith, T. H., R. G. Peatross, I. E. Smith, and S. A. Elde, A Simplified Method for Quantitative Assessment of the Relative Health and Safety Risk of Environmental Management Activities, INEL-95/0645, September 1996.

- Identify the appropriate SF and RfD values for the hazardous material(s).
- Compare the SF and RfD values to the chemical rating threshold values in Table 3.
- If there are SF and RfD values, the relative toxicity of a chemical is determined by the highest chemical rating (e.g., low, moderate, high).
- A chemical rated as a high is assigned a relative toxicity value of 10^{-2}. If the highest rating is a moderate, a value of 3×10^{-4} is assigned. If low is the highest rating, a value of 3×10^{-5} is assigned. Radiological contaminants are given values as follows: Actinides = 2.5, Non actinides = 0.1.

The result of using Table 3 is a listing of toxicity values for each contaminant contained in Appendix C.

3.2.2 Maximum Contaminant Levels

MCLs Provide technical performance criteria and specific clean-up requirements. MCLs are contained in Appendix C.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides the legal and regulatory basis to clean up contaminated soils. Since its introduction in 1980, no criteria exist for the remedial standard. Lack of a standard raises the issue of what level of action must be taken and to what level clean is clean.

For DART, we tried to establish criteria useful for decision making. These criteria are related to the Drinking Water Standards where MCLs are defined for a set of contaminants currently being regulated. The MCLs were determined based on health risks and are promulgated by the Environmental Protection Agency (EPA). MCLs provide information for monitoring level, clean-up level, and detection limits in the requirements database. The list of MCLs is contained in Appendix C. If MCLs have been negotiated between a site and the regulatory agency, and reported by the site, that reported MCL is used in DART.

Table 3. Chemical ratings and associated threshold values for rest states.[a]

Rating	SF Oral $(mg/kg\text{-}d)^{-1}$	RfD Oral (mg/kg-d)
Low = $3*10^{-5}$	—	10^{1}
	—	10^{0}
	10^{-3}	10^{-1}
Moderate = $3*10^{-4}$	—	10^{-2}
	10^{-2}	10^{-3}
	10^{-1}	10^{-4}
High = 10^{-2}	10^{0}	10^{-5}

a. Information sources for values of absolute toxicities are EPA (1994) for SFs and RfDs.

Using MCLs as absolute data has limitations. For example, a monitoring level is difficult because it depends upon factors including the nature of transport and the quantity released to the subsurface environment (the latter is not known a priori). Even for transport, uncertainties in hydrogeological soil properties could make an accurate analysis of the scenario impossible.

MCLs provide a measure for instrumentation sensitivity, concentrations at the parts-per-billion level can be routinely detected. The concern is affordability, since the cost of analysis increases as the detection limit decreases. However, knowing the clean-up level, for an individual site, and understanding that it may be a negotiated value, allows the site manager to know when the site is remediated. Knowing the MCL, the contract agency cleaning up the site knows how sensitive the instrumentation must be in order to prove the contract has been successfully completed. DOE can assess, first order approximation, clean-up levels for the complex based on the contaminants and associated MCL levels.

For groundwater concentrations, units are converted from pCi/ml to pCi/g soil or mg/l to mg/g soil. The unavailability of the DWS for several radioactive species requires the use of the Derived Concentration Guide (DCG) in place of the MCL. An extensive DCG values list can be found in DOE Order 5400.5. Because a discrepancy between the two data bases exists, the DCG based maximum allowable soil concentrations are different. The most conservative value is used for the DART assessment.

3.2.3 Clean Air Act

3.2.3.1 Background. The Clean Air Act (CAA) is a federal law enforced by the Environmental Protection Agency (EPA) that sets air pollutant limits for the United States. This Act ensures Americans the same basic health and environmental protection.

States enforce much of the CAA because pollution control problems often require special understanding of local industries, geography, housing patterns, etc. States can have stronger pollution controls than the federal government, and develop state implementation plans (SIPs) to explain how they will enforce the CAA in cleaning up polluted areas and regulating emissions of contaminants. The EPA must approve each SIP, and if unacceptable, the EPA can enforce the CAA in that state. The EPA enforces the CAA by issuing permits, which include information on pollutants being released, how much may be released, and actions the source's owner or operator is taking to reduce pollution, including plans to monitor (measure) the pollution.

A few common air pollutants (carbon monoxide, nitrogen oxides, sulfur dioxide, particulate matter, ozone, and lead) are found throughout the United States, and are unhealthy, harm the environment, and cause property damage. The EPA calls these pollutants criteria air pollutants.

The EPA developed another list of pollutants classified as hazardous air pollutants (hazardous and toxic have been used interchangeably in federal and state regulations). Federal regulatory limits have not been set for these pollutants, but a goal of the CAA is to require a reduction in hazardous air pollutant emissions up to and including a prohibition on such emissions, where achievable.

Eleven states do not currently have their regulations accessible on the INTERNET: California, Iowa, Kentucky, Mississippi, Missouri, Nevada, Tennessee, South Carolina, New Jersey, New York, and Tennessee. California has state regulations; however, it has air district regulations that may have stricter limits than the state regulations. The following California Air Quality Management Districts are associated with the DOE sites (the district values are not presently on the INTERNET):

Air Quality Management District	DOE Sites
Bay Area	Berkley, LLNL, Palo Alto
Los Angeles	Canoga Park
Yolo-Solano	Davis, CA
Imperial County	Imperial Valley
San Diego	La Jolla, CA

3.2.3.2 Radionuclides. Eighty six listed contaminants were identified at various DOE sites; with 25 related to radionuclides: alpha, americium, antimony-125, beta, carbon-14, californium, curium, cobalt, cesium, europium, francium, iodine, neptunium, plutonium, potassium, promethium, radium, ruthenium, strontium, technetium, thorium, uranium, uranium (depleted), uranium-234, and uranium-238.

Federal guidelines for radionuclides (40 CFR 61.92) state that the emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr. Additionally, (from 40 CFR 61.102), emissions of iodine to the ambient air from a DOE facility shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 3 mrem/yr. Idaho regulations limit the effective dose equivalent to 3 mrem/yr for all radionuclides.

3.2.3.3 Chemicals. Chemical contaminants identified at various DOE sites are listed in Appendix D. Those classified as hazardous/toxic air pollutants by EPA for the CAA are identified in the second column. The "No limit" designation indicates the contaminant is listed but no limit is specified for the contaminant. Those states previously identified without regulations on the INTERNET will follow the federal list until their regulations are found. Illinois, Colorado, Texas, and Ohio provide a list of hazardous chemicals with no limits, therefore, the designation of "No limit" indicates the chemical is listed but no limit is established. The designation of "Not listed" is placed for chemicals listed on the federal list but not identified on the state list.

Idaho and New Mexico are the only two states with limits. The emission limit is the screening emission limit; any emission below these levels are not regulated. The acceptable air concentration listed for Idaho is the maximum concentration for that particular contaminant. There were two Idaho emission limit (EL) values for chromium and ehtylene dibromide; the most conservative based on carcinogenic risks has been listed.

3.2.3.4 Lead and Particulate Matter. Lead is the only criteria air pollutant that has been listed in Appendix D because it is also listed as a toxic air pollutant. Particulate matter, specifically PM-10, may also be a concern at the various sites during remediation activities due to the dust that may be generated. It is not included on the table, however, the maximum ambient air concentration has been set at 50,000 mg/m^3.

3.3 Cost Model

The cost model provides a comparison of the cost of technologies within a technology category to remediate a specific site.

The costs calculated using the DART cost models are high level costs developed to compare the costs of competing technologies in remediating SCFA sites. The costs are calculated on a site-by-site basis and added together to calculate the total cost for a selected group of sites.

Each of the 18 technology categories within the scope of the SCFA has an associated cost model. The description of each cost model relating to a technology category is contained in Appendix E. Cost models implemented for 18 technology categories are the following:

- Subsurface Assessment
- Contaminant Detection and Monitoring
- Excavation
- Vapor Extraction
- Pump and Treat
- Contaminant Control
- Physical Stabilization
- Remote Handling
- In situ Bio Remediation
- In situ Chemical Treatment
- In situ Thermal Treatment
- TRU Assay
- Stabilization to Limit Mobility
- Subsurface Barrier
- Cap
- Containment Integrity Monitoring
- Soil Washing
- Off-gas Treatment.

Ten technology categories, such as Treatment and Drilling, exist without cost models because these technology categories are out of the SCFA scope. These ten technology categories are included in the DART because they are associated with the Industrial Database. If DART is expanded to other focus areas, cost models for these categories can be easily derived. Table 4 shows an example of a cost model, equation, and assumptions. The results of the cost model are displayed for an operator-selected set of sites.

The simplifying assumptions for all cost models follow:

- Cost models assume the technologies are at the Implementation Phase of development
- A list of applicable sites and corresponding configuration options are identified prior to applying the cost data
- Site, configuration option, and technology category are known inputs
- If equipment is not permanently assigned to the site, equipment will be included in the subcontract cost of remediating the site and not purchased as capital equipment
- Equipment transportation costs from site-to-site are not included
- Depth and area give volume
- The configuration option stays the same, regardless of changing out technologies "upstream"
- Area stated in the database is the area to be remediated
- Volume stated in the database is the waste volume to be remediated
- Costs will be calculated on a site-by-site basis.

Table 4. The DART cost model example illustrates how simple it is to get a relative cost value for a technology to compare to other technologies in the same technology category.

Definition: Surface barrier, consisting of one or multiple layers, put in place to prevent vertical water flow through the site and physical transport of contaminants due to wind, erosion, etc. Source term will be left in place, subsurface.
Cost = Area in ft^2 q_1
q_1 = Cap installation cost ($\$/ft^2$)
Assumptions: All cap layers, set up and installation costs are included in the cap installation cost. Cost per ft^2 is independent of area

The cost model provides a relative assessment of competing technologies to remediate a site, and is intentionally limited to use of the data provided via the SCFA site visits and data assimilated through reviewing existing site reports. Additional input data is technology specific: for example, for Physical Stabilization (change the physical form of the waste to enable further remediation activity), what is the operations cost ($/yd^3)? A cost for one technology within a category may be compared to a cost of another technology within the same category. It is not appropriate to compare cost across categories because of this relativity and lack of absoluteness. To simply determine relative cost, a cost within a category does not take credit for reducing cost of another category in the sequence of operations. For example, a technology that reduces volume does not take credit for reducing the subsequent storage or treatment cost which would result from the reduced volume.

3.4 Effectiveness and Implementability Models

There are six effectiveness and implementability models: Reliability of Technologies, Effective Benefit, Residual Risk, Volume Reduction, Toxicity Reduction, and Irreversibility. The models are derived from EPA guidelines for implementing balancing criteria for technology decisions. The models are applied to 18 technology categories that fall within the scope of SCFA. Each score represents a calculated value that is a metric of performance, or measure for each model title area.

3.4.1 Reliability of Technologies

Reliability is defined as the likelihood that technical problems associated with implementation will lead to schedule delays.

Score = P * 1/9(10-x) where P is an evenly distributed probability associated with seven technology gates (see Table 5) ranging from Implementation to Basic Research and x is the number of years before start of remediation from the current year.

The probability of schedule delay for each site is reduced following a linear function from no reduction if start remediation is one year or less (if x <= 1 year), to a total reduction (multiply P by zero) if start remediation is ten or more years in the future (if x>= 10 years). The reliability score is the average over all sites matched to the technology. If the start remediation date is unknown, assume less than one year. This measure applies to all eighteen categories within the SCFA scope. (Note: a high score is not good.)

Table 5. Probability values for technology gates are applied directly to the reliability calculation for implementability assessment.

Technology Gate Status (input value by user)	P
Implementation	0.0
Demonstration	0.17
Engineering Development	0.33
Advanced Development	0.50
Exploratory Development	0.67
Applied Research	0.83
Basic Research	1.0

Technology gate development status (operator input) and "start remediation" year determine schedule delay at implementation. The probability due to technology gate status is cumulative and distributed evenly. For each technology gate, the probability value is contained in Table 5.

3.4.2 Effective Benefit

Effective benefit is the degree to which opposing technologies clean up sites fater.

Score = volume weighted average "remediation complete" year of the sites matched to the candidate technology.

Definition: Volume weighted average remediation complete year is calculated as the sum of volume multiplied by remediation complete year of each of the matched sites divided by the total volume of the matched sites.

No operator input is required to compute effective benefit.

This measure applies to all eighteen categories within the scope of the SCFA.

3.4.3 Residual Risk Reduction

Residual risk is the risk remaining at a site after a remediation activity is completed.

Input: contaminant information from the technology category input template.

Risk reduction score is calculated as reduction of source term health and safety risk following planned remedial activities at matched sites.

Score = reduction in source term health and safety risk.

Residual risk is calculated as the sum of remaining health and safety source term risk of the matched sites subtracted from the initial source term risk. Assumptions vary because each technology category (with its associated site/technology matching input template) may have different data available to support calculations. Note that risk reduction is calculated using user input entered through the technology/site matching template for the technology category being investigated. All calculations are independent of configuration option combinations associated with matched sites. The method of generating the residual risk score is a function of technology category only. It is assumed that remediation of specified contaminants to MCL or MCL derived levels at matched sites result in zero remaining risk contribution by these contaminants at these sites.

For the technology categories of in situ bioremediation and in situ chemical treatment, calculate risk reduction for contaminants specified in the input template. Note that radiological contaminants are not options for user input. Display the initial calculated risk and the reduction in risk due to the technology category being queried.

For the technology category of in situ thermal treatment, assume all contaminants are no longer contributors to risk following treatment. Thus the reduction of risk is equal to the total calculated health and safety risk.

For the technology categories of pump and treat and vapor extraction calculate risk reduction for contaminants specified in the input template. Display the initial calculated risk and the reduction in risk due to the technology category being queried.

For all remaining technology categories, display the total risk associated with respective sites.

3.4.4 Volume Reduction

Anticipated reduction of volume is a metric of effectiveness.

Volume reduction is defined as the reduction or minimization of volume of waste, contaminated matrix, or plume resulting from planned remedial activities at matched sites. The measure is the ratio of resultant total volume to initial total volume.

Score = percent volume reduced

Assumptions:

- Only retrieval or selective retrieval reduces volume
- Retrieval or selective retrieval reduces volume equivalent to total volumes associated with assigned waste streams
- Volume increase is equivalent to zero volume reduction (stabilization is equivalent to zero volume reduction).

3.4.5 Toxicity Reduction

Toxicity is a measure of harmful effects to a human if a dose of a specific contaminant is ingested.

Toxicity only changes with a physical change to the contaminant. Toxicity reduction does not affect radionuclides or metals. Retrieval of any kind, including vapor extraction, does not reduce toxicity.

Input: contaminant information from technology category input template

Score = health and safety source term toxicity reduction associated with matched sites

Toxicity is calculated as the sum of remaining health and safety source term risk subtracted from the initial source term risk for matched sites. This calculation is the same as that used for risk reduction, but is only done for certain contaminant/technology category combinations. This is because toxicity reduction occurs only when contaminants are destroyed by treatment. Like risk reduction, assumptions vary because each technology category (with its associated site/technology matching input template) may have different data available to support calculations. All calculations are independent of configuration option combinations associated with matched sites. The method of generating the toxicity score is a function of technology category only.

For the technology categories of in situ bioremediation and in situ chemical treatment, calculate risk reduction for contaminants specified in the input template with the following exception. Toxicity due to EPA heavy metals is not reduced by bioremediation and in situ chemical treatment. Radiological contaminants (tritium, uranium, transuranics, and other radiological elements) are not destroyed by

treatment and are not options for user input. Display the reduction in toxicity due to the technology category being queried.

For the technology category of in situ thermal treatment there is no input contaminant template. Therefore, assume all contaminants are no longer contributors to toxicity following treatment, with the exception of EPA toxic metals, tritium, uranium, transuranics, and other radiological elements. Reduced toxicity is equal to the total calculated health and safety risk minus the remaining risk due to contaminants in the categories listed.

For the technology categories of pump and treat, vapor extraction, and all remaining categories, no reduction in toxicity exists. Do not display toxicity measure.

3.4.6 Irreversibility

Irreversibility indicates the degree to which toxic material is changed permanently or physically removed.

Score = percent of volume of waste irreversibly remediated.

Assumptions:

- Remediation technology categories are reversible that match sites with single configuration options of walk away, monitor, cap, and barrier
- Technology categories are irreversible that match sites with single configuration options of stabilization, retrieve and dispose, vapor extraction, bioremediation, pump and treat, in situ thermal, in situ chemical, soil washing, and selective retrieval.
- For matched sites with multiple configuration options:
- Where all multiple configuration options are classed as reversible consider the total volume of the site to be reversibly remediated
- Where all multiple configuration options are classed as irreversible consider the total volume of the site to be irreversibly remediated
- Where one or more of the configuration options is irreversible, consider the volume of the waste stream associated with the irreversible configuration options irreversible
- Where one or more of the configuration options is irreversible and if the waste stream volumes are not known, assume all waste streams are irreversible.

3.5 Site Specific Requirements

Decisions to develop a technology or choose an existing technology shall be based on verifiable, quantitative (measurable) data that enable the decision maker to support and defend the decision. Decisions can be supported if they are based upon requirements or performance measures which can be traced to the origin and are verifiable. The origin of requirements can generally be traced back to regulatory drivers. Specific requirements reflect the site characteristics of individual sites such that technologies that meet these requirements will work at specific sites. Other factors, such as stakeholder

concerns, influence requirements and must be considered. The paradigm of technology fulfilling requirements assists the Focus Area to deal with the problem holders or landowners objectively. The problem holders or landowners can work with regulators and stakeholders to defuse the element of subjectivity.

In the past, traceable requirements were not generated, probably because it seemed too difficult. There is a risk that the requirements approach will not be accepted because it is new and represents a departure from the historical paradigm. We are encouraged by the remarks of Under Secretary of Energy, Thomas Grumbly, who when speaking at the Weapons Complex Monitor Decision-makers' Forum in Jacksonville, Florida, on September 27, 1996, said, " somebody famous in the literature of public management said almost 500 years ago, '[T]here is nothing more difficult to execute, nor more dubious of success, nor more dangerous to administer than to introduce a new system of things: for he who introduces it has all those who profit from the old system as his enemies, and he has only lukewarm allies in all those who might profit from the new system.' Machiavelli knew what he was talking about. Changing the culture within which we operate is our most difficult task."

3.5.1 Approach

3.5.1.1 Site Characteristics Drive Requirements. Over 900 identified SCFA waste sites exist, each with its own unique characteristics and planned remedial actions. Site requirements are derived from site physical descriptions and quantified data such as start and end dates, depths, constituents, cleanup concentrations, air emission limits, etc.

The approach is to define requirements for the SCFA complex that will be useful both to the decision-makers within the SCFA and to the technology providers who are developing and demonstrating technologies and systems. It is relatively simple to define requirements for remediating one site where the site characteristics and contaminants are known; it is much more difficult to define requirements for the complex where each site has different characteristics and constraints. In order to develop complex wide requirements, one must understand the complex wide problem and separate the problem into requirements.

Requirements for the complex appear different than requirements for a single site. For example, each site that has a preferred remediation alternative to retrieve waste has waste at a defined depth, which requires a technology to retrieve at that depth. Some sites are less than 5 feet, some from 5 feet to 10 feet, some from 10 to 100 feet, and some are greater than 100 feet. A technology that can retrieve at 5 feet is useful and satisfies a fraction of the site requirements. However, all other things being equal, a technology that retrieves at 50 feet is more useful because it satisfies a greater fraction of the site requirements even though it does not satisfy requirements for all sites. These requirements are expressed most meaningfully as ranges of values embedded in a requirement rather than a specific site requirement.

Similar rationale is used for the other requirements. When all site characteristics are taken into account, a set of requirements based upon the complex wide site characteristics exists. Priorities for technology development can be established based upon the measured benefit to the SCFA complex. The benefit to the complex can be measured based upon the fraction of the requirement range satisfied. Satisfying requirements is one important technology selection criteria. Other selection criteria include regulatory constraints, cost, implementability, effectiveness, and risk, which are also quantifiable. Subjective criteria include the weights given to the selection criteria by the decision-maker and the stakeholder constraints.

3.5.1.2 Preferred Solution Importance. It is important that a site have a preferred solution, even if that solution is later discarded in favor of another solution. Buildings, caps, barriers, in situ stabilization, bioremediation, soil washing, in situ vitrification, retrieval, selective retrieval, vapor extraction, and others are all possible solutions to the problems. Since each solution has its own specific requirements, once a solution or suite of solutions is "preferred", one can develop a set of lower level requirements specific to the solution and specific to the site. Without a "preferred solution," technology developers have many uncorrelated needs to consider and no way of prioritizing those needs.

3.5.1.3 Pulling It All Together. The approach to developing complex wide requirements took all of the above into consideration. A preferred configuration option was chosen or assumed, and the problem was based upon site characteristics which drove the requirements development.

3.5.2 Technical Requirements, Desirables, Trade Studies (Cost, Benefits)

Subsurface Contaminant Focus Area Technical Requirements, Volume I and Volume II[b] contain the technical requirements, desirables, and trade studies recommended to determine benefits to the SCFA.

Three sources of requirements exist: (1) regulatory drivers, (2) site characteristics, and, (3) other constraints. Technical functions and resulting requirements for waste site contaminate containment and retrieval options address the system level requirements. Two examples of system level requirements follow:

- Prevent the formation or development of secondary source contamination due to migrating contaminant concerns to the groundwater or the site boundary or both at a rate faster than the decomposition rate of the contaminate or dispersed to the water supply/cross the boundary in a quantity exceeding EPA standards

- Prevent human ingestion, inhalation, exposure or direct contact with contaminant concerns that would result in a total excess cancer risk of 1E-04 to 1E-06 or exposure to individuals who inadvertently intrude, not to exceed 100 mrem/year for continuous exposure or 500 mrem for a single acute exposure.

Several trade studies suggested[b] are often thought to be requirements. For example, removal of clean overburden during a retrieval remedial action is seen as a requirement. It may be advantageous to remove the overburden, set it aside, and put it back into the pit when all the contaminated material is removed because the overburden is not contaminated. However, it may be more expensive to remove it, assay it to ensure that it is not contaminated, separate it from contaminated soil, and return it to the pit than it would be to include it in the whole retrieval action and treat it along with the waste.

Once a trade study is complete, specific requirements may be generated that are associated with the outcome of the trade study and the associated decision. In the above example, if the decision is to remove the overburden prior to remediating the contaminated waste, this is a requirement that must be satisfied and proven to be satisfied. This requirement becomes part of the remediation specification.

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b. Nickelson, David, John Nonte, and John Richardson, Subsurface Contaminant Focus Area Technical Requirements, Volume I, Volume II, INEL-96/0418, October 1996.

Benefits to the project can be measured by proving the requirements have been satisfied. Benefits for the SCFA can be measured by assessing the degree to which technology development satisfies the complex wide requirements, written as a range of values, such as, if a source term depth ranges from 1 foot to 100 feet, a technology that is capable of retrieving at 40 feet depth can be used at 20 of 50 sites, or satisfies 40 percent of the SCFA requirement. In addition, when that technology is used to remediate a site or several sites, the impact on the total volume, number of sites remaining to be cleaned up, and total area can be computed. That technology has a "quantifiable impact" on the total SCFA problem. When factors such as relative risk and life cycle costs are added, a total benefits determination is made available.

3.5.3 Objectives

The specific objectives are to provide quantitative, unbiased, and measurable criteria for technology development investments. Requirements respond to and support the more general SCFA management objectives of:

1. Accelerate development of technology solutions to meet the Office of Environmental Management's highest priority requirements

2. Ensure applicable technologies are identified or developed or both and delivered ready for field application

3. Facilitate programmatic decision making, reduce uncertainty, and minimize or reduce net remediation costs through a better understanding of site problems

4. Ensure basic research necessary to develop landfill remediation technologies is addressed

5. Develop and maintain a program that is under control managerially and financially.

3.5.4 Technology Development Influences

3.5.4.1 Regulatory Drivers

1. Regulations such as Environmental Protection Agency, RCRA, CERCLA, Clean Air Act, Clean Water Act, Toxic Substance Control Act, NEPA, DOE, NRC.

2. Agreements such as the Federal Facility Compliance Agreement and Consent Order, Interagency Agreement, and State.

3. Health and safety risk assessments.

3.5.4.2 Site Characteristics

1. Site specific requirements based upon waste characteristics and site characteristics such as site geology (soil properties, hydrogeology, topography, climate, depth of waste)

2. Site physical constraints such as access to the waste site.

3.5.4.3 Other Constraints

1. Preferred remedial options (alternatives) including technology availability, implementability, effectiveness, cost, and solution specific requirements

2. Stakeholders with technical, logical, or emotional arguments

3. Program requirements including operations planning.

3.5.5 Configuration Options

Thirteen configuration options show the functions associated with site preferred remedial options. The functions help develop site specific requirements and assign technology categories. Each configuration option is functionally diagramed in Appendix F. Table 6 is provided as an index of configuration options in DART to aid the reader to search for a specific configuration option.

Some requirements apply to all configuration options; for example, meet schedules. Some requirements apply to specific configuration options such as contain or stabilize, or retrieve: maintain the water balance is a contain or stabilize requirement, and retrieve objects of a specific size and weight is a retrieve requirement. Other requirements are specific to a function within a configuration option: such as the requirement not to exceed a specified temperature for in situ stabilization materials. By separating alternatives into configuration options, one can begin requirements development based upon the functions required for the remedial action.

Table 6. List of configuration options which aid requirements development.

Option No.	Configuration Option Title
1	Walk Away
2	Monitor
3	Cap
4	Stabilization
5	Retrieve and Dispose
6	Vapor Extraction
7	Biological Treatment
8	Pump and Treat
9	In situ Thermo Treatment
10	In situ Chemical Treatment
11	Barriers
12	Ex Situ Soil Washing
13	Selective Retrieval

3.5.6 Summary of Applicable Regulatory Requirements

The source of many requirements may be traced to regulatory drivers. Many regulatory drivers are applicable or relevant and appropriate requirements (ARARs). ARARs are a promulgated federal or state statute or regulation that establishes requirements applicable to or otherwise relevant and appropriate to implement remedial action under CERCLA.

Typically, ARAR type criteria are applied by other government agencies responsible for remediation, and are typically grouped into contaminant-specific, location-specific, and action-specific categories. Since they are negotiated, they may differ from state to state and even from site to site.

Contaminant specific ARARs generally establish acceptable limits for hazardous chemical and radiological constituents in various environmental media, based on human health, ecological risks, and exposure pathways. The ARARs may influence the site-specific selection of remediation alternatives by setting objectives that alternatives must meet to reduce risks to health and the environment. Thus, these ARARs relate more to the acceptability of a remedial alternative and not as much to the establishment of a design or performance criteria for the designs. Thus, they are not addressed in this document.

Although several location-specific ARARs apply or may be relevant to the siting of land-disposal facilities and waste-containment units, they only address where certain activities (for example, waste disposal) may or may not be conducted. ARARs do not dictate design criteria or performance requirements, and are not addressed in this document.

Action-specific ARARs generally include design and performance considerations when implementing remedial alternatives. Action specific ARARs constitute the majority of the regulatory criteria for designs.

3.5.6.1 CERCLA Mandates. CERCLA mandates remedies comply with any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent than any federal standard, requirement, or limitation, if applicable or relevant and appropriate to the hazardous substance or release in question.

In general, 10 CFR includes regulations promulgated by the NRC or DOE or both. The 40 CFR regulations are promulgated by the EPA. Regulations that pertain to land disposal of low level waste are promulgated by the NRC. The EPA and the states promulgate regulations controlling air emissions of radionuclides and limiting public exposure to airborne radionuclides. The regulatory documents that serve as a source for technology requirements are 10 CFR Part 61, 40 CFR Part 241 and 264, and DOE Order 5820.2A. Text for the applicable regulatory documents is summarized as follows:

10 CFR Part 61—Licensing Requirements for Land Disposal of Radioactive Waste; Subpart C - Performance Objectives.

10 CFR Part 61.41—Protection of the general population from releases of radioactivity. Concentrations of radioactive material that may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of

25 mrem to the whole body or 75 mrem to any other organ of any member of the public. A reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as reasonably achievable (ALARA).

10 CFR Part 61.42—Protection of individuals from inadvertent intrusion. Design, operation, and closure of the land-disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

10 CFR Part 61.44—Stability of the disposal site after closure.

The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate, to the extent practicable, the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.

10 CFR Part 61 Subpart D—Technical Requirements for Land Disposal Facilities.

10 CFR Part 61.51 (a)—Disposal site design for near-surface disposal. Paragraphs:

(4) Covers must be designed to minimize, to the extent practicable, water infiltration, to redirect percolation or surface water away from the disposed waste, and to resist deterioration by surface geologic processes and biotic activity.

(5) Surface features must direct surface water drainage away from disposal units at velocities and gradients which will not result in erosion that will require ongoing active maintenance in the future.

(6) The disposal site must be designed to minimize to the extent practicable the contact of standing water with waste during disposal, and the contact of percolating or standing water after disposal.

10 CFR Part 61.52—Land disposal facility operations and disposal site closure. Wastes designated as Class C must be disposed of so that the top of the waste is a minimum of 5 meters below the top surface of the cover or must be disposed of with intruder barriers that are designed to protect against an inadvertent intrusion for at least 500 years.

40 CFR Part 241, 209-1—Requirement. Cover material shall be applied as necessary to minimize fire hazards, infiltration of precipitation, odors, and blowing litter; control gas venting and vectors; discourage scavenging; and provide a pleasing appearance.

40 CFR Part 264—Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

40 CFR Part 264.310—Closure and post-closure care.

(a) At final closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill or cell with a final cover designed and constructed to:

(1) Provide long-term minimization of migration of liquids through the closed landfill

(2) Function with minimum maintenance

(3) Promote drainage and minimize erosion or abrasion of the cover

(4) Accommodate settling and subsidence so that the cover's integrity is maintained

(5) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

DOE Order 5820.2A Radioactive Waste Management. Chapter 3: Management of Solid Low-Level Waste, Paragraph 3 -Requirements, a - Performance Objectives, (4) Intruder Protection:

"Disposal closure systems shall be designed to ensure that exposure to individuals who inadvertently intrude the closed facility after the active institutional control period shall not exceed 100 mrem/year for continuous exposure, or 500 mrem for a single acute exposure. For wastes that may remain hazardous to inadvertent intruders beyond 100 years, passive controls (e.g., appropriate markers and barrier systems) shall be incorporated to provide reasonable assurance that inadvertent intruders will be warned and deterred from disturbing the site for up to 500 years."

Figure 6 is a graphic depiction of the number of sites' classes of regulatory drivers for plumes.

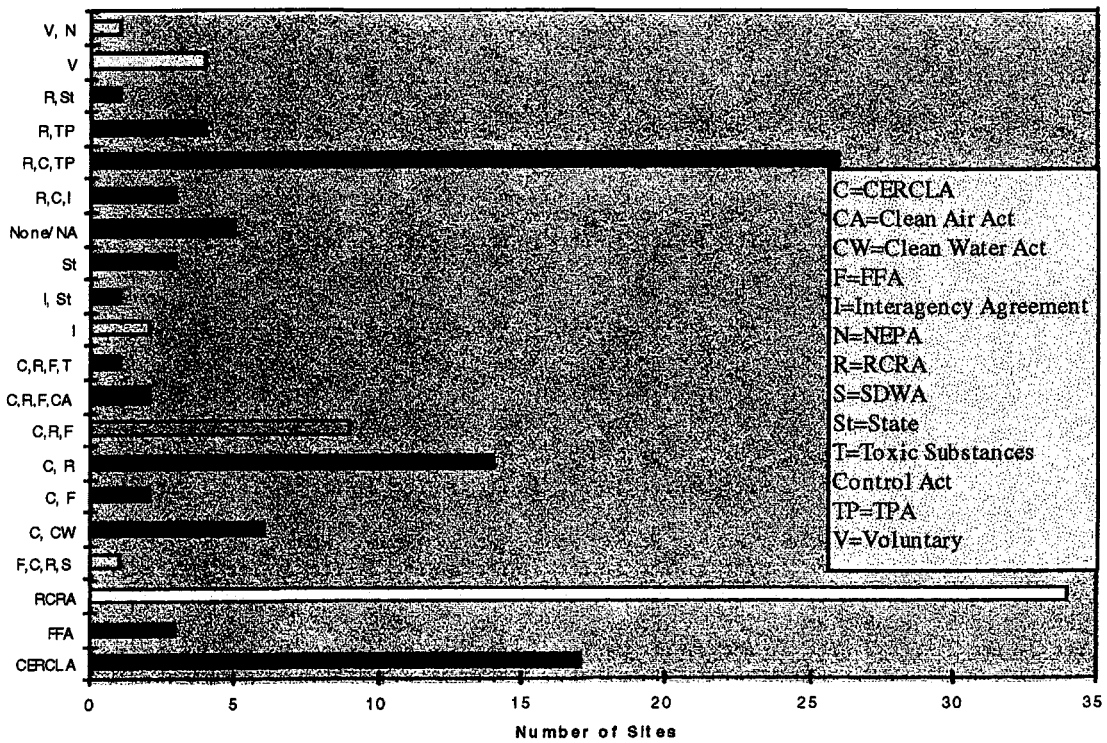


Figure 6. Summary of plumes sites' classes of regulatory drivers. (The major drivers are RCRA and CERCLA.)

3.5.7 DART Requirements Generator

Sites may be sorted so that their characteristics match category technology attributes. This matching derives from each category technical requirement. These requirements are summarized in the requirements document,[b] and have been mapped to applicable technology categories. Matching involves rules that relate site characteristics and attributes. A specific site match, called a "pass" occurs when the input technology attributes and a site's characteristics both satisfy one or more rules. Appendix G summarizes the technology attribute data requirements and the "pass" rules.

3.6 Matching Technologies to Site Requirements

The DART system matches technologies with the site requirements through a technology category. The technology category(s) are assigned to each site and to each technology. Twenty eight technology categories cover all industrial and portfolio technologies. Table 7 lists all the technology categories. Not all the technology categories listed are within the scope of the SCFA, e.g., wastewater treatment; out of scope technology categories were included to accommodate all industrial technologies in the industrial technology database.

Industry can make good use of DART by assessing the potential benefits of a proposed technology. DART can establish the potential market for technology development. DART yields the number of sites and all site characteristics where the technology may be applicable. A developed technology can be matched with site needs through technology categories. Similarly, a technology concept can be matched with site needs. In each case, the technology attributes are entered into DART; the attributes are compared to site data within DART in accordance with the rules contained in Appendix H. When technology performance criteria and site need performance criteria are established, the technology matching will have a more definitive result. Currently, matching through technology categories with specific technology input criteria yields an idea of the technology matches and the proposed technology benefits.

Table 7. Technology categories assigned to industrial and portfolio technologies and to each site (enables matching potential technological systems to site remediation preference).

Technology Category	
Analytical	In situ Thermal Treatment
Barrier Integrity Monitoring	Off-gas Treatment
Cap	People and Equipment
Contaminant Control	Physical Stabilization
Contaminant Detection and Monitoring	Pump and Treat
Decontamination and Decommissioning	Remote Handling
Data Management	Soil Washing
Drilling	Stabilization to limit mobility
Equipment Cleanup	Subsurface Assessment
Ex situ Treatment	Subsurface Barrier
Excavation	Vapor Extraction
In situ Bio Remediation	Waste Assay
In situ Chemical Treatment	Waste Container Handling
In situ Electro	Wastewater Treatment

4. DART USER INTERFACE

Operator interfaces with the system include initiation and data entry, and interfaces between the algorithms, models, and other databases. Operator in the requirements document could have two distinct meanings, user and systems operator. The user can access data and reports through the menus provided on the screens or generate queries. The systems operator can actually change the data in the database.

Figure 7 is a screen display that allows the user to enter the DART system to access data. Each button (block) allows the user to access specific DART data. For example, if the operator selects site data, a site data template will appear for the user to input the site criteria which DART should sort on.

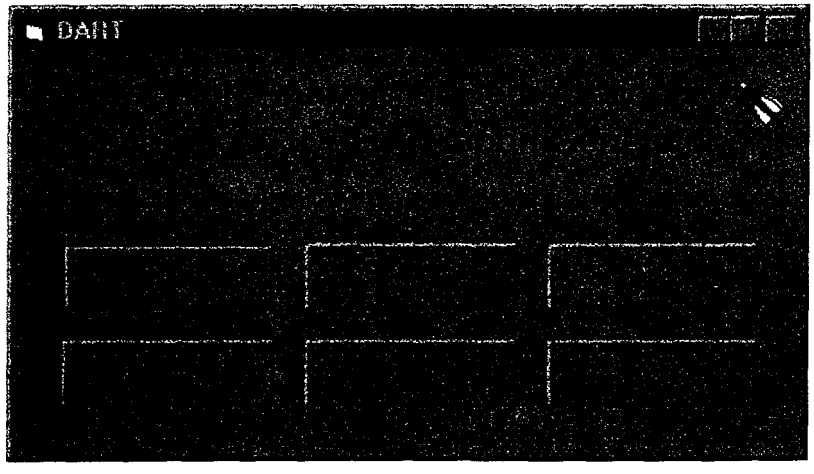


Figure 7. The initial DART screen allows the user to select site data, technology categories, graphics, or search on site needs.

Figure 8 displays the site data input screen that the user can fill in. If the user selects the field office, Idaho, all site data templates for waste sites at the Idaho field office will be displayed. The display is a template filled in with data for each site. The user can page through the sites to find sites of interest. Other blocks on the site data template allow the user to be more selective. For example, the user may select the Operating Unit, the site, and/or characteristics of a site such as specific contaminant. If U-235 is input, DART displays all sites, at the Idaho Field Office containing U-235. This is only one example of DART data screens. For more information on user options, refer to the DART Users Manual.

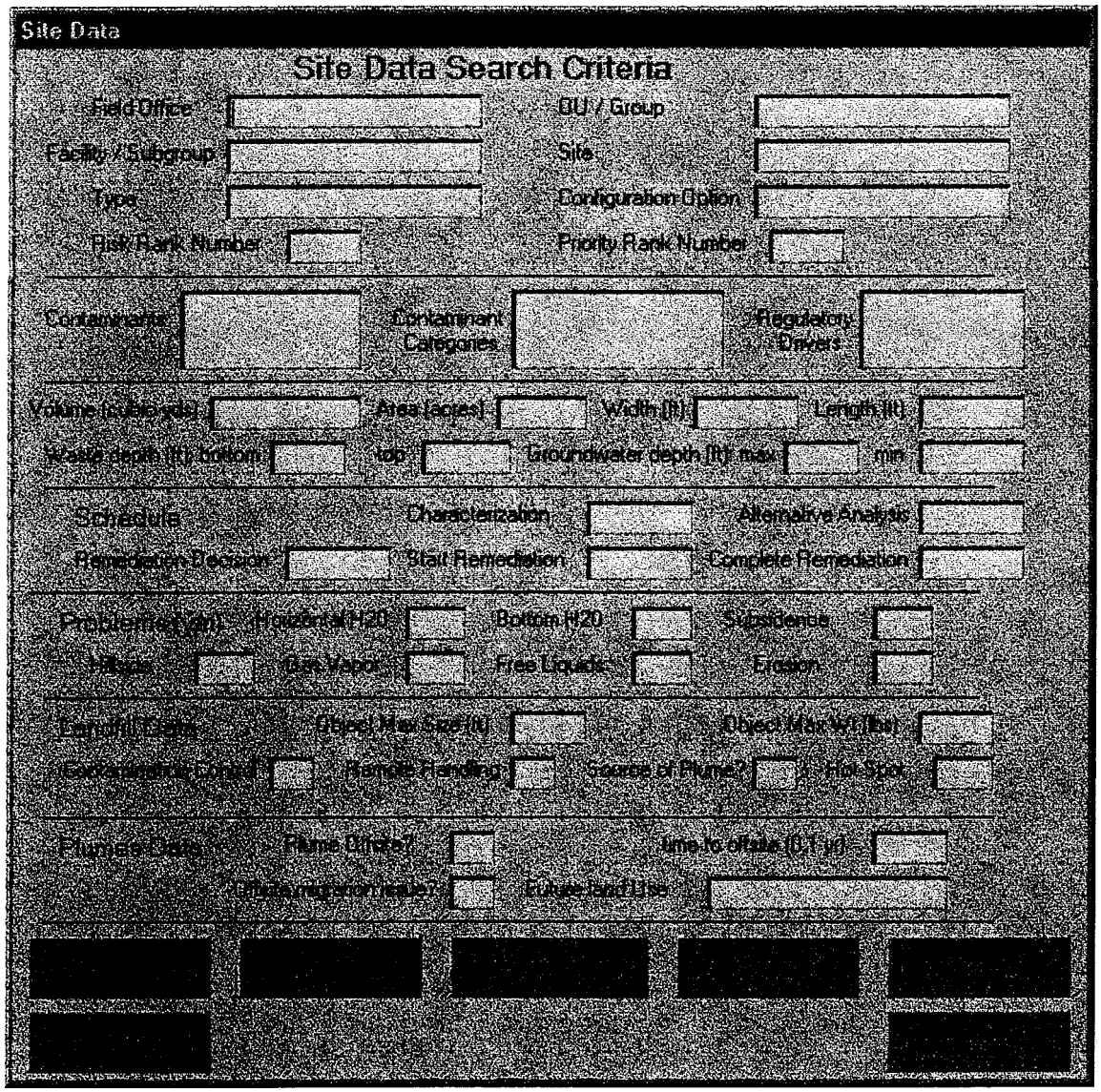


Figure 8. A DART data input screen allows the user to select the data for sorting. Any one or all of the data windows may be filled in to initiate the sort.

Figure 9 shows the full set of window and screen interconnections. One can use Figure 9 to trace a path from any user selection to the display expected on the following screen. The return screen for each exit button is shown to aid a user to know what will happen to the screen display when the button is selected. A description of each form, to input and output data, is contained in Appendix I Interface Forms. Appendix I describes each form in the DART user interface. The following information is provided for each form:

- **Purpose**—a short description of the capability provided to the user by the form.

- **Accessed From**—where the user "comes from" to reach the current form
- **Accesses**—what forms can be reached from the current form
- **Required Data**—what data is needed to open the current form
- **Operations**—what capabilities are accessible to the user in the current form.

The forms used to enter technology performance criteria data and determine sites whose requirements are satisfied by those criteria are identical in operation but not for the data to be entered. As a result, a complete description will be entered only for the initial form of this type. All other such forms will be identified as such and refer to the form "frmCap" for operational details.

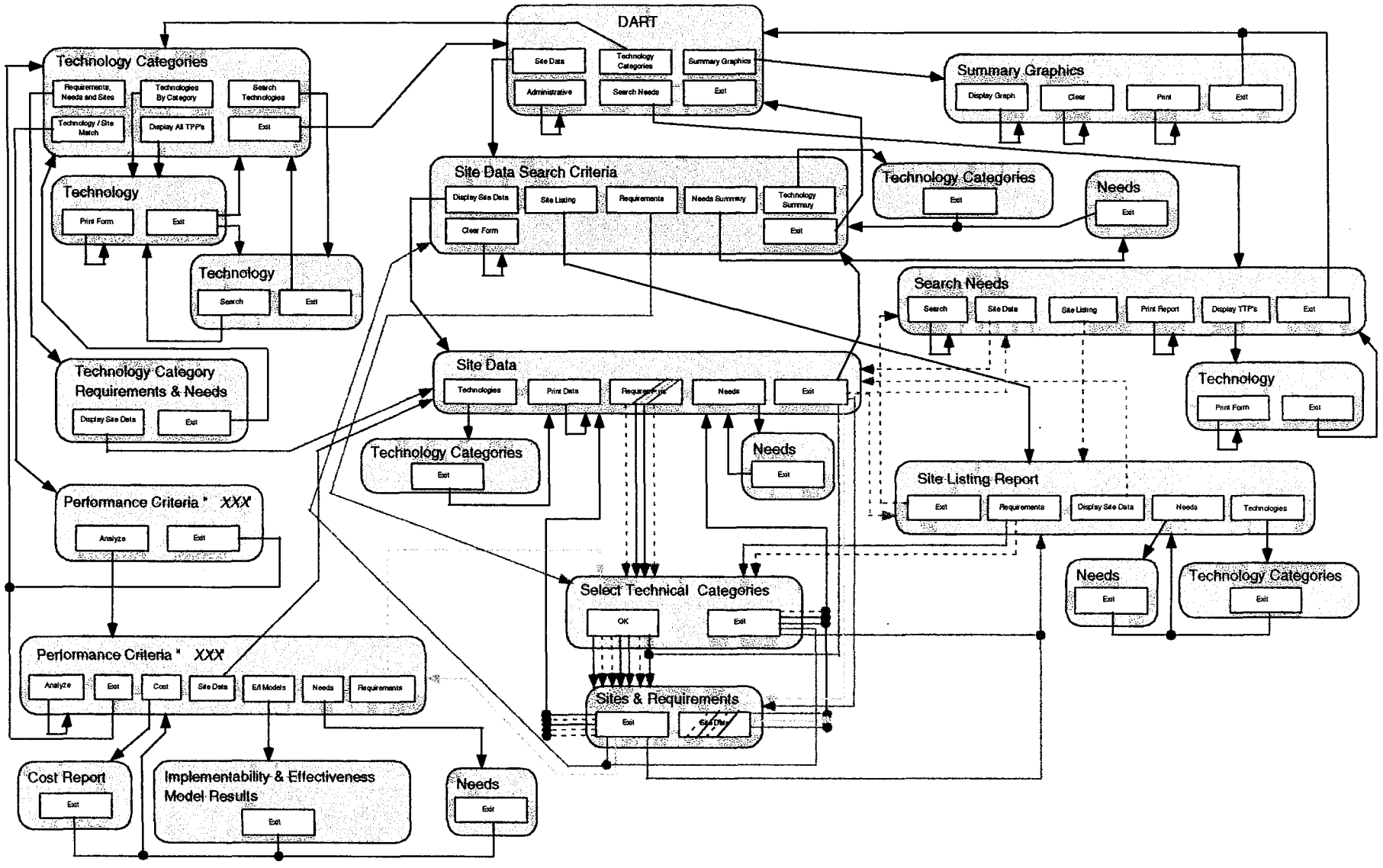


Figure 9. A DART screens and buttons relationship diagram provides the user with a detailed path from initial selection to final action. The path forward and return is traced.

5. CONFIGURATION MANAGEMENT AND INTELLECTUAL PROPERTY

The system is amenable to changing data, but changing the data should be controlled, that is anyone can use the system but only authorized individuals are allowed to change the data in the system. To maintain configuration control, all data input into DART can be traced to a documented source. An authorized member of the DART team currently inputs all data into DART and no data is changed without an approved source document that supports the change.

The DART system user interface and algorithms are protected by copyright.

6. NEEDS DISCUSSION

Needs are the key to the investment planning process. Investment planning involves finding and funding those activities that best meet the technology needs associated with known site problems. The needs are the most direct connection between the site STCG and site/OU managers and the SCFA program. Needs are prioritized, available technologies searched, and technology gaps identified. Trade off studies can then be made and a portfolio technology specified. Finally, the fact that needs are being satisfied is quantified and presented as a success measure of the program.

Requirements are a way of quantifying needs. For technologies to meet site specific needs they must satisfy site specific remediation requirements. Requirements provide a measurable expression of each need. Thus, meeting needs can be measured by satisfying associated requirements. Since requirements are quantitative, they form the basis for technology development performance objectives.

The STCG generated need statements in March 1997 at each of the 10 Field Offices in the DOE complex for the Ten Year Plan. The SCFA Technical Team extracted 66 need statements that are in scope for SCFA technology development. Characterization and ex situ treatment were two major categories that were in scope in past years. They are out of scope now because they reside in other focus areas.. The needs determined to be in scope for the SCFA are listed in Appendix J. Each need is listed with the STCG reference number so that it can be tracked back to the Ten Year Plan.

Each need statement is entered into the DART database, related to a specific site(s), and assigned TTP(s) where the SCFA Technical Team determined that technologies being developed by the SCFA might apply to satisfy the need. In addition, by way of the Industrial Database within DART, the STCG was informed of industrial technologies, which may also apply to satisfying the stated need. The caveats of "might" and "may" are used because the lack of performance measures in the need statements and in the technology descriptions, both Industrial Database and TTP, limit assurance that the technology satisfies the need. This lack of performance measures must be addressed if we are serious about matching technologies to needs and solving remediation problems. Specific measurable requirements must be developed and technology development must satisfy the stated requirements. Requirements can be generated, even complex wide requirements, but it will take management emphasis to accomplish the task.

7. CONCLUSIONS

1. DART contains the most complete integrated database of site characteristics, Site Technology Coordination Group (STCG) need statements, industrial data base, technology. Portfolio, and site technology requirements to assist the SCFA to make investment decisions.

2. Technology investment decisions can be made with quantifiable, traceable, and verifiable data from over 900 subsurface waste sites throughout the DOE complex.

3. Due to the limited quantity and need for interpretation of data, all data input into the DART data base should be validated by the site specific field offices (STCG).

4. For the six Field Offices not visited by the DART team to collect additional data (Albuquerque, Chicago, Nevada, Oakland, Ohio, Rocky Flats), the phase 2 data gathering effort should be completed by visiting the DOE Public Reading Rooms and Administrative Record Files. An INTERNET search should be conducted to gather additional data for those sites not yet searched.

5. The DART database must be placed under configuration management and maintained by inputting new records and changes as they evolve.

6. Summary of site specific information shows that field work proposals can be grouped, needs assigned where they were not specified in the proposal, needs analyzed by applicable site, and benefits analyzed to prioritize proposals.

7. Prioritizing Field Task Proposals based upon the site specific data is supportable and defensible.

8. The only subjective influence on the prioritization is the weight assignments by the decision-maker that indicate importance of specific categories.

9. Provide performance measurement data for needs and for technologies, both industrial and SCFA portfolio, to enable specific technology matching to site specific needs.

APPENDIX A

List of
Database Tables, Table Definitions,
Queries, and Functions

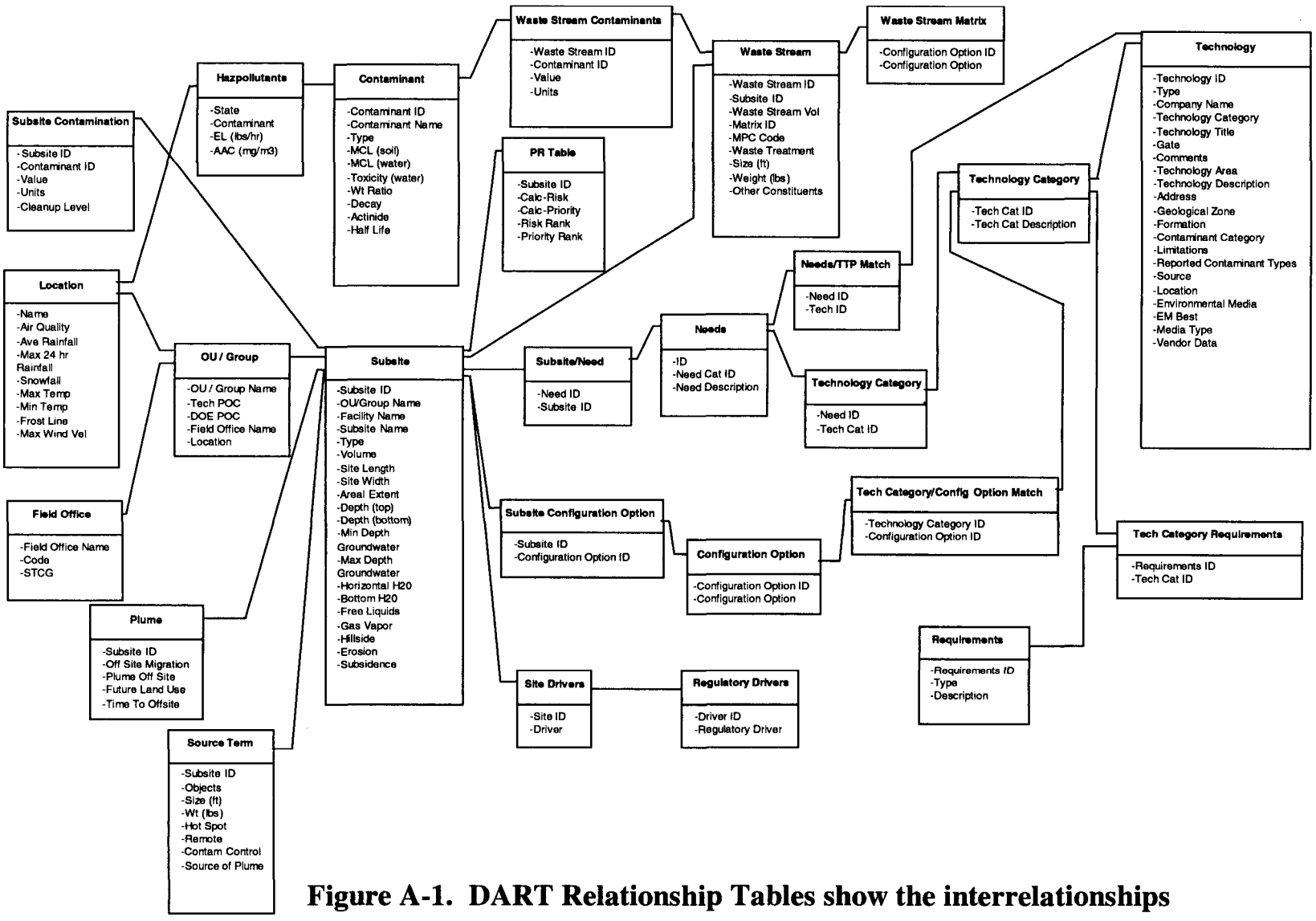


Figure A-1. DART Relationship Tables show the interrelationships between or among the elements in the DART System.

This appendix defines the database used as the basis of DART. The database is implemented in Microsoft Access, Version 7.0. The following sections describe the database tables, queries, and functions used in DART. The relationships among the tables is displayed in Figure A-1, Database Relationships.

A-2.1 List of Tables

The following is a list of all tables used in the database:

Name	Description
Field Office	The Department of Energy organizational unit that oversees the remediation of plumes and/or source terms.
OU/Group	The top level organizational unit within a Field Office by which waste sites are organized.
Location	Table containing geographic location of an OU/Group sufficiently localized for meteorological information. This is used as a look up table to enter location in ou/group table
Subsite	A location or area containing waste (plume or source term) within or administered by a facility for which a specific preferred option decision (contain, retrieve, selective retrieve, or no action) is made.
Plume	A table containing plume specific data for a subsite containing a plume requiring remediation.
Source Term	Table containing data for a subsite containing a source term requiring remediation.
Contaminant	Data associated with a material or substance at a subsite that must be managed to prevent harm to humans or the environment
Subsite Contamination	The table relating contaminants with subsites.
Hazpollutants	The table containing air quality regulatory data.
SubsiteContam Category	Table relating contaminant categories with subsites. Note: this table duplicates data available via contaminant table.
SubsiteContam RegTable	Table relating regulatory emission limts and ambient air concentrations with sites and contaminants. This table is a denormalization but has been added to speed up data access.
Waste Stream	The table containing information concerning material contained in a waste stream generated during retrieval.
Waste Stream Matrix	The table containing data about the bulk physical form of the waste stream. It is one of a set of predefined categories.
Waste Stream Contamination	The table relating waste streams to the contaminants in the waste stream,
Regulatory Drivers	The table containing the list of laws, rules, DOE orders, etc. that provide the regulatory basis driving site remediation, e.g., CERCLA, RCRA
Site Drivers	The table relating the sites to the regulatory drivers for that site
PRTable	The table containing calculated risk and priority together with the risk ranking and priority ranking.

Name	Description
Needs	The table containing all reported needs. A need is an expression of a technology or capability required at a subsite for remediation
Subsite/Need	The table relating needs and subsites, e.g., which subsites have which needs.
Configuration Option	The table listing the configuration options for remediation.. A configuration option is a set of actions taken for remediation at a site, e.g., stabilization.
Subsite Configuration Option	The table relating subsites and configuration options, e.g., which subsites have which configuration options.
Technology Category	The table containing the list of technology categories, e.g., excavation, in-situ chemical treatment, etc.
Technology	The table containing specific technology information. The majority of this data was imported from the Scientech Industry Available Technology Database.
Tech Category /Config Option Match	The table containing the data that matches technology categories and configuration options, e.g., which configuration options a technology category is associated with.
Tech Category /Need Match	The table that relates reported needs and technology category that associating a need with the technology category applies to that need.
Requirement	The table which lists the requirements .
Tech Category Requirement	The table which lists the requirements a technology within a technology category must satisfy for each technology category
Conversions	The table containing unit conversion factors and other values used in the risk calculations.

A-2.2 Table Definitions

Table Name: Field Office

The Department of Energy organizational unit that oversees the remediation of plumes and/or source terms.

Field Name	*Data Type*	*Size*	*Description*
name (PK)	Text	20	Field office name
code	Text	3	2 or 3 letter code for field office, e.g., ID, OAK
STCG	Text	50	Site technology coordinating group contact

Table Name: OU/Group

The top level organizational unit within a Field Office by which waste sites are organized.

Field Name	*Data Type*	*Size*	*Description*
ou/group name(PK)	Text	50	Ou/group name
field office name (FK)	Text	20	Name of filed office overseeing the ou/group
tech POC	Text	50	Name / phone number of site technical POC
DOE POC			Name / phone number of DOE POC
location (FK)	Text	50	Geographic location of the ou/group

Table Name: Location

The geographic location of an OU/Group sufficiently localized for meteorological information. This is used as a look up table to enter location in ou/group table.

Field Name	*Data Type*	*Size*	*Description*
name (PK)	Text	50	Name of the a geographic location
air quality(FK)	Text	20	State or air quality management district for CAA levels
mean rainfall	Number	Single	Mean rainfall (in/yr) at location
max 24hr rainfall	Number	Single	Max 24 hour rainfall (in) at location
max temp	Number	Single	Maximum temperature (deg. F) at location
min temp	Number	Single	Minimum temperature (deg. F) at location
max wind vel	Number	Single	Maximum wind velocity (mph)
frost line	Number	Single	Frost line in inches
snowfall	Number	Single	Mean snowfall (in/yr) at location

Notes:

1. *Climatic data represents data from NWS stations sufficiently close to the individual sites to provide representative numbers. Generally data reflects a sample of at least 20 years.*

2. *Data sources for meteorological data are National Climate Data Center: http://www.ncdc.noaa.gov, Western Regional Climate Center: http://wrcc.sage.unr.edu, NOAA Environmental Research Laboratories, Climate Diagnostics Center: http://www.cdc.noaa.gov.*

3. *Frost line data was interpolated from an illustration of maximum depth of frost penetration in the United States extracted from Introductory Soil Mechanics and Foundations, George B. Sower, Section 4.7*

Table Name: Subsite

A location or area containing waste (plume or source term) within or administered by a facility for which a specific preferred option decision (contain, retrieve, selective retrieve, or no action) is made.

Field Name	*Data Type*	*Size*	*Description*
subsite id (PK)	Autonumber	Long integer	id identifying the subsite
ou/group name(FK)	Text	50	Name of OU/group containing the subsite
facility name	Text	50	Name of facility containing the subsite
subsite name	Text	50	Name of the subsite
type	Text	20	Values: source term, soil plume, groundwater plume, seeps, surface water, Not Given
option	Text	20	Values: contain, retrieve, or selective retrieve
site priority	Number	Integer	Site priority, 1 = high, 2 = medium, 3 = low, not included in current version due to lack of data
volume	Number	Single	Volume of contaminated waste (including soil) in cubic yards
depth top	Number	Single	Depth to top of waste in feet
depth bottom	Text	12	Depth to bottom of waste in feet, for plumes this is depth of plume
min depth groundwater	Number	Single	Minimum depth to groundwater in feet
max depth groundwater	Number	Single	Maximum depth to groundwater in feet
soil conductivity	Number	Single	Soil conductivity, not included in current version due to lack of data
soil texture	Text	20	Not included in current version due to lack of data
soil pH	Number	Single	Soil pH, not included in current version due to lack of data
site length	Number	Single	Length of subsite in feet
site width	Number	Single	Width of subsite in feet
areal extent	Number	Single	Area of subsite in acres
horizontal H2O	Text	1	Is horizontal water a problem? Y/N
bottom H2O	Text	1	Is bottom water a problem? Y/N
free liquid	Text	1	Are free liquids present? Y/N
hillside	Text	1	Is the site on a hillside? Y/N
erosion	Text	1	Is erosion a problem? Y/N
gas vapor	Text	1	Is gas vapor present? Y/N
subsidence	Text	1	Is subsidence a problem? Y/N

Table Name: Subsite (cont'd)

Field Name	*Data Type*	*Size*	*Description*
char	Number	v	Year date, e.g., 1995 that the site characterization will be completed
alt anal	Number	Integer	Year date, e.g., 1995 that the alternative analysis will be completed
rem dec	Number	Integer	Year date, e.g., 1995 that the remedial decision will be made
start rem	Number	Integer	Year date, e.g., 1995 that remedial action will begin
comp date	Number	Integer	Year date, e.g., 1995 that remedial action will be completed
baseline technology	Text	150	Technology desired or planned to be used by the site.
comments	Text	255	Additional comments

Notes:

1. *Impact indicates no impact if technology development cannot meet schedule or baseline technology is deemed adequate*

2. *There are apparently other fields to be added. These are: current baseline cost, baseline waste, baseline duration, privatization potential, ADS, RDS, WBS. It is not precisely clear whether these are strictly site related, should be included in another table, etc.*

3. *If a site consists of several trenches or areas, the length and width given is the length and width of the largest area given.*

4. *For schedule dates, if task is done with no date given or listed as ongoing, a value of zero was entered or date was set equal to completion date of preceding step.*

Table Name: Subsite Contam Category

Table relating contaminant categories with subsites. Note: this table duplicates data available via contaminant table.

Field Name	*Data Type*	*Size*	*Description*
subsite id	Number	Long Integer	id identifying the subsite
type	Text	25	Contaminant category, e.g., VOC, EPA toxic metal, etc.

Notes:

1. *This table is automatically generated when the query MakeSubsiteContam is run. Please note this table denormalizes the database so this table must be regenerated whenever the table Subsite Contamination is updated.*

Table Name: Plume

A table containing plume specific data for a subsite containing a plume requiring remediation. Note: there is a record in this table for a plume only if appropriate data is available.

Field Name	*Data Type*	*Size*	*Description*
subsite id (PK, FK)	Number	Long integer	id identifying the subsite
source	Text	50	the source of the plume
plume off site	Text	1	Is the plume offsite? Y/N/?
off site migration	Text	1	is offsite migration a potential problem, Y/N/?
future land use	Text	50	future anticipated use of the land
time to offsite	Number	Long Integer	units, tenths of year

Table Name: Source Term

Table containing data for a subsite containing a source term requiring remediation. Note: there is a record in this table for a plume only if appropriate data is available.

Field Name	***Data Type***	***Size***	***Description***
subsite id (PK, FK)	Number	Long Integer	id identifying the subsite
objects	Text	50	text listing of intact objects
size(ft)	Number	Single	maximum size of objects in source term
wt(lbs)	Number	Single	maximum weight (lbs) of objects in source term
hot spot	Text	1	Is there a hot spot? Y/N/?
remote	Text	1	Is remote handling required? Y/N/?
contam control	Text	1	Is contamination control required Y/N/?
source of plume	Text	1	Is the source term the source for a plume? Y/N/?

Notes:

1. *For object size and weight, the default is zero. So the default value of these fields are zero. Also for plumes, any retrieve configuration assumes there are no objects.*

Table Name: Contaminant

A material at a subsite that must be managed to prevent harm to humans or the environment.

Field Name	*Data Type*	*Size*	*Description*
contaminant id (PK)	Text	25	short version of contaminant name
contaminant name	Text	50	full name of contaminant
type	Text	25	contaminant category: VOC, SVOC, EPA toxic metal, uranium, precious metal, etc.
toxicity (water)	Number	Single	Waterborne pathway toxicity value
decay	Number	Single	Adjustment factor for radioactive decay, note noradioactives have value 1
actinide	Y/N		Is the contaminant an actinide?
MCL(soil)	Number	Single	Cleanup levels for soil
MCL(water)	Number	Single	Cleanup levels for water
wt ratio	Number	Single	Ratio to convert ppm to kilograms
half life	Number	Single	half life of radioactive contaminant in years

Table Name: Subsite Contamination

The table relating contaminants with subsites.

Field Name	*Data Type*	*Size*	*Description*
subsite id (PK, FK)	Number	Long integer	id identifying the subsite
contaminant id(PK, FK)	Text	25	Short version of contaminant name
value	Number	Single	Maximum concentration or mass of contaminant
units	Text	8	Units of measure
cleanup level	Number	Single	Mandated / accepted cleanup level for the contaminant at a the subsite

Table Name: Hazpollutants

The table containing air quality regulatory data.

Field Name	*Data Type*	*Size*	*Description*
State (PK)	Text	15	Name of the air quality district for which the limits apply.
contaminant id (PK, FK)	Text	25	Short version of contaminant name
EL(lbs/hr)	Text	15	Screening emission limit for the contaminant for the given contaminant and air quality district
AAC (lbs/hr)	Text	15	Acceptable ambient concentration for the contaminant for the given contaminant and air quality district

Notes:

1. *EL and ACC are text as "No Limits" are a legitimate value. Currently, this data is not used only for message generation.*

2. *The field name "State" is used because we do not currently have data for air quality districts in California so data is by state.*

Table Name: Waste Stream

The table containing information concerning material contained in a waste stream generated during retrieval.

Field Name	*Data Type*	*Size*	*Description*
waste stream id (PK)	Number	Long Integer	identifier of a waste stream
subsite id (FK)	Number	Long Integer	identifier of the subsite which is the source of the waste stream
matrix id(FK)	Text	2	a code describing the waste stream matrix
volume	Number	Single	the volume of the waste stream in cubic yards
MPC code	Text	5	
waste treatment	Text	20	a code or phrase describing the waste treatment
size(ft)	Number	Single	Max dimension of objects in waste stream
object wt	Number	Single	Max weight of objects in waste stream
other const	Text	50	a listing of "other" constituents in the waste stream

Notes:

1. *Object size and weight is reported in BOTH source term and waste stream tables. The data is duplicated as the configuration options are assigned by subsite and hence require the maximum size and weight by subsite across all waste streams.*

Table Name: Waste Stream Matrix

The table containing data about the bulk physical form of the waste stream. It is one of a set of predefined categories.

Field Name	***Data Type***	***Size***	***Description***
matrix id (PK)	Text	2	identifier of the waste stream matrix
description	Text	30	a description of the matrix, e.g., soil with debris
density	Number	Single	the density of the matrix in lbs per cubic foot

Table Name: Waste Stream Contamination

The table relating waste streams to the contaminants in the waste stream,

Field Name	***Data Type***	***Size***	***Description***
waste stream id (PK, FK)	Number	Long Integer	identifier of a waste stream
contaminant id (PK, FK)	Text	25	short version of contaminant name
value	Number	Single	concentration or mass of contaminant
units	Text	8	Units of measure

Table Name: Regulatory Drivers

The table containing the list of laws, rules, DOE orders, etc. that provide the regulatory basis driving site remediation, e.g., CERCLA, RCRA.

Field Name	*Data Type*	*Size*	*Description*
driver id (PK)	Text	6	short name identifier for a regulatory driver
regulatory driver	Text	70	expanded name of regulatory driver

Table Name: Site Drivers

The table relating the sites to the regulatory drivers for that site.

Field name	*Data Type*	*Size*	*Description*
site id (PK, FK)	Number	Long Integer	identifier for the subsite
driver id (PK, FK)	Text	6	short name identifier for a regulatory driver

Table Name: PRTable

The table containing calculated risk and priority together with the risk ranking and priority ranking.

Field name	*Data Type*	*Size*	*Description*
site id (PK, FK)	Number	Long Integer	identifier for the subsite
Calc-Risk	Number	Double	calculated risk for the subsite
Calc-Priority	Number	Double	calculated priority for the subsite
Priority Rank	Number	Long Integer	priority rank, e.g., 1 is the site with the highest priority
Risk Rank	Number	Long Integer	risk rank, e.g., 1 is the site with the highest risk

Notes:

1. *This table is automatically generated when the query MakePRTable is run which also calculates the risk and priority values. The data is stored in a separate table from the table subsite..*

2. *Priority / risk ranks are a two step process. First MakePRTable is run to generate the values. There is currently a VB Project called Bookkeeping which contains the functions which calculate and update the risk and priority ranks.*

Table Name: Needs

The table containing all reported needs. A need is an expression of a technology or capability required at a subsite for remediation

Field name	*Data Type*	*Size*	*Description*
STCG-ID (PK)	Text	20	STCG identifier for the need
SCFA-ID	Text	12	SCFA identifier for the need
Need	Text	255	text description of need

Notes:

1. *255 for the size of the text description was set automatically when the data was imported from Excel.*

Table Name: Subsite / Need

The table relating needs and subsites, e.g., which subsites have which needs.

Field name	*Data Type*	*Size*	*Description*
STCG-ID (PK, FK)	Text	20	STCG identifier for the need
Subsite ID (PK, FK)	Number	Long Integer	identifier for the subsite

Table Name: Configuration Options

The table listing the configuration options for remediation.. A configuration option is a set of actions taken for remediation at a site, e.g., stabilization.

Field name	*Data Type*	*Size*	*Description*
config option id (PK)	Number	Integer	identifier for the configuration option
config option	Text	50	text description of the configuration option

Table Name: Subsite Configuration Option

The table relating subsites and configuration options, e.g., which subsites have which configuration options.

Field name	*Data Type*	*Size*	*Description*
config option id (PK, FK)	Number	Long Integer	identifier for the subsite
Subsite ID (PK, FK)	Number	Long Integer	identifier for the subsite

Table Name: Technology Category

The table containing the list of technology categories, e.g., excavation, in-situ chemical treatment, etc.

Field Name	*Data Type*	*Size*	*Description*
Tech Cat ID (PK)	Number	Long Integer	identifier for the technology category
Tech Cat Desc	Text	50	a text description of the technology category

Table Name: Technology

The table containing specific technology information. The majority of this data was imported from the Scientech Industry Available Technology Database.

Field Name	*Data Type*	*Size*	*Description*
Technology ID (PK)	Number	Long Integer	identifier for the technology
type	Text	10	Commercial or TTP
Company Name	Text	100	Name of company providing technology or SCFA for TTP
Technology Category	Text	100	Text description of technology category to which technology belongs
Technology Title	Text	255	Title / name of technology
Gate	Text	30	Developmental state of technology
Comments	Text	Memo	Comments
Technology Area	Text	70	superset of category, e.g., treatment, etc.
Technology Description	Text	Memo	text description of the technology
Address	Text	255	address of company providing technology
Geologic Zone	Text	35	vadose, saturated zone, etc.
Formation	Text	40	lists heterogeneous single layer, etc.
Contaminant Category	Text	255	list of contaminant categories appropriate for technology, e.g., VOC
Limitations	Text	Memo	text listing of advantages and/or limitations of technology
Reported Contaminat Types	Text	Memo	text listing of specific contaminants technology can be applied to
Source	Text	20	source of data, TTP number for TTPs
Location	Text	20	in-situ, ex-situ
Environmental Media	Text	20	arid, humid, not applicable, etc.
EM Best	Text	3	EM best? Yes/no
Media Type	Text	30	soil, groundwater, etc.
Vendor Data	Text	3	vendor data available, yes/no

Notes:

1. *The majority of the data corresponds to the Scientech Industry Available Technologies database. The TTP data has been added. In addition, the fields technology id, type, and CO data were added.*

2. *The technology category field was changed from the original categories to categories contained in the SCFA database.*

Table Name: Tech Category / Config Option Match

The table containing the data that matches technology categories and configuration options, e.g., which configuration options a technology category is associated with.

Field Name	*Data Type*	*Size*	*Description*
config option id (PK)	Number	Long Integer	identifier for the configuration option
Tech Cat ID (PK)	Number	Long Integer	identifier for the technology category

Table Name: Tech Category/Need Match

The table containing the data that matches needs with technology category, e.g., which technology category is associated with a given need.

Field Name	*Data Type*	*Size*	*Description*
STCG-ID (PK, FK)	Text	20	STCG identifier for the need
tech cat id (PK, FK)	Number	Long Integer	identifier for the technology category

Table Name: Requirement

The table which lists the requirements .

Field Name	*Data Type*	*Size*	*Description*
requirement id (PK)	Number	Integer	identifier for a requirement
description	Text	50	requirement text
requirement	YES/NO	1	Y = requirement, N = desirable, not a requirement

Table Name: Tech Category Requirements

The table that lists the requirements a technology within a technology category must satisfy for each technology category.

Field Name	*Data Type*	*Size*	*Description*
requirement id (PK)	Number	Integer	identifier for a requirement
Tech Cat ID (PK)	Number	Long Integer	identifier for the technology category

Table Name: Conversions

The table containing unit conversion factors and other values used in the risk calculations.

Field Name	*Data Type*	*Size*	*Description*
unit (PK)	Text	20	the unit to be converted
factor	Number	single	the conversion factor for the unit

A-2.3. Database Queries

The following are queries that are used in the DART interface or to determine quantities used in the DART system. Note: all queries with initial characters "VB" were created specifically for use by the DART interface or to calculate or display values in the DART interface. Other existing queries were, in general, created to answer specific questions.

Query Name	Discussion
Alpha Contamination	Returns a table of sites with reported contaminant of type alpha. It is used in the calculation of priority.
DNAPLs	Returns a table of sites with reported contaminant of type DNAPL. It is used in the calculation of priority.
DNAPLs-sub1	Used by query DNAPLs to find sites with DNAPLs.
EPAToxic	Returns a table of sites with reported contaminant of type EPA toxic metal. It is used in the calculation of priority.
GeneralSubsite Data	Query used as the bases of report "Subsite Data" used to print the one sheet summaries of site data
HighExplosive	Returns a table of sites with reported contaminant of type High Explosive. It is used in the calculation of priority.
MakeContam RegTable	An update query that generates the table SubsiteContamRegTable relating subsites, contaminants with requlatory emission limits and ambient air concentrations,
MakeSubsite Contam	This is an update query that updates the table SubsiteContamCategory relating subsites and contaminant categories.
MakePRTable	This is an update query which combines risk and priority values and collects them in the table PRTable.
Priority	Displays site ids and calculated site priorities in descending order of priority.
Priority-sub1	Calculates site priority for each site using the values determined in the paired comparison model.
Risk	Calculates the risk for each subsite using the subqueries Risk-sub1 and Risk-sub2.
Risk-sub1	Adds the risks determined in Risk-sub2 together for each site.
Risk-sub2	Determines the risk due to a particular contaminant at a particular site.
Requirements by TechCategory	Returns the list of requirements assigned to a technology category. Used in frmTechReqs.
SoluableRads	Returns a table of sites with reported contaminant Cs, Eu, I, Ru, Sb, Sr, or TC. It is used in the calculation of priority.
Soluable Rads-sub1	Used by query SoluableRads to find sites with soluable rads.
TRUs	Returns a table of sites with reported contaminant Am, Cm, Np, Pu, CH-TRU, or RH-TRU. It is used in the calculation of priority.
TRUs-sub1	Used by query TRUs to find sites with TRUs.
VBCapData	Accesses the data required to determine which sites satisfy the performance criteria input for the Cap technology category. See CapSites in frmCap.

Query Name	Discussion
VBCOFOContam CatCount	Returns the count of each contaminant category across the DOE complex, e.g., the number of sites reporting a contaminant category. This is required if a configuration option selected to avoid double counts when not selected, see VBFOContamCatCount. (frmGraphics)
VBCOFOContam Count	Returns the count of each contaminant across the DOE complex, e.g., the number of sites reporting a contaminant. (frmGraphics) when a configuration option is also selected.
VBContam Risk	Returns data required to calculate risk for a contaminant at a site. It is used in the function CalcRiskReduction.
VBExcavatorData	Accesses the data required to determine which sites satisfy the performance criteria input for the Excavation technology category. See ExcavatorSites in frmExcavators.
VBFOContam Count	Returns the count of each contaminant category by field office. E.g., the number of sites in a field office reporting a contaminant category when there are no configuration option selected.. (frmGraphics)
VBFOContam Count	Returns the count of each contaminant by field office. E.g., the number of sites in a field office reporting a contaminant when there are no configuration option selected.. (frmGraphics)
VBNeedsby TechCategory	Returns a list of needs associated with a technology category using the list of sites associated with that tech category. Called from Requirements, Needs and Sites button in form frmTechCategories.
VBNeedsList	Returns a list of needs for a given site(s). Used in frmNPReport.
VBNeedsList	Returns a list of needs for a given site(s) for a given technology category. Used in frmNPReport.
VBNeed Search	Finds list of needs satisfying input criteria when a technology category is selected. Called when Search button is selected in frmNeedsSearch.
VBNeed Search1	Finds list of needs satisfying input criteria when a technology category is not selected. Called when Search button is selected in frmNeedsSearch. This is required as needs can be assigned to multiple technology categories.
VBRiskData	This query access information required to calculated residual risk in the function ResidualRisk in Global.Bas.
VBRiskInput	Used in function DetermineRisk to calculate risk. Not currently used but will be possibly used to calculate risk in interface rather than in MS Access.
VBSite LocationData	Returns climatic data for a given site and is used to determine site specific requirements (frmCOReq) based on climate, e.g., location.
VBSitePR	Returns the field office, ou/group, facility, and subsite name given a subsite id. Used to generate the list of sites satisfying performance criteria in ListCandidateSites in Global.Bas
VBSite Technology	Returns the list of technology categories that apply to a site. Used in frmTCSelect and frmEquipCleanup.
VBSubsiteCO Data	Returns site data for use in graphing (frmGraphics) when a configuration option is selected. VBSubsiteData is used otherwise to prevent double counting due to multiple configuration options.
VBSubsite ConfigOption	Returns the configuration option(s) for a site. Used in frmSiteDataDisplay.

Query Name	Discussion
VBSubsite Contaminatio n	Returns contaminant data for a site including site specific cleanup level. Used in all technology performance criteria forms to determine if cleanup levels are satisfied.
VBSubsite Data	Returns site data for use in graphing (frmGraphics)
VBSubsite Display	Query that returns data, except for contaminant and driver data for displaying site specific data in frmSiteDataDisplay.
VBSubsite Sub1	The query is used to determine sites satisfying search criteria in frmSiteData when no contaminant or contaminant category data is used as a search criteria.
VBSubsite Sub2	The query is used to determine sites satisfying search criteria in frmSiteData when contaminant data is used as a search criteria.
VBSubsite Sub3	The query is used to determine sites satisfying search criteria in frmSiteData when contaminant category data is used as a search criteria
VBVolume Reduction	Returns information necessary to determine the volume of a site or its waste streams at a site. Used in function Irreversibility
VBWasteObj	Returns object size and weight data for a site. It is used in frmCOReqs.
VBWaste Streams	Returns waste stream information including matrix and volume. It is used in multiple locations including frmWasteArray, frmExcavators, frnExcavators, and is used to determine waste stream volume for retrieval.
Waste Streams	Used as the underlying query for the Waste Stream subreport in the report Site Data.

A-2.4. Database Functions

This module contains Access functions that are used in the queries developed to calculate site risk and site priority. Find Toxicity is used in the query (or associated subqueries) while the remaining functions are used to calculate site priority.

Aridity: Returns a priority number based on average rainfall. An element in site priority determination. This is called from the query Priority-sub1.

Find Toxicity: Returns the toxicity value for a specific contaminant amount. Arguments are toxicity level, contaminant amount, units, etc. This is called from the query Risk-sub2.

Land Use: Returns a priority number based on future land use. This is called from the query Priority-sub1.

Plume Source: Returns a priority number based on whether the site is a source of a plume or not. An element in site priority determination. This is called from the query Priority-sub1.

Rest Priority: Returns a priority number based on the presence or absence of problems including horizontal water, bottom water, gas vapor, etc., e.g., multiple elements in site priority determination. This is called from the query Priority-sub1.

Time To Offsite: Returns a priority number based on the time to offsite for a plume. An element in site priority determination. This is called from the query Priority-sub1.

Waste To Ground Water: Returns a priority number based on how far the contaminants at a site are above groundwater. An element in site priority determination. This is called from the query Priority-sub1.

A-2.5. Database and DART Administrative Actions

This section describes required actions by the SCFA database system administrator whenever the SCFA database is updated. Denormalization of the database and updating model results stored in the database both require action whenever the data in the database is updated.

Risk/Priorities: Site risk and priorities are based on site data. Whenever new data is added it is necessary to recalculate these priorities and associated rankings. Running the action query MakePRTable, from within Access, will calculate the risk and priority values and store them in the table MakePRTable. As this remakes the table PRTable, it is necessary to add the fields Risk Ranking and Priority Rankings to the table after the update is complete. These fields are Long Integers. Selecting the button "Update Risk / Priority Rankings" in the Update form will then recalculate and store the new priority and risk rankings in the table PRTable.

Subsite/Contaminant Categories: The table SubsiteContamCategory is a denormalization of the database relating subsites and categories of contaminants at the site. This denormalization was undertaken to improve performance of search queries. However, to maintain consistency, it is necessary to update SubsiteContamCategory whenever new site contaminant data is added. This update can be performed by selecting the button "Update Contaminant Categories" in the Update form. This action causes the action query MakeSubsiteContam to be run which remakes the table SubsiteContamCategory and includes any new site contaminant data that has been added to the database.

Hazardous Pollutants Regulatory Limits: The table SubsiteContamRegTable is a denormalization of the database relating subsites and contaminants to hazardous pollution emission limits and ambient air concentration regulatory limits. The denormalization increase the speed of determining site specific versions of the associated requirements. It is necessary to update the SubsiteContamRegTable table whenever new contaminant or regulatory data is added. This update can be performed by selecting the "Update Subsite Contaminant Reg Limits" button in the Update form. This runs the action query MakeContamRegTable which remakes the SubsiteContamRegTable and includes any new regulatory or contaminant data that has been added to the database.

APPENDIX B

Units Conversion

Conversion factors must be used because sites use various units in reporting contaminants. These conversion factors are used in DART model calculations to normalize units. The models use the amount of radioactivity in curies and the weight of chemicals in kilograms.

Assumptions:

1. 40% of the volume is water (from J. Wilson). Documentation: The porosity of the ground is about 0.4. Swen Magnuson, et al. Radiological Performance Assessment for the Area 5 Radioactive Waste Management Site at the Nevada test site (Draft) EG&G Idaho, 9/23/91

2. A rule of thumb weight of soil is 1 ton (2000 pounds) per cubic yard

3. cubic yd = .765 cubic meters = 765 liters

4. p means pico, e.g., 10^{-12}

5. ug means micrograms e.g. 10^{-6} grams

6. ppm: The conversion factor calculated below for ppm is multiplied by a weight factor for each of the different contaminants in the risk model. Note: the weight factors for alpha, beta, and TRU are the average weight factors for alpha emitters, beta emitters, and TRU respectively. This should not matter as they may not be any units of ppm for these contaminants. Unknown weight factors were left as one until further information is available.

Assumptions: used to determine curies, kilograms needed by risk model.

1. All concentrations are max so divide by 10 to get average.

2. Density is density of soil 2000 lbs/cubic yard or 909 kg/cubic yard.

3. Additional conversion factors: Ci = 1, mg = 0.001. Depleted uranium was reported in kg but toxicity for depleted uranium is not known. The calculations in the database assume contaminant values are max concentrations. These can be converted to concentrations if the volume of the site is known.

Conversion Factors

1. pCi/L
   pCi/L / 10 * (0.40) * (volume in cubic yds) * (765 L/cubic yds) * 10^{-12} = total curies
   Value * Volume * 3.06 x 10^{-11} = total (curies)
   factor: 3.06 x 10^{-11}

2. ppm
   milligrams/liter / 10 * (0.40) * (volume in cubic yds) * (765 L/cubic yds) * 10^{-6} = total kilograms
   Value * Specific density * Volume * 3.06 x 10^{-5} = total (kilograms)
   factor: 3.06 x 10^{-5}

3. ug/L
   ug/L / 10 * (0.40) * (volume in cubic yds) * (765 L/cubic yds) * 10^{-9} = total kilograms
   Value / 10 * Volume * 3.06 x 10^{-7} = total (kilograms)
   factor 3.06 x 10^{-8}

4. mg/L
   mg/L / 10 * (0.40) * (volume in cubic yds) * (765 L/cubic yds) * 10^{-6} = total kilograms
   Value / 10 * Volume * 3.06 x 10^{-5}= total (kilograms)
   factor: 3.06 x 10^{-5}

5. mg/m3
   mg/cubic meter / 10 * (volume in cubic yards) * (.765 cubic meters/cubic yd) * 10^{-6} = total kilograms
   Value / 10 * Volume * 7.65 x 10^{-7} = total (kilograms)
   factor: 7.65 x 10^{-8}

6. ug/kg
   ug/kg / 10 * (volume in cubic yards) * (909 kilograms / cubic yard) * 10^{-9} = total kilograms
   Value / 10 * Volume * 9.09x10^{2} * 10^{-9}= total (kilograms)
   factor: 9.09 x 10^{-8}

7. mg/kg
   mg/kg / 10 * (volume in cubic yards) * (909 kilograms / cubic yard) * 10^{-6} = total kilograms
   Value / 10 * Volume * 9.09x 10^{2} * 10^{-6}= total (kilograms)
   factor: 9.09 x 10^{-5}

8. pCi/gm
   pCi/gm / 10 * (volume in cubic yards) * (909 kilograms / cubic yard) * 10^{-9} = total curies
   (Note: 1000gm/kg * 10^{-12} = 10^{-9})
   Value / 10 * Volume *9.09x 10^{2} * 10^{-9} = total (curies)
   factor: 9.09 x 10^{-8}

APPENDIX C

Contaminants
MCL and Toxicity Values

Contaminant ID	Contaminant Name	Type	MCL (soil)	MCL (water)	Toxicity (water)
1,3 dichlorobenzine	1,3 dichlorobenzine	VOC	0.00752	0.075	0.00003
Ac	Actinium	Alpha			2.5
Acetone	Acetone	VOC			0.00003
Ag	Silver	EPA Toxic Metal	0.00501	0.05	0.0003
Al	Aluminum	Other Metals		0.2	0
Alpha	Alpha	Alpha		0.003	2.5
Am	Americium	Alpha			2.5
As	Arsenic	EPA Toxic Metal	6.25E-06	0.05	0.01
B	Boron	Non Metallic Inorganic			0.00003
Ba	Barium	EPA Toxic Metal	0.2	2	0.0003
Be	Beryllium	EPA Toxic Metal	0.000401	0.004	0.0003
Benzene	Benzene	VOC	0.000501	0.005	0.0003
Benzoanthracene	Benzoanthracene	Other Organic			0.01
Benzofluoranthene	Benzofluoranthene	Other Organic			0.01
Benzopyrene	Benzopyrene	Beta-Gamma	0.001	0.01	0.00003
Beta	Beta	Beta-Gamma		0.03	0.1
BNA	Base Neutral Acid	Acid			0.01
BTEX	benzene, toluene, eythl benzene	VOC			0.0003
C-14	Carbon 14	Beta-Gamma	3.5	2.8	0.003
Ca	Calcium	Beta-Gamma	0.000501	0.005	0.1
Carbon Tet	Carbon Tetrachloride	VOC	6.25E-06	0.005	0.001
Cd	Cadmium	EPA Toxic Metal		.005	0.0003
Ce	Cesium	Beta-Gamma			0.1
Cf	Californium	Beta-Gamma			2.5
CH-TRU	Contact Handled TRU	TRU			2.5
Chloroform	Chloroform	VOC		0.1	0.0003
Chromate	Chromate	EPA Toxic Metal	0.01	0.1	0.0003
Cl	Chlorine	Non Metallic Inorganic			0.00003

Contaminant ID	Contaminant Name	Type	MCL (soil)	MCL (water)	Toxicity (water)
Cm	Curium	Alpha			2.5
Co-60	Cobalt	Beta-Gamma	40.1	0.4	0.1
Cr	Chromium	EPA Toxic Metal		0.1	0.00003
Cs	Cesium	Beta-Gamma	12.03	0.12	0.1
Cu	Copper	EPA Toxic Metal	0.13	1.3	0.0003
Cyanide	Cyanide	Non Metallic Inorganic	0.00025	0.2	0.0003
DCA	Dichloroethane	VOC	6.25E-06	0.005	0.00003
DCE	Dichloroethene	VOC		0.007	0.00003
Dichlorobenzene	Dichlorobenzene	VOC		0.075	0.00003
Dioxin	Dioxin	Other Organic			0.01
EDB	Ethylene Dibromide	SVOC		0.00005	0.001
Ethyl Benzene	Ethyl Benzene	VOC	0.0702	0.7	0.00003
Eu	Europium	Alpha			0.1
F	Fluorine	Non Metallic Inorganic	0.005	4	0.0003
Fe	Iron	Alpha	0.0301	0.3	2.5
Fr	Francium	Alpha			2.5
Freon	Freon	VOC			0.00003
H_3	Tritium	Tritium	100	80	0.00015
HE	High Explosive	High Explosive			0.01
Hg	Mercury	EPA Toxic Metal	0.000201	0.002	0.01
HLW	High Level Waste	HLW			2.5
I-29	Iodine	Alpha			0.1
K-40	Potassium	Beta-Gamma			0.1
Li	Lithium	Other metals			0.01
Methylene Chloride	Methylene Chloride	VOC			0.0003
Mg	Magnesium	Other metals			0.0003
TCE	Trichloroethene	VOC	6.25E-06	0.0005	0.0003
TCFE	TCFE	Other Organic			0.00003

Contaminant ID	Contaminant Name	Type	MCL (soil)	MCL (water)	Toxicity (water)
Tetrachloroethene	Tetrachloroethene	Other Organic		2	0.0003
Th	Thorium	Alpha			2.5
Ti	Titanium	Other metals			0.0003
Tl	Thallium	EPA Toxic Metal		0.002	0.01
Toluene	Toluene	VOC	0.1	1	0.00003
TPH	Total Petroleum Hydrocarbon	VOC			0.0003
U	Uranium	Uranium			2.5
U (depleted)	Uranium (depleted)	Uranium			0.0003
U-234	Uranium 234	Uranium	3.01	0.03	2.5
U-238	Uranium 238	Uranium			2.5
V	Vanadium	EPA Toxic Metal			0.0003
Vinyl Chloride	Vinyl Chloride	SVOC	0.000025	0.002	0.01
Xylene	Xylene	VOC	1	10	0.00003
Zn	Zinc	Other metals		5	0.00003

APPENDIX D

Clean Air Act Requirements/Limits

Hazardous/toxic air pollutants

Contaminant	Federal[c]	Illinois	Colorado	Texas[i]	Ohio[j]	Idaho	Idaho	New Mexico
						EI[a] (lb/hr)	AAC[b] (mg/m^3)	EI[a] (lb/hr)
Acetone				No limit		119	89	
Actinium								
Aluminum					No limit	0.667	0.5	0.667
Arsenic	No limit	No limit	No limit	No limit	No limit	1.5E-06	0.23	Not listed
Barium					No limit	0.033	0.025	0.0333
Base Neutral Acid								
Benzene	No limit	No limit	No limit	No limit	No limit	8.00E-04	120	Not listed
Benzoanthracene					No limit			
Benzofluoranthene		No limit			No limit			
Benzo(a)pyrene		No limit			No limit	2.00E-06	0.30	
Beryllium	No limit	No limit	No limit	No limit	No limit	2.80E-05	4.2	Not listed
Cadmium	No limit	No limit	No limit	No limit	No limit	3.70E-06	0.56	0.00333
Calcium								
Carbon Tetrachloride	No limit	No limit	No limit	No limit	No limit	4.40E-04	67	Not listed
Chloride								
Chloroform	No limit	No limit	No limit	No limit	No limit	2.80E-04	43	Not listed
Chromate								
Chromium	No limit	No limit	No limit	No limit	No limit	5.60E-07	0.025	0.0333
Copper	No limit	No limit	Not listed	No limit	No limit	0.067	0.05	0.0667
Cyanide	No limit	Not listed	No limit	No limit	Not listed	0.333	0.25	Not listed
Dichlorobenzene[k]	No limit	Not listed	No limit	No limit	No limit	30	22.5	20
Dichloroethane[l]	No limit	No limit	No limit	No limit	No limit	2.5E-04	20.25	Not listed
Dichloroethene[m]			No limit		No limit	2.3E-04	20	52.7
Dioxin[d]	No limit	No limit	No limit	No limit	Not listed	1.50E-10	2.2E-05	Not listed
Ethlene Dibromide	No limit	No limit	No limit	No limit	No limit	3.00E-05	2	Not listed
Ethyl Benzene	No limit	Not listed	No limit	No limit	No limit	29	21.75	Not listed
Fluorine		No limit	No limit		No limit	0.133	0.1	0.133
Freon[h]								
n-hexane	No limit	Not listed	No limit	No limit	No limit	12	9	Not listed
Iron								
Lead	No limit	No limit	No limit	No limit	No limit		1,500	Not listed
Lithium								
Magnesium								
Manganese	No limit	No limit	No limit	No limit	No limit	0.333	0.25	0.333
Mercury	No limit	No limit	No limit	No limit	No limit	0.001	0.0005	Not listed
Methanol (methyl alcohol)	No limit	Not listed	No limit	No limit	No limit	17.3	13	Not listed
Methyl-tert-butyl ether	No limit	Not listed	No limit	No limit	No limit			Not listed
Molybdenum						0.333	0.25	0.333
Naphthalene	No limit	Not listed	No limit	No limit	No limit	3.33	2.5	Not listed
Nickel	No limit	No limit	No limit	No limit	No limit	2.70E-05	4.2	0.0667
Nitrate								
Perchloroethylene	No limit	Not listed	Not listed	No limit	Not listed	9.10E-05	14	Not listed
Polychlorineated biphenyl		No limit				6.60E-05	10	
Polycyclic Aromatic Hydrocarbons[f]	No limit	Not listed	Not listed	No limit	No limit	9.10E-05	14	Not listed
Selenium	No limit	No limit	Not listed	No limit	No limit	0.013	0.01	0.0133
Silver					No limit	0.007	0.005	0.00667
Tetrachloroethene	No limit	No limit	Not listed	No limit	No limit	1.30E-02	2,100	Not listed
Tin						0.133	0.1	0.133
Titanium								

Toluene	No limit	No limit	No limit	No limit	No limit	25	18.75	Not listed
Total Petroleum Hydrocarbons[g]								
Trichloroethane	No limit	Not listed	No limit	No limit	No limit	4.20E-04	62	Not listed
Trichloroethene	No limit	No limit	No limit	No limit	No limit	17.93	13.45	Not listed
TCFE								
Vinyl chloride	No limit	No limit	No limit	No limit	No limit	9.40E-04	140	Not listed
Xylene	No limit	Not listed	No limit	No limit	No limit	29	21.75	0.00667
Zinc	No limit	Not listed	Not listed	No limit	No limit	0.667	0.5	Not listed

a) EL - screening emissions levels.

b) AAC - Acceptable ambient concentrations.

c) Federal hazardous air pollutants identified in 1) United States Code Title 42 chapter 85 Paragraph 7412 "Hazardous air pollutants;" 2) 40 CFR 61.01, "Lists of pollutants and applicability of part 61;" and 3) 40 CFR 63.100, "Applicability and designation of source." Regulations for the following states were not found on the INTERNET, therefore, the federal list will be used for these states until the information is available: California, Iowa, Kansas, Kentucky, Mississippi, Missouri, Nevada, Tennessee, South Carolina, New Jersey, New York, and Tennessee.

d) Federal and state regulations list dioxin as 2,3,7,8-tetrachlorodibenzo-p-dioxin.

e) Idaho information from IDAPA 16 Department of Health and Welfare - 16.01.01 Rules for the control of Air Pollution in Idaho URL http://www.idwr.state.id.us/apa/idapa16/index.htm.

f) Polycyclic Aromatic Hydrocarbons include the following chemicals: acenaphthene, anthracene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, carbazole, chrysene, dibenze[ah]anthracene, fluroanthene, fluorene, indeno[1,2,3-cd]pyrene, naphthalene, pyrene, benzo(j)fluoranthene, Benzo(rst)pentaphene, Benzo(a)phenanthrene, Dibenz(a,h)acridine, Dibenzo(a,j)acridine, 7H-Dibenzo(c,g)carbazole, Dibenzo(a,e)flupranthene, Dibnezo(a,e)pyrene, Dibenzo(a,h)pyrene, Dibenzo(a,l)pyrene, 7,12-dimethlbenz(a)anthracene, 5-methlchrysene, and 1-nitropyrene.

g) Total Petroleum Hydrocarbons include the following chemicals: t-butyl alcohol, methyl alcohol (or methanol), dibromoethane, 1,1-dichloroethane, ethylene dibromide, methyl-t-butyl_ether, benzene, ethlybenzene, eip-isopropylbenzene, toluene, xylenes, PAHs, and n-hexane.

h) Freon includes the following chemicals (as defined in the NIOSH Pocket Guide to Chemical Hazards): Freon-10 carbon tetrachloride, Freon-11 fluorotrichloromethane, Freon-12 dichlorodifluoromethane, Freon-21 dichloromonofluoromethane,Freon-22 chlorodifluoromethane, Freon-112 1,1,2,2-Tetrachloro-1,2-difluoroethane, Freon-112a 1,1,1,2-tetrachloro-2,2-difluoroethane, Freon-113 1,1,2-trichloro-1,2,2-trifluoroethane, Freon-114 dichlorotetrafluoroethane, Freon-12B2 difluorodibromomethane, and Freon-13B1 trifluorobromomethane. Only Freon-10 is tracked in the table.

i) Texas regulations follow the federal list of pollutants in addition to volatile organic chemicals listed in URL http://www.sos.state.tx.us/tac/30/I/index.html.

j) Ohio regulations are found at INTERNET address URL http://www.epa.ohio.gov/dapc/regs/4510010.html.

k) Dichlorobenzene - Idaho limits for 1,4-dichlorobenzene (or p-dichlorobenzene), New Mexico limit for 1,2-dichlorobenzene (or o-dichlorobenzene).

l) Dichloroethane - Federal, Illinois, Texas, and Ohio specifies 1,2-dichloroethane. Colorado specifies 1,1 dichloroethane. Idaho values are for both 1,2 dichloroethane and 1,1 dichloroethane.

m) Dichloroethene - Colorado specifies 1,1 dichloroethylene. Idaho values are for 1,1 dichloroethylene, which has the most restrictive guidelines compared with 1,2 dichloroethylene. New Mexico and Ohio are for 1,2 dichloroethylene.

APPENDIX E

Dart Cost Model Description

For Each Technology Category

within Scope For The SCFA

COST MODEL

Subsurface Assessment

Definition: Detection or mapping of physical structures.

$C = (\text{area in acres}) * a_1 * a_2 + a_3$

a_1 = measures/acre
a_2 = $/measure
a_3 = capital cost + set up cost
= integer [(total acreage of the applicable sites)/X +1] * PP + (total # of applicable sites) * Y

INPUT SCREEN:

How many measures will be taken per area?	a_1
What is the cost per measure?	a_2
Determination of the capital costs:	
What is the capital cost (purchase price) per system?	PP
How many acres can be serviced by one system?	X
Determination of set up cost:	
What is an average set up cost per system?	Y

ASSUMPTIONS:

- Area = area to be remediated.
- One set up cost per site.
- Set up cost is a staging cost.
- The first term will be rounded up if calculated into a fraction.
- Depth is included in the design of the system, hence included in the purchase price.
- The Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.)
- Purchase Price includes delivery and assembly.

COST MODEL

Contaminant Detection & Monitoring

Definition: Detection of subsurface contaminants for site characterization, during remediation, or during post monitoring.

2A - For Site Characterization:

$C = (\text{area in acres}) * b_1 + b_2$

b_1 = characterization cost ($/acre)
b_2 = purchase cost + set up cost
= [(total acreage of the applicable sites)/X * PP] + (total number of applicable sites * Y)

INPUT SCREEN:

What is the characterization cost per acre?	b_1
Determination of the capital costs:	
What is the purchase price per system?	PP
How many acres can be serviced by one system?	X
Determination of set up cost:	
What is an average set up cost per system?	Y

ASSUMPTIONS:

- Depth is covered in the design of the system.
- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.)
- Assume one setup cost per site.
- Assume one system per site.
- Assume one setup cost per site.
- Remediation monitoring and post monitoring will not be done at the same time.

COST MODEL

Contaminant Detection & Monitoring

2B - For Remediation Monitoring/Clean Up Verification:

C = [(complete remediation date-start remediation date + 0.5) * 365 days/yr * b_1'] + b_2
Note: 0.5 ensures that the term with complete date minus the start date is not zero.

b_1'= remediation cost ($/day)
b_2 = purchase cost + set up cost
= total acreage of applicable sites/X * PP + total number of applicable sites * Y

INPUT SCREEN

What is the operating cost per day?	b_1'
Determination of the capital costs:	
What is the purchase price per system?	PP
How many acres can be serviced by one system	X
Determination of set up cost:	
What is an average set up cost per system?	Y

ASSUMPTIONS

- Remediation monitoring starts when remediation starts and ends when remediation ends
- A year is calculated to start in January and end in December; therefore, any remediation date starting or ending in mid-year will be extrapolated to that same year
- Depth is covered in the design of the system
- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.)
- Since the same system will be used for characterization and remediation functions, assume 1 system per site
- Verification monitoring will be performed during remediation; therefore, the cost for clean up verification will not be counted
- There is no regulatory guidance for remediation monitoring
- Remediation monitoring does not include contamination control
- Assume one setup cost per site
- Assume 365 days per year as actual remediation operating time
- Remediation monitoring and post monitoring will not be done at the same time.

COST MODEL

Contaminant Detection & Monitoring

2C - For Post Monitoring:

$C = (30 \text{ years}) * \text{area (in acres)} * b_1'' + b_2$

b_1'' = Post remediation cost ($/acre/year)
b_2 = purchase cost + set up cost
= (total number of applicable sites) * [PP + Y]

INPUT SCREEN

What is the operating cost per year?	b_1''
Determination of the capital costs: What is the purchase price per system?	PP
Determination of set up cost: What is an average set up cost per system?	Y

ASSUMPTIONS

- Depth is covered in the design of the system
- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.)
- One system will be used for the duration of the post monitoring function
- One set up cost per site
- Remediation monitoring and post monitoring will not be done at the same time.

In order to identify the applicable phase of contaminant detection and monitoring for each site and prevent double counting the cost of monitoring throughout the remediation of each site, a matrix was developed. The matrix identifies the phase(s) of contaminant detection and monitoring required within each configuration option.

Contaminant Detection and Monitoring Matrix

Technology Category ID	*Configuration Option*	*Characterization (2A)*	*Remediation Monitoring and Clean Up Verification (2B)*	*Post Monitoring (2C)*
1	Walk Away	X		
2	Monitor	X		X
3	Cap	X		X
4	Stabilization	X		X
5	Retrieve and Dispose	X	X	
6	Vapor Extraction	X	X	
7	Bio-remediation	X	X	
8	Pump and Treat	X	X	
9	In situ Thermo Treatment	X	X	
10	In situ Chemical Treatment	X	X	
11	Barriers	X		X
12	Ex situ Soil Washing	X	X	

DART allows the user to choose more than one applicable mode in the Contaminant Detection and Monitoring Cost Model. To prevent double counting the purchase and set up costs in the total cost of remediating a group of applicable sites when more than one mode is chosen, the following Assumption is applied in the model:

If the Post Monitoring mode is chosen, either alone or in conjunction with another mode, assume one purchase and set up cost per applicable site.

This Assumption can be made due to the fact the monitoring equipment will be required to stay at the site throughout the post remediation monitoring phase, therefore will be used at one site, only.

If the Characterization and Remediation Monitoring modes are chosen together, double counting the purchase and set up costs are prevented by calculating these costs through the characterization phase and not calculating these costs for the remediation phase. This is done in the model by using an "if, then" statement.

COST MODEL

Excavation

Definition: Bulk removal of subsurface waste, either spot retrieval or full retrieval.

$C = \{[(\text{area in ft}^2) * A] + [(\text{square root of the area in ft})*4) * B]\} * c_1 + c_2$

A = cubic yards of excavation for various depths based upon the surface area of excavation taken from Table 3 of The Process Plant Construction Estimating Standards, "The Richardson Rapid System" (a linear equation) = 0.037 * (depth of waste)

B = cubic yards of excavation created by the excavation of the angle of repose per lineal foot of wall (or side) based on the depth of excavation taken from Table 4 of The Process Plant Construction Estimating Standards, "The Richardson Rapid System" (a quadratic equation) = $0.01852 * (\text{depth of waste})^2$

c_1 = operating cost ($/yd^3)
c_2 = capital cost + set up cost
= [(total volume of the applicable sites) * PP] + [(total # of applicable sites) * Y]

INPUT SCREEN

What is the operating cost per cubic yard?	c_1
Determination of the capital costs:	
What is the capital cost (purchase price) per system?	PP
Determination of set up cost:	
What is an average set up cost per system?	Y

ASSUMPTIONS

- Volume of waste to be treated equals the area of the site times the depth of the waste.
- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.)
- Excavation estimates are based on a pit excavation, utilizing the angle of repose slopes method.
- An estimated perimeter, square root of the area*4, was used in the calculation due to non-symmetrical site formations.

COST MODEL

Vapor Extraction

Definition: Extract and treat subsurface vapors through a process of pumping the vapors through a filtering system and disposing of the filtered waste.

C = (volume of waste in yd^3) * d_1

d_1 = $/yd3

INPUT SCREEN

What is the operation cost ($/$yd^3$)? d_1

ASSUMPTION

· Operation cost includes any set up and maintenance of the system required for operation.

COST MODEL

Pump & Treat

Definition: Treat groundwater through a process of pumping the water through a system of filters, until acceptable contaminant levels are reached, and disposing of the filtered waste.

$C = (\text{volume of waste in } yd^3) * e_1$

$e_1 = \$/ yd^3$

INPUT SCREEN

What is the operation cost ($\$/yd^3$)? e_1

ASSUMPTION

- Operation cost includes any set up and maintenance of the system required for operation.

COST MODEL

Contaminant Control

Definition: Prevent the spread of airborne contaminants. Triple containment buildings, water/chemical sprays, etc. are examples of this type of technology.

C = [(complete remediation date-start remediation date + 0.5) * f_1] +
max [f_2, f_3 * (area in acres)]

f_1 = $/year
f_2 = minimum capital cost (purchase price) of equipment/materials
f_3 = $/acre
0.5 = constant to ensure that term is not zero when start and complete dates are the same

INPUT SCREEN

What is the operating cost per year? f_1

Determination of the purchase costs:
What is the capital cost (purchase price) for equipment and materials, including set up cost, for contaminant control for one site? f_2
What is the capital cost per acre, including setup cost? f_3

ASSUMPTIONS

- Detection of contaminants during remediation is the function being performed.
- Depth is covered in the design of the system.
- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.)
- One system will be used for the duration of remediation.

COST MODEL

Physical Stabilization

Definition: Change the physical form of the waste and the associated surrounding matrix to enable further remediation activity. It is usually done prior to a cap or excavation remediation and includes the contamination control function.

$C = (\text{volume of waste in } yd^3) * g_1$

$g_1 = \$/ yd^3$

INPUT SCREEN

What is the operation cost ($\$/yd^3$)? g_1

ASSUMPTION

· Operation cost includes any set up and maintenance of the system required for operation.

COST MODEL

Remote Handling

Definition: Handle the waste without physical contact by personnel.

C = [(complete remediation date-start remediation date + 0.5) * 270 days/year * 8 hrs/day * h_1

h_1 = $/hour

0.5 = constant to ensure that term is not zero when start and completion dates are the same.

INPUT SCREEN

What is the operation cost ($/hr)? h_1

ASSUMPTIONS

- Operation cost includes any set up and maintenance of the system required for operation.
- The project will operate 8 hours/day.
- Assume 270 days per year as actual remediation operating time.

COST MODEL

In-Situ Bio Remediation

Definition: Remediate subsurface waste, in place, using biological treatments.

C = volume of waste * average concentration of contaminant to be treated * j_1 * j_2 + j_3

j_1 = amount of "bugs" (concentration) (kg/ kg)
j_2 = cost of "bugs" ($/kg)
j_3 = application cost
= [(total area of the applicable sites) * PP]

INPUT SCREEN

What is the concentration of the bio "stuff" ("bugs") used?	j_1
How much does the bio "stuff" ("bugs") cost ($/kg)?	j_2
Determination of the application cost: What is the capital cost per area ($/ft^2)?	PP

ASSUMPTIONS

- Application cost includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.) and setup costs.

COST MODEL

In-Situ Chemical Remediation

Definition: Neutralize the hazardous constituents of the waste, in place.

C = (area of site in ft^2) * (depth of waste in ft) * (concentration of constituent in kg/ft^3) * $k_1 + k_2$

k_1 = \$/kg
k_2 = purchase cost + installation cost
= [(total volume of the applicable sites)/X * PP] + [(total volume of the applicable sites)/X * Y]

INPUT SCREEN

How much do the chemicals cost (\$/kg)?	k_1
Determination of the purchase costs:	
What is the purchase price per system?	PP
How many cubic feet can be serviced by one system?	X
Determination of set up cost:	
What is an average installation cost per system?	Y

ASSUMPTIONS

- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.).
- Primary cost is a function of area.

COST MODEL

In-Situ Thermal Treatment

Definition: Treat waste in place, using heat and various additives.

$C = (\text{area of site in ft}^2) * l_1 + l_2$

$l_1 = \$/\text{ft}^2$
l_2 = purchase cost + installation cost
= [(total area of the applicable sites)/X * PP] + [(number of applicable sites) * Y]

INPUT SCREEN

What is the operation cost ($/ft^2)?	l_1
Determination of the purchase costs:	
What is the capital cost (purchase price) per system?	PP
How many square feet can be serviced by one system?	X
Determination of set up cost:	
What is an average installation cost per system?	Y

ASSUMPTIONS

- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.).
- Primary cost is a function of area based on restaging the thermal system.
- The electrical consumption varies with volume, but is not a cost driver.
- Installation cost includes the one-time set up cost of getting equipment, power, etc. to the site, prior to operation.

COST MODEL

Waste Assay

Definition: Waste Assay includes the passive, radiological assay function to detect the natural occurring radiation on the waste, and the active assay function of injecting neutrons into the waste to get a gamma ray reading out. Typically, both, active and passive systems, are used together in a Passive Active Neutron (PAN) System. Waste assay is used as part of the sorting function.

$C = \text{Volume} * m_1$

$m_1 = \$/yd^3$

INPUT SCREEN

What is the operation cost ($\$/yd^3$)? m_1

COST MODEL

Stabilization to Limit Mobility

Definition: Stabilize waste in place.

$C = (\text{volume of waste in } yd^3) * o_1$

$o_1 = \$/ yd^3$

INPUT SCREEN

What is the operation cost ($\$/yd^3$)? o_1

ASSUMPTION

- Operation cost includes any set up and maintenance of the system required for operation.

COST MODEL

Subsurface Barrier

Definition: Subsurface barrier put in place to prevent horizontal migration of contaminants outside the barriers of the site.

$C = [\text{cube root of (volume of site in } ft^3)]^2 * 5 * p_1$

$p_1 = \$/ft^2$

INPUT SCREEN

What is the barrier installation cost ($\$/ft^2$)? p_1

ASSUMPTIONS

- The length of the barrier is equal to the length of the site.
- The depth of the barrier is equal to the depth to the bottom of the waste.
- The width of the barrier is equal to the width of the site.
- The barrier installation cost is independent of depth.
- Assume full containment barrier, which includes 5 subsurface barriers (4 sides and 1 bottom).
- Depth is accounted for in the equipment design. Specification for the system is for the width of the remediation site and a system is purchased to handle the width. Therefore, if the system is specified for a 3 meter wide site, it will also work for sites less than 3 meters in width and not affect the capital cost.

COST MODEL

CAP

Definition: Surface barrier, consisting of one or multiple layers, put in place to prevent vertical water flow through the site and physical transport of contaminants due to wind, erosion, etc. Source term will be left in place, subsurface.

$C = (\text{area in ft}^2) * q_1$

$q_1 = \$/\text{ft}^2$

INPUT SCREEN

What is the cap installation cost ($\$/\text{ft}^2$)? q_1

ASSUMPTIONS

- All cap layers, set up and installation costs are included in the cap installation cost.
- Cost per ft^2 is independent of area.

COST MODEL

Containment Integrity Monitoring

Definition: Direct monitor measurements of the subsurface barrier in order to anticipate potential failures (i.e., cracks, breaks, etc.) in the barrier.

$C = [\text{cube root of (volume of site in ft}^3)]^2 * 5 \text{ sides} * r_1 * r_2 + r_3$

r_1 = measures/ft^2

r_2 = \$/measure

r_3 = purchase cost + installation cost
= (total number of applicable sites) * [PP + Y]

INPUT SCREEN

How many measures will be taken per area?	r_1
What is the cost per measure?	r_2
Determination of the purchase costs: What is the purchase price per system?	PP
Determination of set up cost: What is an average installation cost per system?	Y

ASSUMPTIONS

- The length of the barrier is equal to the length of the site.
- The depth of the barrier is equal to the depth to the bottom of the waste.
- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.)
- Assume full containment barrier, which includes 5 barriers, 4 vertical sides and 1 horizontal bottom.

COST MODEL

Ex-Situ Soil Washing

Definition: Separate contaminants from soil particles. This may include chemical processes such as dissolution or suspension of contaminants in a washing solution, or physical processes such as particle size separation.

C = (volume of waste in yd^3) * (assumed density of 1.3 tons/ yd^3) * s_1

s_1 = $/ton

INPUT SCREEN

What is the operation cost ($/ton)? s_1

ASSUMPTION

- Operation cost includes any set up and maintenance of the system required for operation.
- The equipment is sized in units of tons/hr; therefore, the assumed density to convert volume in cubic yards to tons is 1.3 tons/yd^3.
- The sites have already been sorted by applicable contaminants.

COST MODEL

In-Situ Electro

Definition: Electrically driven ion migration used to remediate waste in place.

$C = (\text{volume of waste in } ft^3) * v_1 + v_2$

$v_1 = \$/ ft^3$
v_2 = purchase cost + installation cost
= [(total volume of the applicable sites)/X * PP] + [(total volume of the applicable sites)/X * Y]

INPUT SCREEN

What is the operation cost ($/ft^3)?	v_1
Determination of the purchase costs:	
What is the purchase price per system?	PP
How many cubic feet can be serviced by one system?	X
Determination of set up cost:	
What is an average installation cost per system?	Y

ASSUMPTIONS

- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.).
- The electrical consumption varies with volume, but is not a cost driver.
- This process will solidify all the constituents at the same time.
- Total kg/conc. = volume
- Volume of the waste = volume of the site to be remediated.

COST MODEL

Off-Gas Treatment

Definition: Remove contaminants from process air emissions, pump the vapors through a filtering system, and dispose of the filtered waste.

C = [(complete remediation date-start remediation date + 0.5) * x_1] + x_2

x_1 = $/yr

x_2 = purchase cost + set up cost
= (total number of applicable sites) * [PP + Y]

0.5 = constant to ensure that term is not zero when start and complete dates are the same.

INPUT SCREEN

What is the operation cost per year?	x_1
Determination of the purchase costs: What is the capital cost per system?	PP
Determination of set up cost: What is an average set up cost per system?	Y

ASSUMPTION

- Operation cost includes any set up and maintenance of the system required for operation.
- Purchase Price includes all the capital items needed to operate the system (i.e., containment shelter, wires, software, hardware, etc.)

APPENDIX F

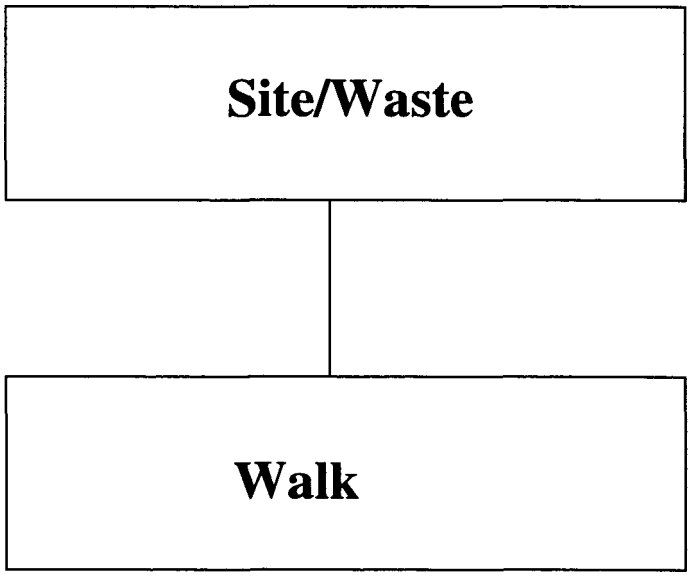
Configuration Options

Thirteen (13) configuration options were developed to list the functions associated with site preferred options. The functions are use to develop site specific requirements and to assign technology categories. Each of the configuration options are functionally diagramed in this appendix. The table below is provided as an index to aid the reader to search for a specific configuration option.

Option #	Configuration Option Title
1	Walk Away
2	Monitor
3	Cap
4	Stabilization
5	Retrieve and Dispose
6	Vapor Extraction
7	Biological Treatment
8	Pump and Treat
9	In situ Thermo Treatment
10	In situ Chemical Treatment
11	Barriers
12	Ex Situ Soil Washing
13	Selective Retrieval

Configuration Option 1.

Walk Away Configuration Option
Risk < 10^{-6} and Uncertainty is Low



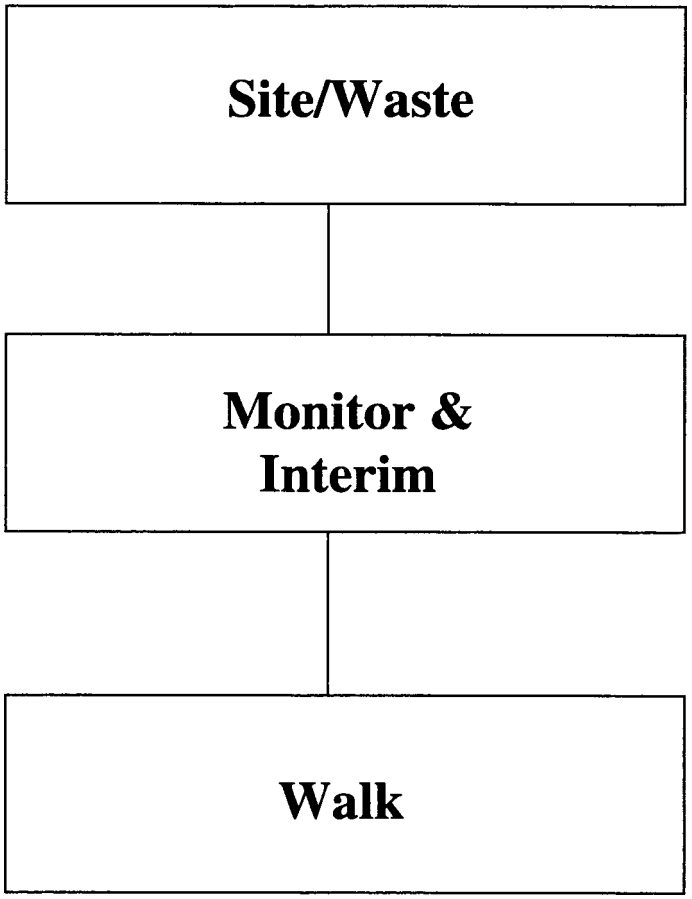
Defines Boundaries

Defines Contaminants

Provides Inputs to Risk

Configuration Option 2.

Monitor Configuration Option
Risk <10^{-4} and Uncertainty is Low



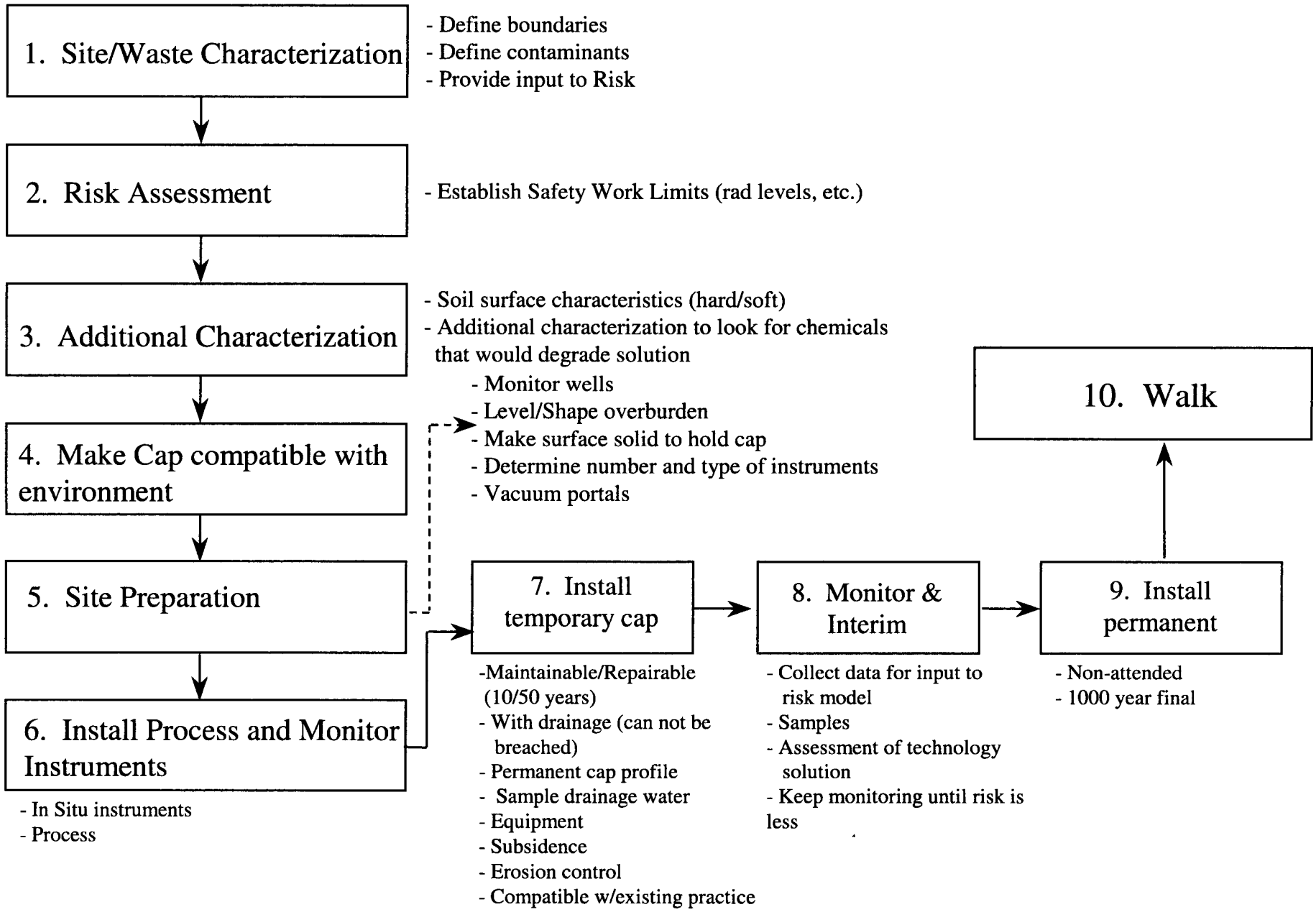
Defines Boundaries

Defines Contaminants

Provides Inputs to Risk Model

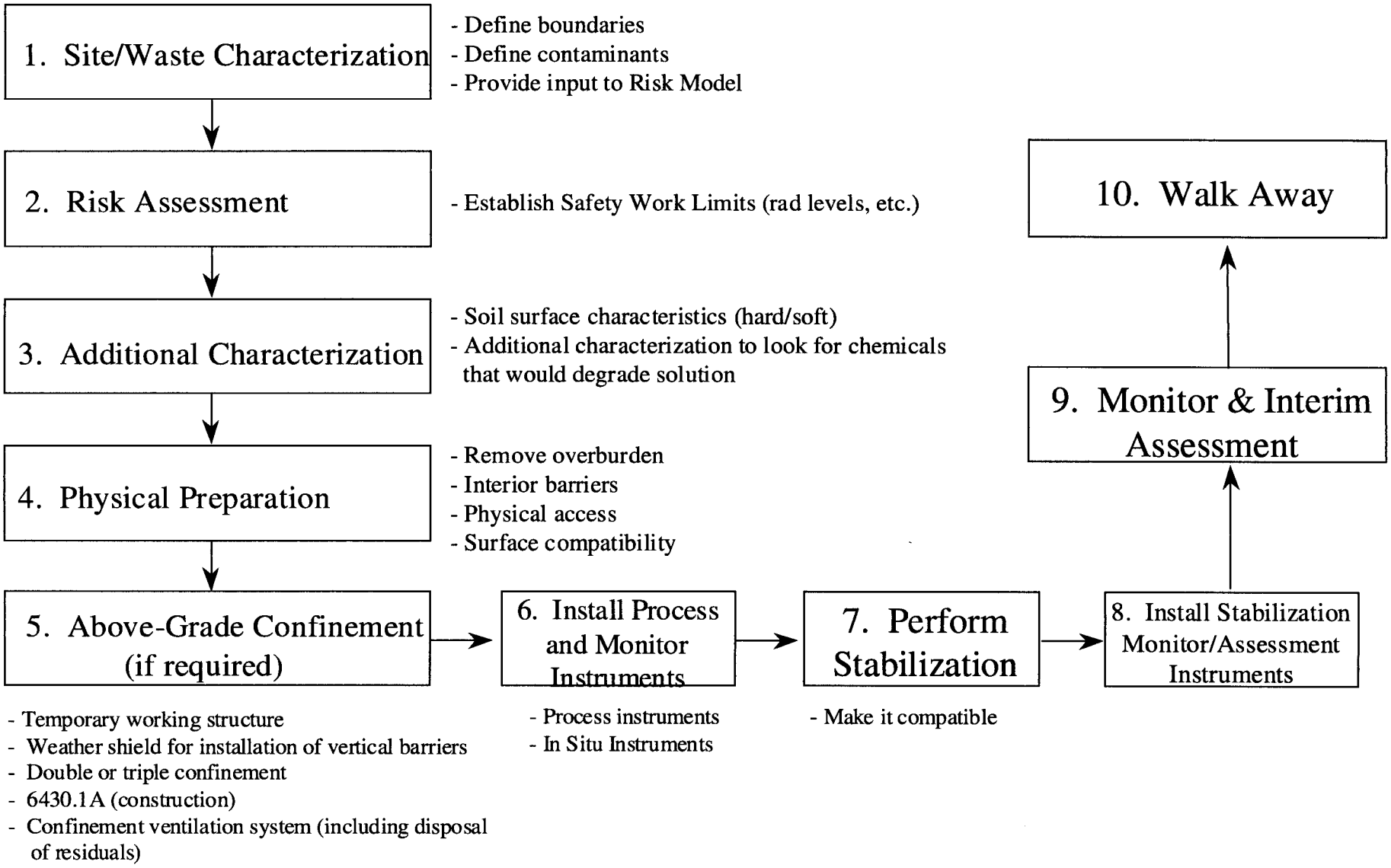
- Collect data for input to Risk Model
- Samples
- Keep monitoring until risk is less than 10^{-4} and uncertainty is low

Configuration Option 3.



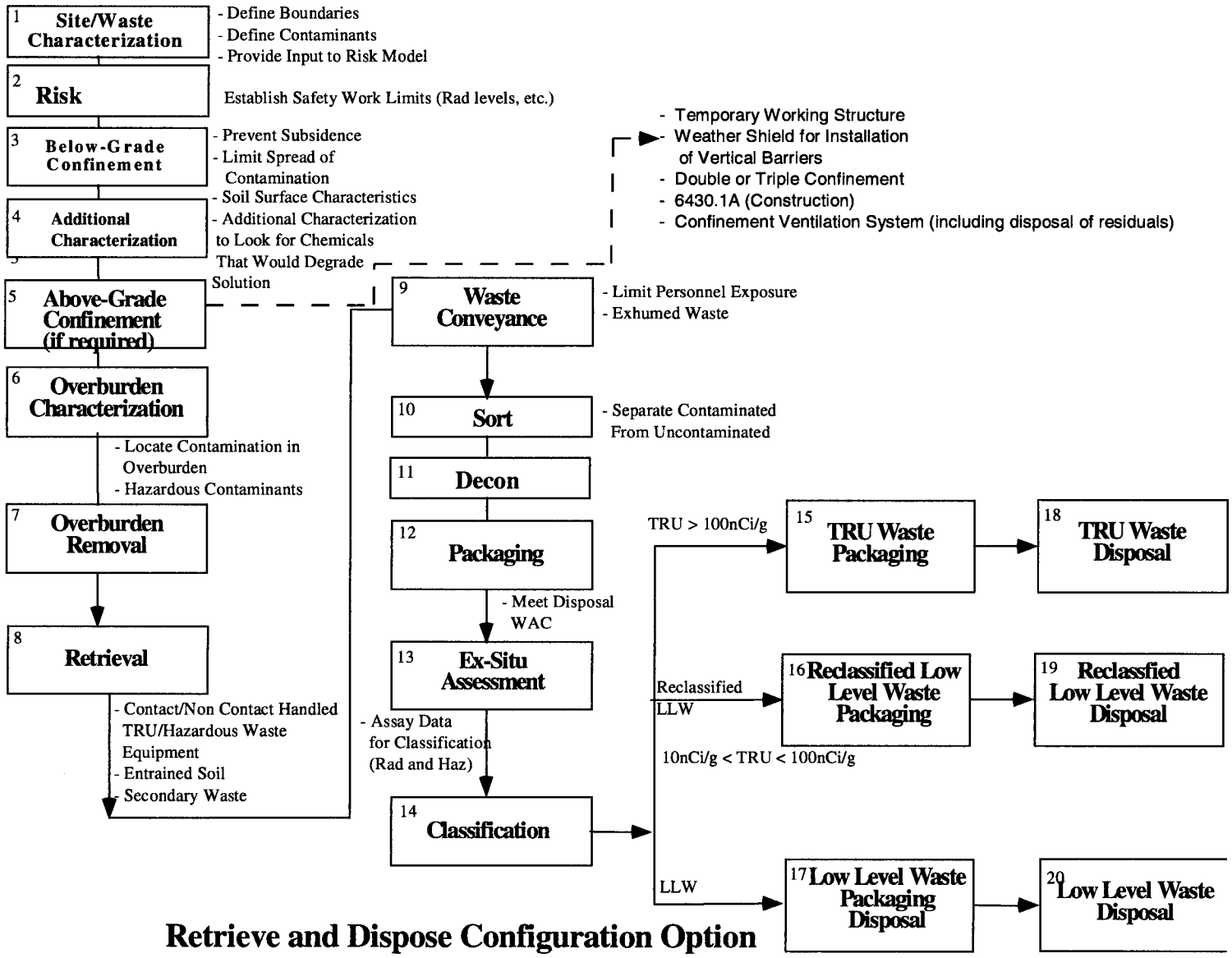
Cap Configuration Option

Configuration Option 4.



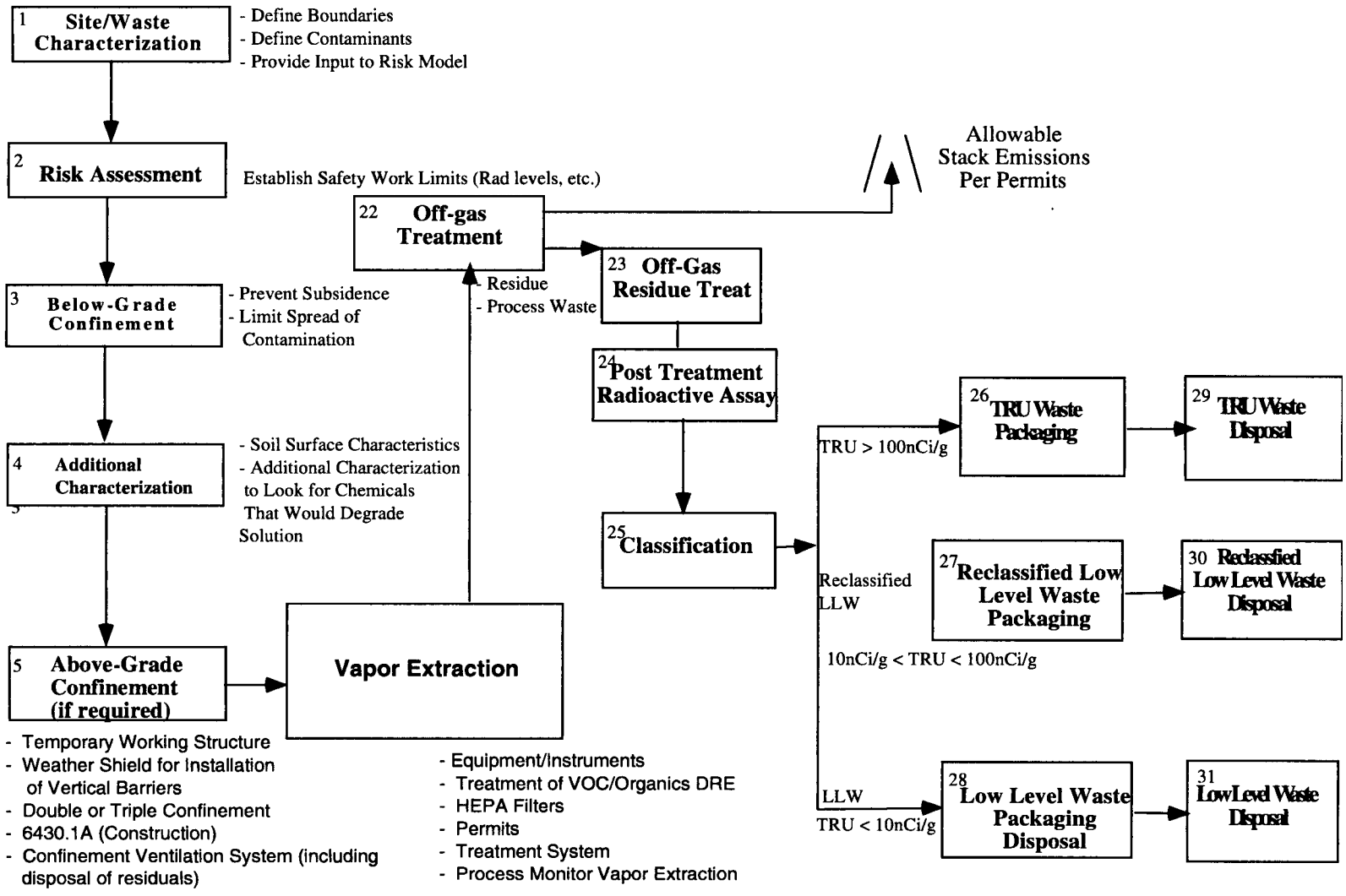
Stabilization Configuration Option

Configuration Option 5.



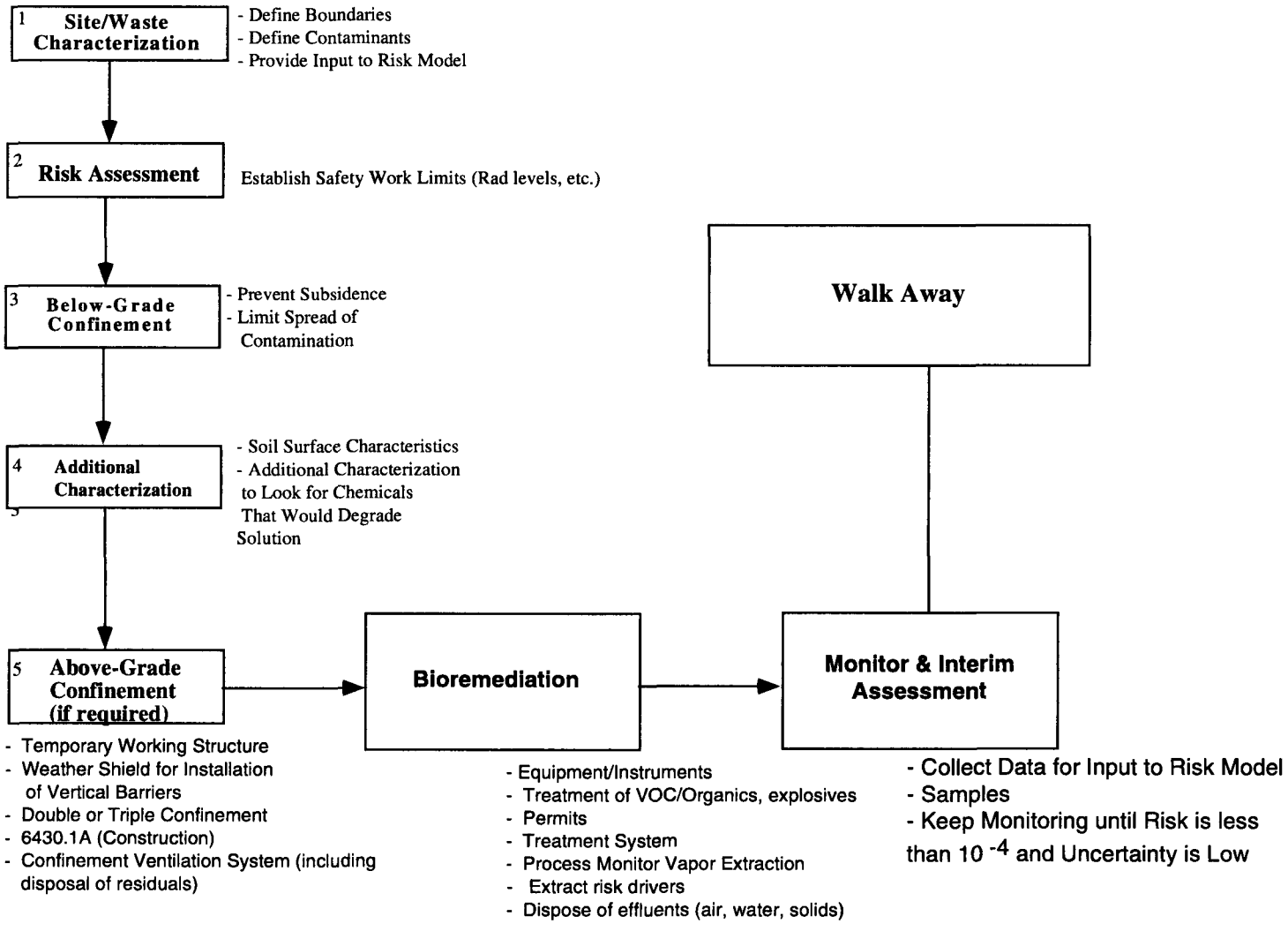
Retrieve and Dispose Configuration Option

Configuration Option 6.



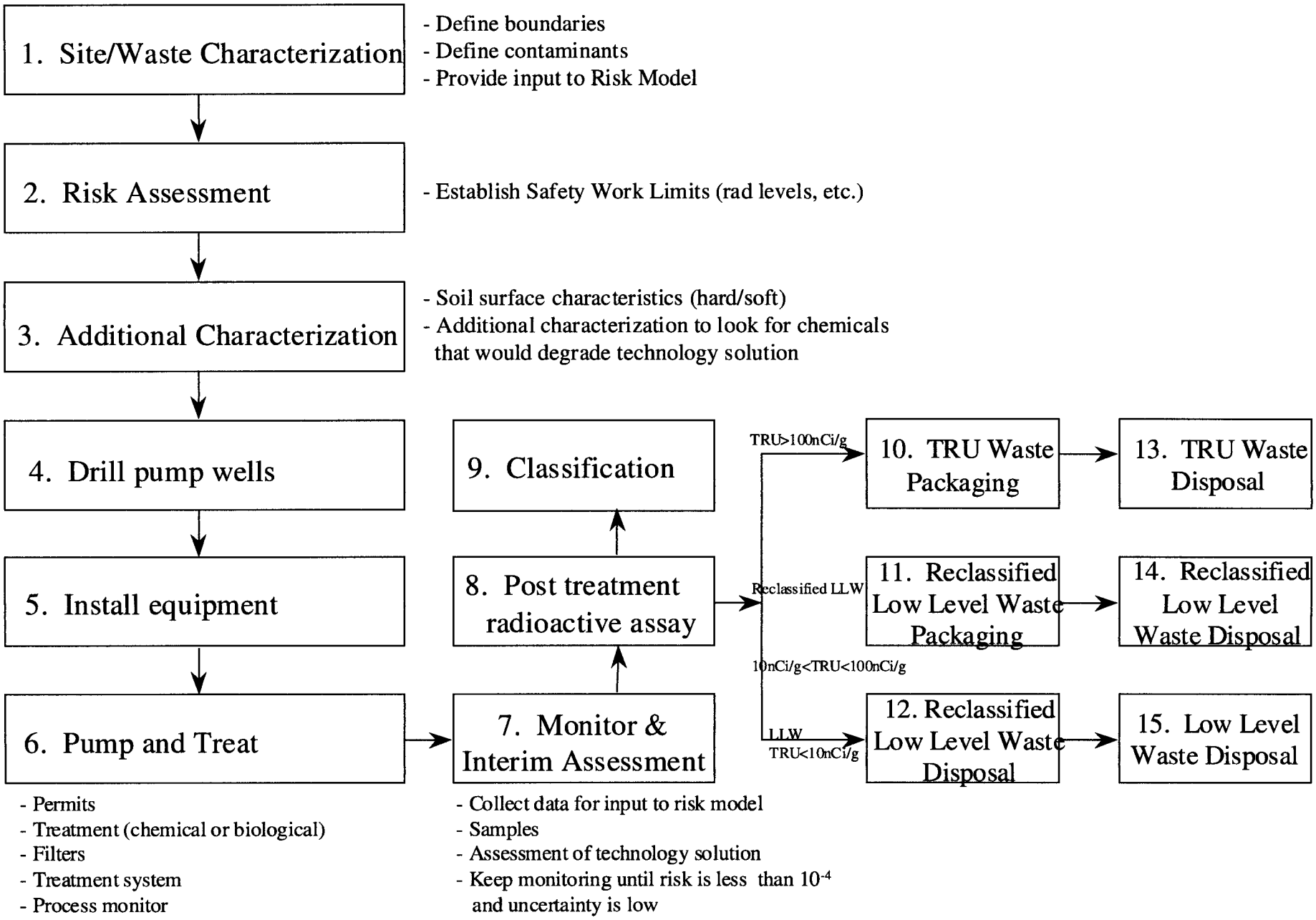
Vapor Extraction Configuration Option

Configuration Option 7.



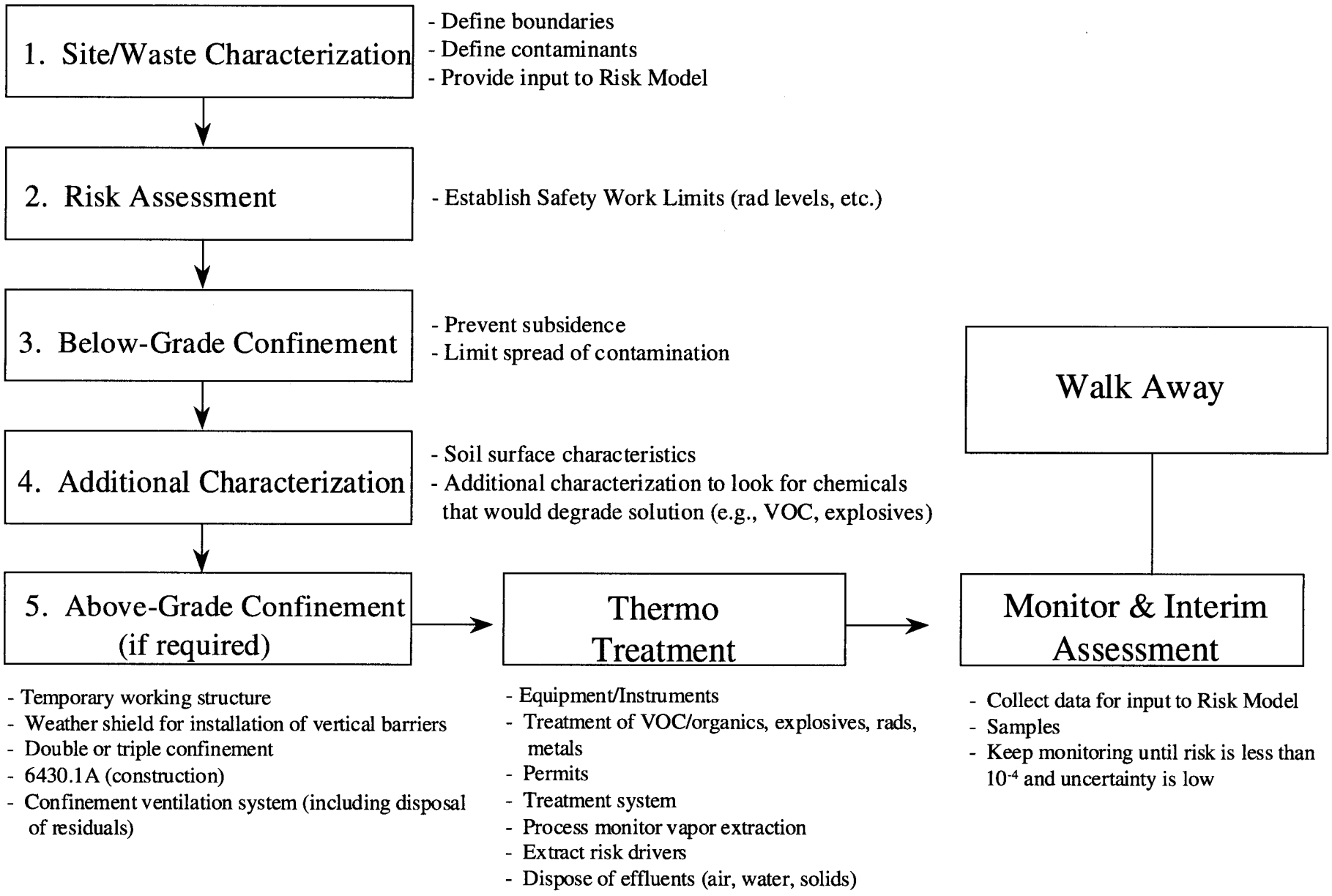
Bioremediation Configuration Option

Configuration Option 8.



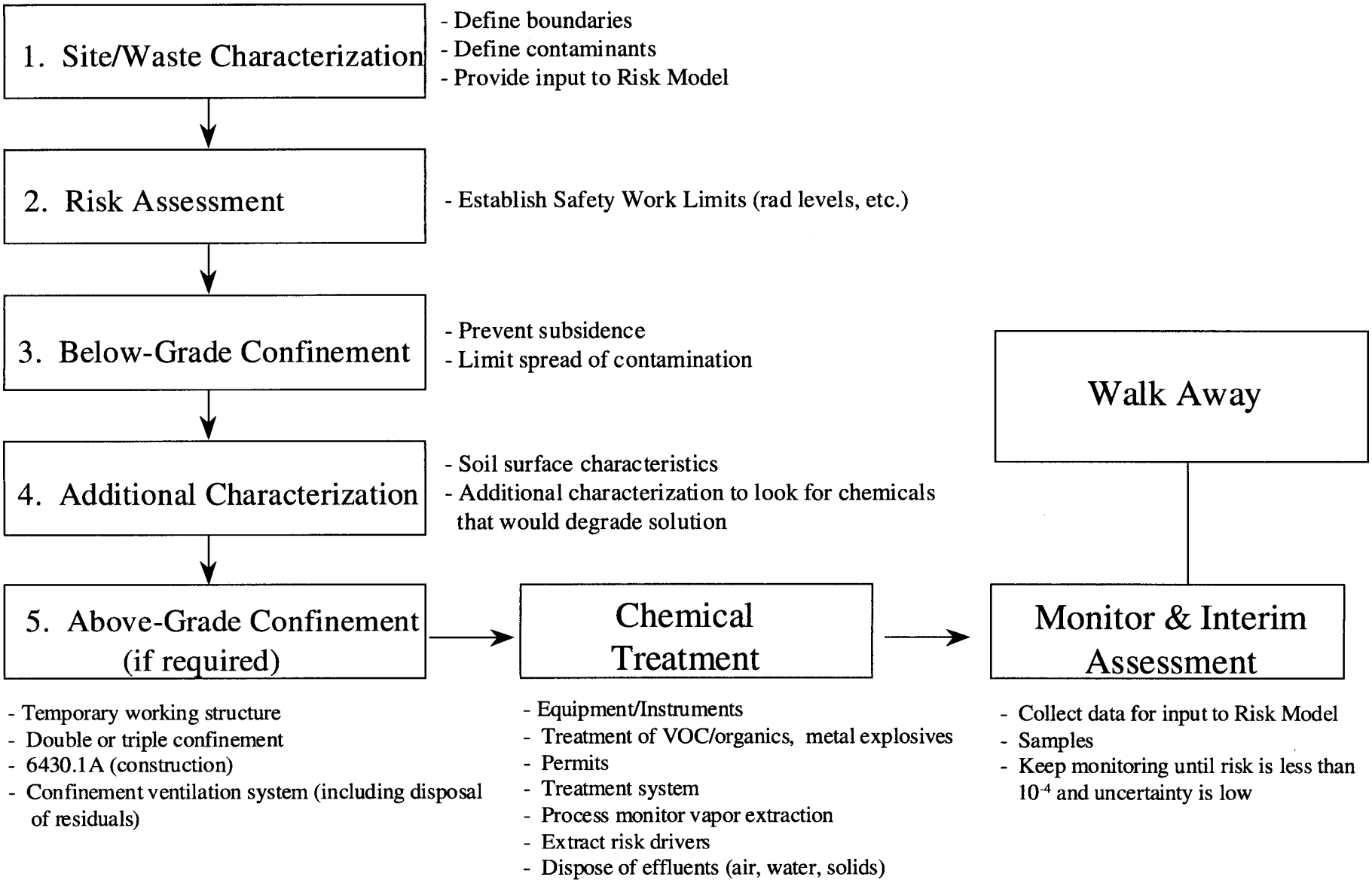
Pump and Treat Configuration Option

Configuration Option 9.



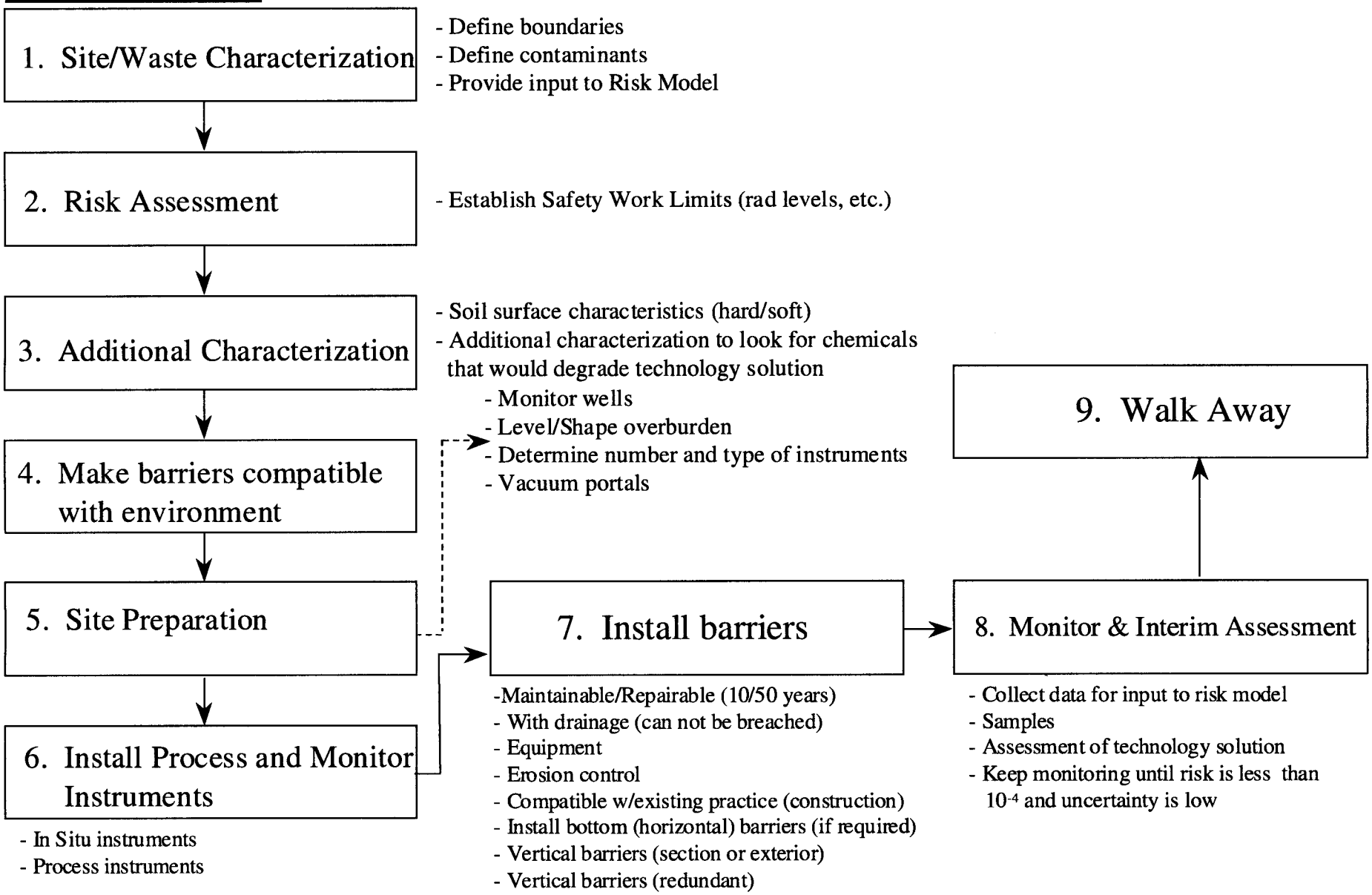
In Situ Thermo Configuration Option

Configuration Option 10.



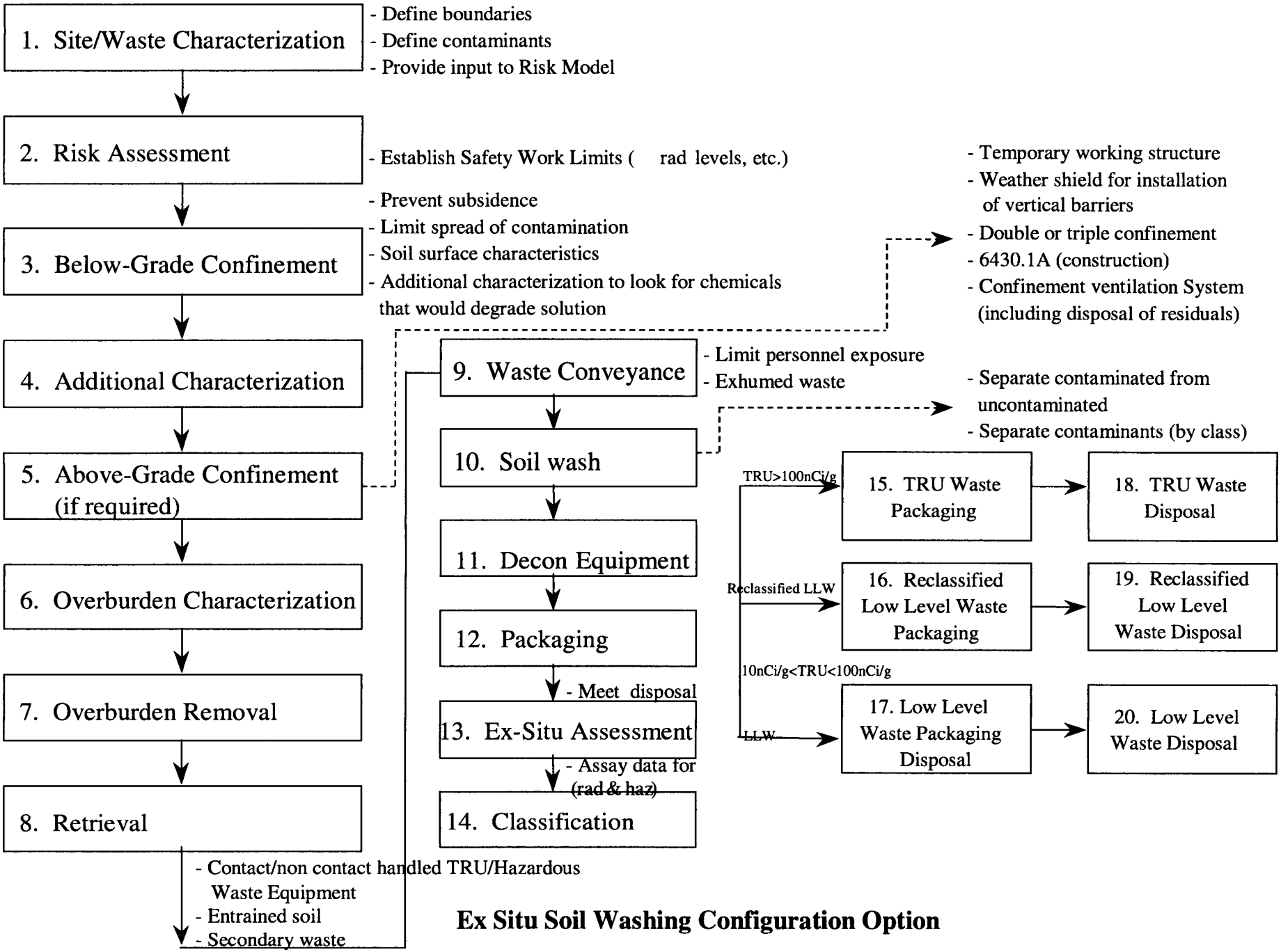
In Situ Chemical Configuration Option

Configuration Option 11.



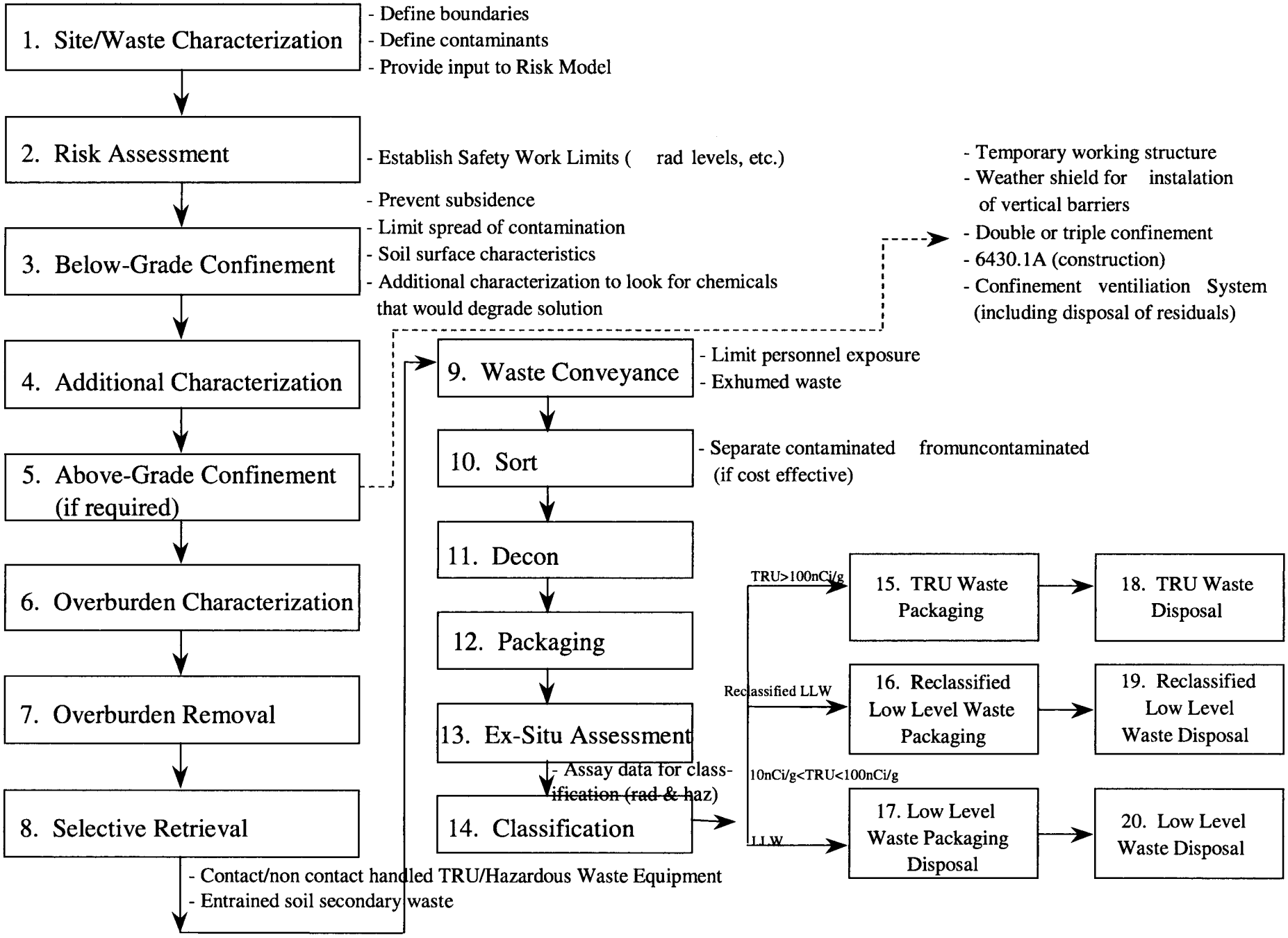
Barriers Configuration Option

Configuration Option 12.



Ex Situ Soil Washing Configuration Option

Configuration Option 13.



APPENDIX G

DART Requirements Generator

DART Requirements Generator Notes

Many technical requirements can be generated from site characteristics. The requirements summarized here are assigned to various technology categories and subsequently to preferred configuration options. Site data dependence is summarized for each requirement that is dependent upon site data, both for single sites and for groups of selected sites.

Technology Category Requirement 1:

The technology shall be able to withstand climactic extremes.

Item	*Single Site*	*Multiple Sites*
maximum temperature	Degrees F	maximum value
minimum temperature	Degrees F	minimum value
frost depth	Inches	maximum value
arid/humid	Inches of rain	min. and max. values

Technology Category Requirement 2:

The category technology must be compatible with the waste constituents.

Item	*Single Site*	*Multiple Sites*
Compatible contaminants or categories	list	union of lists

Technology Category Requirement 3:

The remedial technology shall have a certain design life.

Site requirement assignment rules:

30 year: sites that contain VOC, SVOC, TOSCA organics, EPA toxic metals, other metals
300 year: 30 year contaminant classes plus sites that contain Tritium, beta-gamma
1000 year: 30 year and 300 contaminant classes plus sites that contain U, alpha, and TRU ***(Note: this will pass for all sites with known contaminant classes)***

Item	*Single Site*	*Multiple Sites*
30,300,1000 life	assigned life	maximum of set

Technology Category Requirement 4:

Control advective and diffusive flow of contaminants to maximum depth of waste.

Does not change with site assignment.

Technology Category Requirement 5:

The remedial solution must prevent biological transport to the surface.

Does not change with site assignment.

Technology Category Requirement 6:

The cap must prevent exposure of buried waste.

Item	*Single site*	*Multiple sites*
wind speed tolerance	max. wind speed	max. of set

Technology Category Requirement 8:

The remedial solution must be continuous.

Does not change with site assignment.

Technology Category Requirement 11:

Meet the remedial schedule.

Item	*Multiple sites*	*Single site*
ROD date	avail.>earliest ROD	availability >ROD date

Technology Category Requirement 12:

The technology shall be compatible with equipment, structures, and material.

Technology Category Requirement 16:

Map the boundaries.

Item	*Single Site*	*Multiple Sites*
Contaminant detection requirements. To be detected of list	list	union
contaminant levels to be detected level	list	min.
Object detection		
Object dimension	list	min. dimension
		max dimension
Depth	list depth	max depth in set
		min. depth in set

Note: depth is maximum depth reported per site

Technology Category Requirement 17:

Detect or monitor mass or radioactivity and concentration of constituents.

Item	*Single site*	*Multiple sites*
Conc. of constituents	reported levels	max. of set
Cleanup levels	levels or MCLs/SMCLs	minimum of set
Set		

Note: this applies to both groundwater and soil/landfill levels and is by constituent
Note: if reported level is below cleanup level, only required to measure to cleanup level.

Technology Category Requirement 19:

A cap shall maintain water balance.

Item	*Single*	*Multiple Sites*
Precipitation	reported 24 hour	min. and max. of set

Technology Category Requirement 20:

Vertical barriers shall extend from top of waste and keyed into bottom barrier such that no contaminant . . .

Does not change with site assignment.

Technology Category Requirement 24:

The technology shall not generate unacceptable byproducts due to chemical reactions.

Technology Category Requirement 23:

The technology shall produce temperature <100 degrees C.

Technology Category Requirement 25:

Final waste stabilization material after setting cannot pose a threat to human health or environment.

list constituents:

Item	*Single site*	*Multiple sites*
Compatible constituent	List	union of lists

Technology Category Requirement 26:

Hydraulic properties of pressure grouting materials pumpable, liquid-like, viscosity < 30 Cp

Does not change with site assignment.

Technology Category Requirement 27:

Hydraulic properties of pressure grouting materials: particle size < 3 mm.

Does not change with site assignment.

Technology Category Requirement 28:

Hydraulic properties of pressure grouting materials: have set time > 120 minutes.

Does not change with site assignment.

Technology Category Requirement 29:

Hydraulic conductivity shall be less than 0.000001 cm/s

Does not change with site assignment.

Note: assign to subsurface barrier and stabilization to limit mobility categories.

Technology Category Requirement 32:

Stabilization materials shall prevent contamination migration to less than EPA limit.

Item	*Single site*	*Multiple sites*
cont. migration level	cleanup standard	min. value in set

This applies to each listed constituent for both groundwater and contaminated soil/soil waste matrix.

Technology Category Requirement 33:

There shall be less than 0.5 percent free liquids after solidification.

Does not change with site assignment.

Technology Category Requirement 34:

Final waste form shall resist biodegredation.

Input data: check off incompatible constituents or categories of constituents for any of the above requirements

Item	*Single Site*	*Multiple Sites*
Compatible constituent	List	union of lists

Note: must be compatible with all constituents since process is likely irreversible.

Technology Category Requirement 35:

Chemical and biological reactions do not generate gases unless gases are eliminated.

Does not change with site assignment.

Technology Category Requirement 36:

The treatment technology shall change form such that form and change are not an EPA listed or characteristic waste.

Input data: list incompatible constituents

Item	*Single Site*	*Multiple Sites*
Constituents	Site	union of set

Technology Category Requirement 39:

Measure vertical boundary of pit or trench from surface to estimated depth of landfill.]

[Note: this is now combined with requirement 16.]

Technology Category Requirement 40:

Be compatible with waste matrix.

Item	*Single site*	*Multiple site*
compatible matrix	List	union of lists
pH	Value	min. and max. of set
conductivity	Value	min. and max. of set

Assumption: waste streams were not separately placed.
Assumption: waste streams are soil unless otherwise specified.

Technology Category Requirement 43:

The technology shall accommodate remote operation.

Item	*Single site*	*Multiple site*
remote operation (y/n)/	present from list	union of single site (y/n)

yes if alpha, pyrophorics, UXO, HE, RH-TRU are present
no if above not listed or not known

Technology Category Requirement 49:

The technology must excavate to the bottom of the landfill.

Input data: depth capability of excavation category technology
Pass rule: capability depth equals or exceeds actual site depth

Item	*Single site*	*Multiple sites*
excavation depth	max. depth	max. of max. depths

Technology Category Requirement 50:

The technology shall retrieve objects of maximum dimension.

Technology Category Requirement 51:

The technology shall retrieve objects of maximum weight.

Item	*Single site*	*Multiple Sites*
max. dimension	list max. site dimenstion	max. of max. listed
max. weight	list max. Site weight	max. of max. listed

Technology Category Requirement 52:

The technology shall remove or treat waste to clean levels.

Input data: Constituents and levels to which technology is intended to treat (specify soil, groundwater, or both)
Pass rule: Below associated cleanup levels (or MCL/SMCL estimates)

Item	*Single site*	*Multiple Sites*
clean levels	cleanup level	min. cleanup level

Note: above data for each constituent (cleanup levels for each constituent at a site; for multiple sites minimum cleanup levels for each constituent appearing at one or more sites in set). Note: applies to soil and groundwater values at respective sites.

Technology Category Requirement 53:

The technology shall provide contamination control (CC).

Item	*Single site*	*Multiple Sites*
CC (y/n)	if CC constituents present	all sites with CC

Assumption: contamination control required if certain constituents present (see requirements report).

Technology Category Requirement 58:

Sort waste into treatment categories.

Does not change with site assignment.

Technology Category Requirement 60:

Excavation system shall be compatible with waste form and matrix.

Input data: Check off compatible matrices
Pass rule: Sites that have selected matrices pass. If one site has multiple matrices, all must be selected for site to pass.

Item	*Single site*	*Multiple Sites*
Compatibility	waste forms listed	union of sites

Assumptions: Different waste streams cannot be separated by excavation. Assume contaminated soil plumes are soil matrix only. The matrix of source terms is the assigned waste stream matrix in DART.

Technology Category Requirement 61:

The technology shall maintain a required daily throughput.

Item	*Single site*	*Multiple Sites*
cubic yards/day	as described below	max. value in set

Calculate site cubic yards per day as follows:

Assumption: for sites with volume <1000 yds, assume remediation lasts one year; for sites without volume or schedule information, do not consider in calculation; for all other sites, calculate cubic yards per year.

Assumption: throughput is calculated for a site as the volume divided by (complete remediation year minus begin remediation year) converted to days by dividing by 272 days/year for Excavation and 365 days/year for Pump and Treat.

Assumption: minimum site remediation time is one year.

Technology Category Requirement 62:

System shall be capable of being decontaminated/decommissioned.

Does not change with site assignment.

Technology Category Requirement 65:

The technology shall prevent contaminants from reaching groundwater.

Does not change with site assignment.

Technology Category Requirement 66:

The technology shall meet minimum air quality district regulatory emission limits. Not site testable.

Technology Category Requirement 67:

The technology shall meet minimum air quality district acceptable air concentration limits.

Not site testable.

APPENDIX H

Technology Attribute Matching To Site Data

Sites may be sorted so their characteristics match category technology attributes. This matching derives from each category technical requirement. These requirements are summarized in the requirements document and have been mapped to applicable technology categories. Matching involves rules that relate site characteristics and attributes. A specific site match, called a "pass" occurs when the input technology attributes and a site's characteristics both satisfy one or more rules. This document summarizes the technology attribute data requirements and the "pass" rules.

CAP TECHNOLOGY CATEGORY

Technology Category Requirement 3:

The remedial technology shall have a certain design life.

Input Data: Specify tech design lifetime as 30 years, 300 years, or 1000+ years
Pass rules: 30 year: sites that contain VOC, SVOC, TSCA organics, EPA toxic metals, other metals
300 year: 30 year contaminant classes plus sites that contain Tritium, beta-gamma
1000 year: 30 year and 300 contaminant classes plus sites that contain U, alpha, and TRU (Note: this will pass for all sites with known contaminant classes).

Technology Category Requirement 1:

The technology shall be able to withstand climactic extremes.

Input Data: Maximum and minimum temperature extremes; state whether compatible with arid or humid sites or both; acceptable frost depth
Pass rules:
Temperature extremes within limits in data base
and
match to arid or humid
and
frost depth attribute equals or exceeds site data frost depth
Note: Pick arid sites as sites with 19 inches of annual precipitation or less; humid sites with greater than 19 inches of annual precipitation
Note: for all climactic criteria default to pass if no data is input.

Technology Category Requirement 2:

The category technology must be compatible with the waste constituents

Input data: Check incompatible constituents and/or categories
Pass rules:
Fail if any present on list (category or constituent).

Technology Category Requirement 6:
The cap must prevent exposure of buried waste.

Input data: Wind speed the cap technology can tolerate
Pass rules:
Pass if wind tolerance is greater than or equal to site maximum wind speed

Technology Category Requirement 8:

The remedial solution must be continuous.

Not site testable

Technology Category Requirement 11:
Meet the remedial schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year
Note: pass if no data input.

Technology Category Requirement 19:
A cap shall maintain water balance.

Input data: For technology, maximum allowable 24 hour precipitation and maximum annual precipitation
Pass rule: Pass if technology maximum 24 hour precipitation exceeds site maximum 24 hour precipitation
and
technology maximum annual precipitation exceeds site annual precipitation
Note: default to pass if no is data input.

Technology Category Requirement 5:

The remedial solution must prevent biological transport to the surface.

Not site testable

CONTAINMENT INTEGRITY MONITORING

Technology Category Requirement 3:

The remedial technology shall have a certain design life.

Input Data:
Specify technology design lifetime as 30 years, 300 years, or 1000+ years
Pass rules:
30 year: sites that contain VOC, SVOC, TOSCA organics, EPA toxic metals, other metals
300 year: 30 year contaminant classes plus sites that contain Tritium, beta-gamma
1000 year: 30 year and 300 contaminant classes plus sites that contain U, alpha, and TRU (Note: this will pass for all sites with known contaminant classes).

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

CONTAMINANT CONTROL CATEGORY

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories
Pass rules:
Fail if present on list (category or constituent).

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 53:

The technology shall provide contamination control.

Input data: None
Pass rule: Sites that have constituents requiring contamination control (contamination control contaminants in DART).

Technology Category Requirement 66:

The technology meet minimum air quality district regulatory emission limits.

Not site testable.

Technology Category Requirement 67:

The technology meet minimum air quality district acceptable air concentration limits.

Not site testable.

CONTAMINANT DETECTION AND MONITORING

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 17:

Detect or monitor mass or radioactivity and concentration of constituents.

Input data: Constituent and concentration measurement range (maximum and minimum)
Pass rule: For each constituent, match to soil (pCi/g and/or mg/kg) and/or groundwater (pCi/liter and/or mg/liter)
and
technology lower limit is less than cleanup/monitoring level (actual or MCL/ SMCL estimated values)
and
technology upper limit exceeds reported concentration levels
Note: no sites matched if no contaminant information is input

Note: pass is OK if one or more constituents meet the above test (groundwater or soil). Fail if none of the reported constituents meet the above test.

Technology Category Requirement 12:

The technology shall be compatible with equipment, structures, and material.

Not site testable.

SITE MATCHING CRITERIA

In addition to matching requirements above, select sites based on operational mode. Operator input modes of characterization, remediation monitoring, and post remediation monitoring.

Characterization: Candidates include sites with assigned configuration options of all configuration options.

Remediation monitoring: Candidates include sites with assigned configuration options of retrieve and dispose, vapor extraction, bioremediation, pump and treat, in situ thermal treatment, in situ chemical treatment, ex situ soil washing, selective retrieve.

Post Remediation monitoring: Candidates include sites with assigned configuration options of monitor, cap, stabilization, and barriers.

EXCAVATION TECHNOLOGY CATEGORY

Technology Category Requirement 61:

The technology shall maintain a required daily throughput.

Input data: Category technology throughput in cubic yards per day
Pass rules:
If the start and complete remedial action years are known:
- pass if the category technology throughput equals or exceeds calculated throughput requirement for a site
if the start remedial action year is unknown:
- pass if estimated throughput available from the technology provider will remediate the site in less than one year
- pass if site volume is less than 1000 cubic yards
- pass if technology availability is greater than ten years prior to scheduled end of remedial action and the scheduled completion is current year plus 10 years, or later (this prevents passing technologies only because of historical availability before current year)

Assumptions: If start and complete years are the same, assume one year
Assumption: Throughput is calculated for a site as the volume divided by (complete remediation year minus begin remediation year) converted to days by dividing by 272 days/year.

Technology Category Requirement 49:

The technology must excavate to the bottom of the landfill.

Input data: Depth capability of excavation category technology
Pass rule: Capability depth equals or exceeds actual site depth.

Technology Category Requirement 62:

System shall be capable of being decontaminated/decommissioned.

Not site testable.

Technology Category Requirement 43:

The technology shall accommodate remote operation.

Input data: Category technology ability to accommodate remote operation (Y/N)
Pass rule: If yes, all site pass
if no, alpha, pyrophorics, UXO, HE sites fail, remaining sites pass
Note: default to pass if no data is input.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 50:

The technology shall retrieve objects of maximum dimension.

Technology Category Requirement 51:

The technology shall retrieve objects of maximum weight.

Input data: Maximum dimension and weight that category technology can handle
Pass rule: Site object dimension and weight equal or less than category technology values.

Technology Category Requirement 60:

System shall be compatible with waste form and matrix.

Input data: Check off incompatible matrices
Pass rule: Sites that have selected matrices fail. If one site has multiple matrices, all must be selected for site to pass
Assumptions: Different waste streams cannot be separated by excavation. Assume contaminated soil plumes are soil matrix only. The matrix of source terms is the assigned waste stream matrix in DART.

Technology Category Requirement 66:

The technology meet minimum air quality district regulatory emission limits.

Not site testable.

Technology Category Requirement 67:

The technology meet minimum air quality district acceptable air concentration limits.

Not site testable.

IN SITU BIOREMEDIATION CATEGORY

Technology Category Requirement 52:

The technology shall remove or treat waste to clean levels.

Input data: Constituents and levels to which technology is intended to treat (specify soil, groundwater, or both)
Pass rule: Below associated site cleanup levels (or MCL/SMCL estimates if negotiated site cleanup levels are unknown).

Technology Category Requirement 36:

The treatment technology shall change form such that form and change are not an EPA listed or characteristic waste.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible or constituents and/or categories for which technology meet requirements
Pass rules: Fail if present on list (category or constituent)
Note: pass if no incompatible constituents/categories are input.

Technology Category Requirement 35:

Chemical and biological reactions do not generate gases unless gases are eliminated.

Not site testable.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: year that technology will be available for deployment
Pass rule: input availability year occurs before or same as remedial decision year.

IN SITU CHEMICAL TREATMENT CATEGORY

Technology Category Requirement 35:

Chemical and biological reactions do not generate gases unless gases are eliminated.

Not site testable.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 52:

The technology shall remove or treat waste to clean levels.

Input data: Constituents and levels to which technology is intended to treat (specify soil, groundwater, or both)
Pass rule: Below associated cleanup levels (or MCL/SMCL estimates).

Technology Category Requirement 36:

The treatment technology shall change form such that form and change are not an EPA listed or characteristic waste.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible or constituents and/or categories for which technology meets requirements
Pass rules: Fail if present on list (category or constituent)
Note: pass if no incompatible constituents/categories are input.

IN SITU THERMAL TREATMENT CATEGORY

Technology Category Requirement 36:

The treatment technology shall change form such that form and change are not an EPA listed or characteristic waste.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible or constituents and/or categories for which technology meets requirements
Pass rules: Fail if present on list (category or constituent).

Technology Category Requirement 35:

Chemical and biological reactions do not generate gases unless gases are eliminated.

Not site testable.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Physical Stabilization Category

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Not site testable.

Technology Category Requirement 24:

The technology shall not generate unacceptable byproducts due to chemical reactions.

Not site testable

Technology Category Requirement 23:

The technology shall produce temperature <100 degrees C.

Not site testable.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

PUMP AND TREAT CATEGORY

Technology Category Requirement 52:

The technology shall remove or treat waste to clean levels.

Input data: Constituents and levels to which technology is intended to treat (groundwater only)
Pass rule: Each specified constituent technology treatment level below associated cleanup levels (or MCL estimates)
Assumption: Pump and treat technology performance can be specified in terms of soil and groundwater MCL type limits

Note: most pump and treatments are done for one constituent only.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories.
Pass rules:
Fail if present on list (category or constituent).

Technology Category Requirement 61:

The technology shall maintain a required daily throughput.

Input data: Category technology throughput in milligrams per day for each listed constituent
Pass rules:
If the start remedial action year is known:
- pass if the category technology throughput equals or exceeds calculated throughput requirement for a site
if the start remedial action year is unknown:
- pass if estimated throughput available from the technology provider will remediate the site in less than one year
- pass if technology availability is greater than ten years prior to scheduled end of remedial action and the scheduled completion is ten years past current date or later (this prevents passing technologies only because of historical availability before current date)

Assumption: throughput is calculated for a site as the volume divided by (complete remediation year minus begin remediation year) converted to days by dividing by 365 days/year.
Assumptions: If start and complete years are the same, assume one year.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

REMOTE HANDLING CATEGORY

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories
Pass rules:
Fail if present on list (category or constituent)

Technology Category Requirement 43:

The technology shall accommodate remote operation.

Input data: No input
Pass rule: Sites containing alpha, pyrophorics, UXO, RH-TRU or HE.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

STABILIZATION TO LIMIT MOBILITY CATEGORY

Technology Category Requirement 33:

There shall be less than 0.5 percent free liquids after solidification.

Technology Category Requirement 34:

Final waste form shall resist biodegredation.

Technology Category Requirement 25:

Final waste form cannot pose a threat to health or environment.

Input data: Check off incompatible constituents or categories of constituents for any of the above requirements.
Pass rule: Pass if site contains none of the checked constituents or categories

Note: must be compatible with all constituents since process is likely irreversible.

Technology Category Requirement 5:

The remedial solution must present biological transport to the surface.

Not site testable.

Technology Category Requirement 35:

Chemical and biological reactions do not generate gases unless gases are eliminated.

Not site testable.

Technology Category Requirement 32:

Stabilization materials shall prevent contamination migration to less than EPA limit.

Input data: Check off contaminants and/or categories for which technology cannot meet requirement
Pass rule: Sites pass when none of the Noted contaminants are present.

Technology Category Requirement 1:

The technology shall be able to withstand climactic extremes.

Input Data: Maximum and minimum temperature extremes; state whether compatible with arid or humid sites or both; acceptable frost depth
Pass rules:
Temperature extremes within limits in data base
and
match to arid or humid
and
frost depth attribute equals or exceeds site data frost depth

Note: Pick arid sites as sites with 19 inches of annual precipitation or less; humid sites with greater than 19 inches of annual precipitation
Note: for all climactic criteria default to pass if no data is input.

Technology Category Requirement 27:

Hydraulic properties of pressure grouting materials: particle size < 3 mm.

Not site testable.

Technology Category Requirement 29:

Hydraulic conductivity shall be less than 0.000001 cm/s.

Not site testable

Technology Category Requirement 65:

The technology shall prevent contaminants from reaching groundwater.

Duplicated by limiting contaminant migration requirement. No input or test.

Technology Category Requirement 28:

Hydraulic properties of pressure grouting materials: have set time > 120 minutes.

Not site testable.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories
Pass rules:
Fail if present on list (category or constituent).

Technology Category Requirement 24:

The technology shall not generate unacceptable byproducts due to chemical reactions.

Technology Category Requirement 23:

The technology shall produce temperature <100 degrees C.

Technology Category Requirement 26:

Hydraulic properties of pressure grouting materials: pumpable, liquid-like, viscosity < 30 Cp.

Not site testable.

Technology Category Requirement 4:

Control advective and diffusive flow of contaminants to maximum depth of waste.

Input data: TBD
Pass rule: TBD

Technology Category Requirement 3:

The remedial technology shall have a certain design life.

Input Data:
Specify technology design life as_ 30, 300, or 1000+ years
Pass rules:
30 year: sites that contain VOC, SVOC, TSCA organics, EPA toxic metals, other metals
300 year: 30 year contaminant classes plus sites that contain Tritium, beta-gamma
1000 year: 30 year and 300 contaminant classes plus sites that contain U, alpha, and TRU Note: this will pass for all sites with known contaminant classes.
Note: no TRU sites should be associated with this technology category unless the TRU is selectively removed prior to stabilization.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement NEW:

The technology shall be compatible with site soil characteristics.

Input data: pH range (minimum and maximum) and conductivity range (minimum and maximum)
Pass rule: no data, no action
Note: this is a placeholder only.

Technology Category Requirement 34:

The final waste form shall resist degradation. See requirement # 24.

Not site testable.

SUBSURFACE ASSESSMENT CATEGORY

Technology Category Requirement 40:

Be compatible with waste matrix.

Input data: Select incompatible matrix classes
Pass rule: Fail if one or more incompatible classes present
Assumption: Waste streams were not separately placed.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories
Pass rules:
Fail if present on list (category or constituent).

Technology Category Requirement 39:

Measure vertical boundary of pit or trench from surface to estimated depth of landfill.

Technology Category Requirement 16:

Map the boundaries.

Input Data: Select contaminant detection or object detection
for contaminant detection: enter detectable contaminants and measurable concentrations (soil or groundwater)

for object detection: enter the following:
    object detection class (select all that apply)
        metallic/conductive
        non-conductive
Pass rule:
for contaminant detection: measurable concentrations less than cleanup levels or MCL estimates.
For object detection:
{list object items instead?}.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

SUBSURFACE BARRIER CATEGORY

Technology Category Requirement 3:

The remedial technology shall have a certain design life.

Input Data:
Specify technology design lifetime as 30, 300, or 1000+ years
Pass rules:
30 year: sites that contain VOC, SVOC, TSCA organics, EPA toxic metals, other metals
300 year: 30 year contaminant classes plus sites that contain Tritium, beta-gamma
1000 year: 30 year and 300 contaminant classes plus sites that contain U, alpha, and TRU

Note: this will pass for all sites with known contaminant classes

Note: no TRU sites should be associated with this technology category unless the TRU is selectively removed prior to stabilization.

Technology Category Requirement 8:

The remedial solution must be continuous.

Not site testable.

Technology Category Requirement 65:

The technology shall prevent contaminants from reaching groundwater.

Not site testable.

Technology Category Requirement 20:

Vertical barriers shall extend from top of waste and keyed into bottom barrier such that no contaminant.

Not site testable.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 4:

Control advective and diffusive flow of contaminants to maximum depth of waste.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Is barrier performance a function of concentration of constituents? (Y or N)
if Yes: input constituents and maximum compatible concentrations (soil and/or water units)
input incompatible constituents and categories (soil and/or water units)
if No: input incompatible constituents or categories (soil and/or water units)
Pass rules:
If Yes: pass if one or more target category/constituents appear and reported concentrations are less than input maximum compatible concentrations, and no incompatible constituents or categories appear; otherwise fail
if No:: pass if no incompatible constituents or categories appear, otherwise fail.

Technology Category Requirement 1:

The technology shall be able to withstand climactic extremes.

Input Data: Maximum and minimum temperature extremes; state whether compatible with arid or humid sites or both; acceptable frost depth
Pass rules:
Temperature extremes within limits in data base
and
match to arid or humid
and
frost depth attribute equals or exceeds site data frost depth

Note: pass if no input entered.

Technology Category Requirement 29:

Hydraulic conductivity shall be less than 0.000001 cm/s.

Not site testable.

VAPOR EXTRACTION CATEGORY

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories (soil units only)
Pass rules:
Fail if present on list (category or constituent)

Technology Category Requirement 52:

The technology shall remove or treat waste to clean levels.

Input data: Constituents and levels to which technology is intended to treat (soil units only)
Pass rule: Below associated reported cleanup levels (or MCL/SMCL estimates)

Note: if passes for one constituent, then technology passes.

Technology Category Requirement 11

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 66:

The technology meet minimum air quality district regulatory emission limits.

Not site testable.

Technology Category Requirement 67:

The technology meet minimum air quality district acceptable air concentration limits.

Not site testable.

WASTE ASSAY CATEGORY

Technology Category Requirement 60:

System shall be compatible with waste form and matrix.

Input data: Check off compatible matrices
Pass rule: Sites that have selected matrices pass. If one site has multiple matrices, all must be selected for site to pass
Assumptions: Different waste streams cannot be separated by excavation. Assume contaminated soil plumes are soil matrix only. The matrix of source terms is the assigned waste stream matrix in DART.

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment

Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 43:

The technology shall accommodate remote operation.

Input data: Category technology ability to accommodate remote operation (Y/N)
Pass rule: If yes, all site pass
if no, alpha, pyrophorics, UXO, HE sites fail, remaining sites pass

Note: if no input, all sites pass.

Technology Category Requirement 58:

Sort waste into treatment categories.

Not site testable.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories (soil units only)
Pass rules:
Fail if present on list (category or constituent)
Assumption: assay performed only on soil or solid waste.

Technology Category Requirement 59:

Place waste for shipment or storage.

Not site testable.

Technology Category Requirement 40:

Be compatible with waste matrix.

Input data: Select incompatible matrix classes
Pass rule: Fail if one or more incompatible classes present
Assumption: Waste streams were not separately placed.

EX SITU SOIL WASHING CATEGORY

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment

Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories (soil units only)
Pass rules:
Fail if present on list (category or constituent).

Technology Category Requirement 62:

System shall be capable of being decontaminated/decommissioned.

Not site testable.

Technology Category Requirement 52:

The technology shall remove or treat waste to clean levels.

Input data: Constituents and levels to which technology is intended to treat (soil units only)
Pass rule: Below associated cleanup levels (or MCL/SMCL estimates).

Technology Category Requirement 66:

The technology meet minimum air quality district regulatory emission limits.

Not site testable.

Technology Category Requirement 67:

The technology meet minimum air quality district acceptable air concentration limits.

Not site testable.

WASTE CONTAINER HANDLING

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories (soil units only)
Pass rules:
Fail if present on list (category or constituent).

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 59:

Place waste for shipment or storage.

Not site testable.

OFFGAS TREATMENT

Technology Category Requirement 2:

The technology shall be compatible with waste constituents.

Input data: Check incompatible constituents and/or categories (soil units only)
Pass rules:
Fail if present on list (category or constituent).

Technology Category Requirement 11:

The technology shall meet the remediation schedule.

Input data: Year that technology will be available for deployment
Pass rule: Input availability year occurs before or same as remedial decision year.

Technology Category Requirement 66:

The technology meet minimum air quality district regulatory emission limits.

Not site testable.

Technology Category Requirement 67:

The technology meet minimum air quality district acceptable air concentration limits.

Not site testable.

APPENDIX I

Interface Forms

The relationship diagram, Figure A-1, displays the interface connections between/among the DART elements. The diagram depicts the interactions of the elements such that when one element is called, the impact and influence on other elements is known.

This appendix describes the user interface to the DART system. The DART interface is implemented using Microsoft Visual Basic 4.0 and Graphics Server 5.0. The following information is provided in this appendix for each form in the DART interface.

PURPOSE: a short description of the capability provided to the user by the form
ACCESSED FROM: where the user "comes from to access the current form
ACCESS: what forms can be reached from the current form
REQUIRED DATA: what data is need to open the current form
OPERATIONS: what capabilities are accessible to the user in the current form.

Additional description of the DART interface can be found in the DART User's Manual.

The forms used to enter technology performance criteria data and determine sites whose requirements are satisfied by those criteria are identical in operation except for the data to be entered. As a result, a complete description will be entered only for the initial form of this type. All other such forms will be identified as such and refer to frmCap for operational details..

FORM: frmCap

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Cap.

ACCESSED FROM: "Technology/Site Match" button in form frmTechCategories

ACCESSES:
"Cost" opens the form frmCost.
"E/I Models" opens the form frmEIModels.
"Site Data" button opens frmSiteDataDisplay
"Needs" button opens frmNP
"Requirements" button opens frmCOReqs
"Exit" button closes frmCap and returns to frmTechCategories

REQUIRED DATA: None

OPERATION:

1. The "Analyze" button determines the sites for which the entered performance criteria satisfy site specific requirements for caps by comparing the performance criteria to site specific data. A list of sites is printed in the form.

2. After the set of sites that are satisfied by the input performance criteria, the remaining buttons apply to a user selected subset of the displayed sites.

   - The "Cost" button runs the cap cost model and displays the cost of applying the input technology to the sites determined during the analysis phase.
   - The "E/I Models" button runs the implementability and effectiveness models and displays the results in the form frmEIModels.
   - The "Needs" button displays the reported needs and problems associated with the selected sites.
   - The "Site Data" button opens the form frmSiteDataDisplay to display the site data associated with the selected sites.
   - The "Requirements" button" opens the form frmCOReq and displays the site specific requirements for the selected sites.

FORM: frmContainmentMonitor

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Containment Integrity Monitoring.

OPERATION: Technology performance criteria input screen. See frmCap.

FORM: frmContamControl

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Contaminant Control.

OPERATION: Technology performance criteria input screen. See frmCap.

FORM: frmContamDetection

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Contaminant Detection and Monitoring.

OPERATION: Technology performance criteria input screen. See frmCap.

FORM: frmCOReq

PURPOSE: The frame that is used to display the site specific requirements relating to a specific technology category for a site or group of sites.

ACCESSED FROM:
"Requirements" button in all technology performance criteria input forms, see frmCap.
"Requirements" button in form frmSiteData.

"Requirements" button in form frmSiteDataDisplay
"Requirements" button in form frmSiteReport.
ACCESSES:
"Exit" button returns the user to the form frmCOReq was accessed from.
"Site Data" opens form frmSiteDataDisplay.

REQUIRED DATA: A technology category and a list of sites.

OPERATION:

1. The technical category is selected in the form frmTCSelect except when frmCOReq is accessed from a technology performance criteria input window when the category of the technology being investigated is used as the technology category.

2. The "Site Data" button is not displayed if frmCOReq was accessed from frmSiteDataDisplay.

FORM: frmCost

PURPOSE: The form used to display the results of the cost models for a site or selected set of sites.

ACCESSED FROM:
"Cost" button in most technology performance criteria input forms.

REQUIRED DATA: Results of cost model calculations and the sites for which the calculations were performed.

ACCESSES: Returns to the technology performance criteria input window from which it was called.

OPERATION

1. Currently the technology categories Equipment Cleanup Technology, Off-gas Treatment, and Waste Container Integrity and Handling do not have cost models.

2. This form is used to display results of the cost calculations only. Actual calculations are performed by the models associated with the technology category.

FORM: frmEIModels

PURPOSE: The form used to display the results of the effectiveness and implementability models for a site or selected set of sites.

ACCESSED FROM:
"E/I Models" button in the technology performance criteria input forms.

REQUIRED DATA: Results of implementability and effectiveness model calculations and the sites for which the calculations were performed.

ACCESSES: Returns to the technology performance criteria input window from which it was called.

OPERATION

1. This form is used to display results of the effectiveness and implementability model calculations only. Actual calculations are performed by the models which are in the module Global.Bas.

2. The model results are calculated in the functions: EffectiveBenefit, Irreversibility, ReliabilityModel, ResidualRisk, ToxicityReduction, and VolumeReduction found in Global.Bas.

FORM: frmEnterID

PURPOSE: The form used to enable the user to enter a set of site id numbers to display graphs of site characteristics associated with those user ids..

ACCESSED FROM:
"User Selected Sites" item in the "Apply To" menu in frmGraphics..

REQUIRED DATA: A list of site ids separated by spaces.

ACCESSES:
"Clear" button clears the list of ids entered by the user.
"OK" button exits the form and saves the list of site ids to be used for graphing.

OPERATION

1. The list of site ids are used for graphing while "User Selected Ids" is selected until either the user changes the list of site ids or the user exits frmGraphics.

FORM: frmEquipCleanup

PURPOSE: Enables the user to enter performance criteria data, and data required for the effectiveness and implementability models for the technology category Equipment Cleanup Technology.

OPERATION: Technology performance criteria input screen. See frmCap.

FORM: frmExcavators

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Excavation

OPERATION: Technology performance criteria input screen. See frmCap.

FORM: frmGraphics

PURPOSE: The form used to display graphs of data from the database.

ACCESSED FROM:
"Summary Graphics" button in the top level window..

REQUIRED DATA: The graph type, graph definition, and or data required to display a user selected graph..

ACCESSES:

1. The "Exit" button returns to the top level form
2. The "User Selected Sites" item in the "Apply To" opens a form to enable the user to enter site ids to use in the graphing capability. The ids must be entered separated by a single space. The user enter ids will be used in all graphs whenever the "User Selected Sites" is selected until changed by the user or the user exits the form frmGraphics.

OPERATION

1. The "Display" button will take user input data, access the database to obtain required data and generate a graph.
2. The "Print" button prints a bitmap image of the form when a graph is displayed.

FORM: frmInSituBio

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category In-situ Bio Remediation.

OPERATION: Technology performance criteria input screen. See frmCap.

FORM: frmInSituChem

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category In-situ Chemical Treatment.

OPERATION: Technology performance criteria input screen. See frmCap.

FORM: frmInsituThermal

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category In-situ Thermal Treatment.

OPERATION: Technology performance criteria input screen. See frmCap.

FORM: frmNeedsSearch

PURPOSE: The form used to enable the user to search for needs.

ACCESSED FROM:
"Needs" button in form frmTopLevel.

ACCESSES:
"Search" buttons determines and displays needs satisfying criteria entered by the user.
"Site Data" button displays site data for the sites to which selected needs are assigned.
"Display TTPs" button displays TTP data for the TTPs which address user selected needs.
"Site Listings"
"Technology"
"Print Reports"
"Exit" button returns to the window from which frmNPReport was called.

REQUIRED DATA: Either a field office or search strings to determine which needs to display.

OPERATION:

1. The user can select a field office or enable the user to display needs from across the complex.

2. The use can select a technical category to search for needs that are associated with the selected technical category.

3. The user can also enter two search strings. The option buttons (AND, OR) enables the user to select whether the need must contain both or either one of the search strings.

FORM: frmNPReport

PURPOSE: The form used to display the reported needs and problems associated with a set of subsites.

ACCESSED FROM:
"Needs" button in all technology performance criteria input forms, e.g., frmCap
"Needs Summary" button in frmSiteData.
"Needs" button in frmSiteDataDisplay.
"Needs" button in frmSiteReport.

ACCESSES: "Exit" button returns to the window from which frmNPReport was called.

REQUIRED DATA: A set of sites for which the needs and problems are to be displayed.

OPERATION:
1. This window displays the union of needs. If multiple sites are selected, the needs are not associated directly with the reporting site.

FORM: frmNumeric

PURPOSE: The form used to have the enter numeric data and logical relationships, e.g., < 5, to search for sites or technologies satisfying specific search criteria.

ACCESSED FROM: Numeric data input text boxes in frmSiteData and frmSearchTech.

ACCESSES: "Close" and "OK" button return focus to the form from which frmNumeric was called.

REQUIRED DATA: The label and current value of the text box for which the user wishes to enter data and the screen location to open the window.

OPERATION:
1. The current value in the text box will be changed only if "OK" is selected. If "Close" is selected, frmNumeric will close without changing the current value. If "Clear" is chosen, the current value displayed in frmNumeric will be cleared.

2. The required input is made available to frmNumeric in the "Click" procedure of the text box associated with the value the user wishes to change.

FORM: frmOffgas

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Off-gas Treatment.

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frmPhyStab

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Stabilization to Limit Mobility.

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frmPumpTreat

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Pump & Treat

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frmRemote

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Remote Handling.

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frmSearchData

PURPOSE: The form used to select contaminants, contaminant categories, and regulatory drivers for inputting search criteria and technology performance criteria.

ACCESSED FROM: Clicking the mouse in the contaminant, contaminant category, and regulatory driver List Boxes in frmSiteData and technology performance criteria input forms.

ACCESSES: "Close" and "OK" button returns focus to the form from which frmSearchData was called.

REQUIRED DATA: The name of the List Box, and by implication the containing form, where the selected values will be displayed.

OPERATION:

1. The current value in the list box will be changed only if "OK" is selected. If "Close" is selected, frmNumeric will close without changing the current value. If "Clear" is chosen, the current value displayed will be cleared.

2. A maximum of three contaminants, two contaminant categories and two regulatory drivers can be chosen. This limitation is actually only required for frmSearchData due to the query that is used to search the database for sites satisfying the selected criteria.

FORM: frmSearchTech

PURPOSE: Enables the user to enter data to search for technologies from the Industry Available Database plus added TTP technologies that satisfy specific criteria and display those technologies.

ACCESSED FROM: "Search Technologies" button in frmTechCategories.

ACCESSES:
"Search" button opens form frmTechDisplay
"Exit" button returns to form frmTechCategories.

REQUIRED DATA: None

OPERATION:

1. The data input by the user is used as search criteria to search the technologies in the database.

2. Whenever a users "buttons" on an active site data field, a form, lstNumeric, or list box, List1, is opened for the user to input the data. List1 is populated with the appropriate data in the Click function of the text box whenever a data list is used for input.

3. Not all technology fields are active for search.

FORM: frmSiteData

PURPOSE: Enables the user to enter data to search for sites that satisfy specific criteria and display those sites and information about those sites.

ACCESSED FROM: "Site Data" button in form frmTopLevel

ACCESSES:
"Display Site Data" button opens frmSiteDataDisplay
"Site Listing" button opens form frmSiteReport
"Technology Summary" button opens frmSiteTechCat
"Needs Summary" button opens frmNP
"Requirements" button opens frmCOReqs
"Clear Form" button clears currently selected search criteria
"Exit" button closes frmSiteData and returns to frmTopLevel

REQUIRED DATA: None

OPERATION:

1. Whenever a users "buttons" on a site data field, a form or list box is opened for the user to input the data. These are: List1, List2, and frmNumeric and are accessed via the Click or MouseDown events of the selected text box. frmNumeric is to enter numeric data, List2 handles yes/no input, and List1 handles all other menu input including contaminant data, site location, regulatory drivers, etc.

2. Other than "Exit" and "Clear Form", operations initiated by the buttons apply to all sites that satisfy the search criteria.
   - "Display Site Data" opens a form that displays, for one site at a time, all site data for the selected sites in frmSiteDataDisplay.
   - "Technology Summary" displays all technology categories that apply to the selected sites. Technology categories are accessed via configuration options associated with the selected sites.
   - "Needs Summary" displays the union of all needs associated with the selected sites.
   - "Requirements" displays the union of the requirements and the list of selected sites.

3. "Clear Form" clears the current search criteria while "Exit" closes frmSiteData and opens frmTopLevel.

FORM: frmSiteDataDisplay

PURPOSE: Displays the site data in the database for an individual site.

ACCESSED FROM:
"Site Data Display" button in form frmSiteData.
"Site Data" button in form frmCOReq.
"Site Data Display" button in form frmSiteReport.
"Site Data" button in all technology performance criteria input forms.

ACCESSES:
"Technologies" button opens form frmSiteTechCat
"Requirements" button opens form frmCOReq
"Needs Summary" opens form frmNP
"Exit" opens form frmSiteData

REQUIRED DATA: The site Ids of sites for which data will be displayed to generate the SQL query to access the site data.

OPERATION:

1. When the "Display Site Data" button of frmSiteData is selected, the function determine sites is called. Within this function, the SQL query is generated which determines the sites that satisfy the search criteria. This data is stored in the array

SelectedSites which is by the Load event of frmSiteDataDisplay to access the required site data.

2. The data object Data1 is used to move from one site to another to display site data.

3. Other than "Exit" the operations initiated by the buttons apply to only to the currently displayed site.
   - The "Technologies" button opens the form frmSiteTechCat and displays the technology categories associated with the configuration option(s) associated with the site currently being displayed.
   - The "Needs Summary" button "Technologies" opens the form frmNP and displays the needs associated with the site currently being displayed.
   - The "Requirements" button" opens the form frmCOReq and displays requirements associated with the configuration option(s) associated with the site currently being displayed.

4. The "Requirements" button is not displayed if frmSiteDataDisplay is accessed from form frmCOReq.

FORM: frrnSiteReport

PURPOSE: The form displays a list of sites that satisfy a list of search criteria entered in frmSiteData.

ACCESSED FROM:
"Site Listing" button in form frmSiteData.

ACCESSES:
"Requirements" button opens form frmCOReq.
"Display Site Data" button opens form frmSiteDataDisplay.
"Needs" button opens form frmNPReport.
"Technologies" button opens form frmSiteTechCat.
"Exit" button returns focus to frmSiteData.

REQUIRED DATA: A list of sites to display.

OPERATION:
1. A list of sites is used as input rather than the search criteria as input as the database search function is also used to generate the list of sites for frmSiteDataDisplay.

2. Other than "Exit" the operations initiated by the buttons apply to only to the currently selected sites in the list box displaying site names.
   - When the "Requirements" is selected, a list of technology categories applicable to the selected sites is displayed. When the user selects a category, the site specific requirements for the selected sites and technology category are displayed in frmCOReq.

- When "Display Site Data" is selected, frmSiteDataDisplay is opened to show site data for the selected sites.
- "Needs Summary" button will open frmNPReport with the union of needs and problems reported for the selected sites.
- "Technologies" button displays the union of all technology categories associated with the configuration options assigned to the selected sites.

FORM: frrnEx SituSoilWash

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Soil Washing.

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frrnStabLimitMob

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Stabilization to limit mobility.

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frrnSubAssess

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Subsurface Assessment..

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frrnSubBarrier

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Subsurface Barrier.

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frrnTCSelect

PURPOSE: Displays a list of technical categories for user selection. This form appears when site specific requirements are to be displayed and enables the user to display the requirements associated with a technology category for a set of sites.
ACCESSED FROM:
"Requirements" button in frmSiteReport
"Requirements" button in frmSiteData

"Requirements" button in frmSiteDataDisplay

ACCESSES:
"OK" button opens form frmSiteTechCat is opened when after a technology category has been selected.
"Exit" button returns focus to the calling form.

REQUIRED DATA: A list of sites.

OPERATION:

1. Given a list of sites, a list of the technology categories, obtained using each site's configuration option(s), is generated and displayed to the user to choose to display the site specific requirements for the selected technology category and site list.

FORM: frrnTechCategories

PURPOSE: Enables the user to select a technology category to input performance criteria, display associated technologies, requirements, etc.

ACCESSED FROM:
"Technology Categories" button of frmTopLevel.

ACCESSES:
"Requirements, Needs. And Sites" button opens form frmTechReqs.
"Technology/Site Match" button opens a technology category performance criteria input window.
"Technologies by Category" button opens form frmTechDisplay.
"Display all TTPs" button opens form frmTechDisplay.
"Search Technology" button opens form frmSearchTech.
"Exit" button returns to form frmTopLevel.

REQUIRED DATA: None

OPERATION:

1. All buttons, except "TTP:By Category," "Search Technologies," and "Exit" require user choice of a technology category from the list box.
   - "Requirements, Needs. And Sites" button displays all requirements associated with the selected technology category and all sites, together with reported needs, whose configuration option has the selected technology category mapped to it.
   - "Technology Site" is opens the performance criteria window for the selected technology category. Note, only 20 of the 30 categories have performance criteria defined.
   - "Technologies Category" displays the technologies in the databases with field Technology Category the same as that selected by the user.

2. "TTPs By Category" displays all TTP technologies, associated with selected category.

3. "Search Technology" opens the form that enables the user to enter search criteria to find technologies satisfying specific criteria.

FORM: frrnTechDisplay

PURPOSE: The form that displays the data associated with the set of technologies satisfying a given set of search criteria.

ACCESSED FROM:
"Display all TTPs" button in form frmTechCategories.
"Technologies by Category" button in form frmTechCategories.
"Search" button in form frmSearchTech.

ACCESSES:
"Exit" button returns to the accessing form.

"PRINT FORM"

REQUIRED DATA: The set of technologies to display.

OPERATION:

FORM: frrnTechReqs

PURPOSE: Display all requirements for the selected technology category, reported needs for the selected technology category, and potential sites at which the selected technology category may be applied

ACCESSED FROM: "Requirements, Needs and Sites" button in form frmTechCategories

ACCESSES: "Exit" button closes this form and returns the user to the form frmTechCategories "Display Site Data"

REQUIRED DATA: Technology category selected in the technology category list box of frmTechCategories

OPERATION:

1. Requirements are associated directly with a technology category. This data is stored in the table Tech Category / Need Match. The query Requirements by Tech Category returns the description of all requirements associated with a given technical category.

2. Needs are associated directly with a technology category. This data is stored in the table Tech Category / Needs Match. The query VBNeedsbyTechCategory returns the needs descriptions for all needs associated with a technology category.
3. Potential sites at which a technology category can be applied are accessed via configuration options. Given a technology category, the configuration options that this technology category is appropriate for, is determined. This data is stored in the table Tech Category / Config Option Match. The list of sites associated with these configuration options is generated from table Subsite Configuration Option. These are combined in the query VBSiteTechnology. The exception is for tech categories: contamination control, remote handling, and waste assay. A subset of the sites associated with the configuration options is determined by the contaminants associated with the site. The functions to perform these functions, in Global.Bas are: CheckRemoteHandling, CheckContaminantControl, and CheckForTRU.

FORM: frmTopLevel

PURPOSE: This is the top level form opened when the DART system is started

ACCESSED FROM:

ACCESSES:
"Site Data" button opens frmSiteData.
"Technology Categories" button opens the form frmTechCategories.
"Administration" button opens the form frmUpdate
"Needs" button opens the form frmNeedsSearch
"Summary Graphics" opens the form frmGraphics
"Exit" button exits the DART system

REQUIRED DATA: None

OPERATION: The form is opened when the DART system is started.

FORM: frrnUpdate

PURPOSE: The form that displays the buttons to update risk and priority rankings in table PRTable and update table SubsiteContamCategory.

ACCESSED FROM:
"Administration" button in frmTopLevel..

ACCESSES:
"Update Risk / Priority Rankings" updates table PRTable with new risk and priority rankings.
"Update Contaminant Categories" updates table SubsiteContamCategory.
"Update Subsite Contaminant Reg Limits" updates the table SubsiteContamRegTable
"Exit" button returns to the accessing form.

REQUIRED DATA: None

OPERATION:

1. Whenever data is added it is necessary to recalculate priorities and risk values. This is performed by running the query MakePRTable in Access. This calculates new values and stores them in MakePRTable. It is then necessary to define the columns Risk Ranking and Priority Ranking as Long Integers. Running Update Risk / Priority Rankings will calculate new rankings and store them in MakePRTable.
2. When new contaminant data is added, it is necessary to update the table SubsiteContamCategory. Note: this is a denormalization of data already in the database in the SubsiteContamination and Contaminants table. This is performed by running Update Contaminant Categories.

FORM: frrnVaporExtract

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Vapor Extraction.

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frmWasteAssay

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Waste Assay.

OPERATION: Technology performance criteria input screen. See frmCap

FORM: frrnWasteContainer

PURPOSE: Enables the user to enter performance criteria data, cost data, and data required for the effectiveness and implementability models for the technology category Waste Container Integrity and Handling..

OPERATION: Technology performance criteria input screen. See frmCap

FILE: Global.Bas

PURPOSE: Module that defines all global constants and variables, and contains the functions that are globally accessible.

APPENDIX J

List Of Needs
and
Technical Task Plan (TTP) Assignments

Field Office	Site Location	Operable Unit	STCG ID Number	SCFA ID Number	NEED Statement	TTP Assignment
Albuquerque	Los Alamos National Laboratory	Field Unit 3	AL-07-01-01-SC	AL-97-0011	High explosives (HE) & Barium (Ba) remediation of soils, surface water and groundwater.	NONE
Albuquerque	Los Alamos National Laboratory	Field Units 1, 4 & 5	AL-07-01-03-SC	AL-97-0002	Cost-effective Remediation of Plumes in Soil and Tuff	NONE
Albuquerque	Sandia National Laboratories	Mixed Waste Landfill	AL-07-02-03-SC	AL-97-0005	Low-level radioactive waste landfill cap design, tritium treatment/removal technology	AL27SS27, TASK A,B,C
Albuquerque	Kansas City Plant	Main manufacturing building	AL-07-04-01-SC	AL-97-0009	Non-intrusive removal of PCBs from soil both above and below the water table underneath buildings	SF17SS31 OR17SS31-TASK B,C,D,E SR17SS31
Albuquerque	Kansas City Plant	TCE still area, underground tank farm area, northeast area/outfall 001 area	AL-07-04-02-SC	AL-97-0006	Soil and groundwater contamination include tetrachloride (PCE), trichlorethene (TCE), 1, 2-dichloroethenes (1,2-,DCE), vinyl chloride, aromatic and halognerated VOCs, petroleum hydrocarbons, PCBs, and selected metals. Additionally, chlorinated VOCs have	AL27SS56 RF17SS51
Albuquerque	Pantex Plant	1207 Former Cooling Tower, AL-PX-3 SWMU Grouping	AL-07-06-01-SC	AL-97-0001	In situ reduction of chromium-contaminated soils, construction materials and debris	AL37SS57
Albuquerque	Pantex Plant	Zone 12 Groundwater OU 6 (ADS 1230)	AL-07-06-02-SC	AL-97-0008	In situ biobarrier for contaminated groundwater	AL27SS36

Field Office	Site Location	Operable Unit	STCG ID Number	SCFA ID Number	NEED Statement	TTP Assignment
Albuquerque	Pantex Plant	Building 12-24, HE Fabrication Facility; Building 12-43, HE Waste Water Treatment System	AL-07-06-03-SC	AL-97-0010	High Explosives/VOCs/SVOCs in situ biodegradation project	NONE
Albuquerque	Pantex Plant	Construction Landfill; AL-PX-7 (ADS 1200); Burning Grounds; AL-PX-1 (ADS 1232)	AL-07-06-04-SC	AL-97-0004	In situ remediation/immobilization of landfill materials	AL27SS27-TASK A,B,C PE17SS41
Albuquerque	Grand Junction Office	Monticello Surface and Groundwater Project & UMTRA Groundwater	AL-07-09-02-SC	AL-97-0007	Availability of innovative treatment for radionuclide and metal contamination in groundwater	NONE
Chicago	Brookhaven National Laboratory	I, IV, VI	CH-0001	CH-97-0004	Subsurface barriers/reactive rad barriers	RF17SS51
Chicago	Brookhaven National Laboratory	V	CH-0002	CH-97-0005	Treatment of metals in sediments	NONE
Chicago	Brookhaven National Laboratory	I, II/VII, III & IV	CH-0004	CH-97-0002	Treatment of rad-contaminated soils	CH27SS51
Chicago	Argonne National Laboratory – East	N/A	CH-0008	CH-97-0001	In situ treatment of organic solvents in clay soils	CH27SS31

Field Office	Site Location	Operable Unit	STCG ID Number	SCFA ID Number	NEED Statement	TTP Assignment
Idaho	Idaho National Engineering Laboratory (INEL); Radioactive Waste Management Complex (RWMC)	7-13; Subsurface Disposal Area Pits and Trenches	ID-6.1.01	ID-97-0011	In-situ debris characterization for partial retrieval	ID77SS41 RL17SS41
Idaho	Idaho National Engineering Laboratory (INEL)	WAGs 2, 3, 4, 6, and 10	ID-6.1.02	ID-97-0010	Real-time field instrumentation for characterization for radioactive and metal contaminated soils	ID77SS41
Idaho	Idaho National Engineering Laboratory (INEL)	1-07B	ID-6.1.04	ID-97-0001	In-situ treatment of VOC contaminated groundwater in deep fractured rock	SR17SS31 OR17SS31-TASK C,D,E SF27SS31
Idaho	Idaho National Engineering Laboratory (INEL); Radioactive Waste Management Complex (RWMC)	OU 7-13 Subsurface Disposal Area Pits and Trenches	ID-6.1.05	ID-97-0009	Digface characterization to reduce volume of waste to be remediated	ID77SS41
Idaho	Idaho National Engineering Laboratory (INEL)	OU 7-13	ID-6.1.19	ID-97-0004	Pretreatment prior to in-situ treatment	NONE
Idaho	Idaho National Engineering Laboratory (INEL)	WAG 3 (OU 3-07) and WAG 1 (OU 1-07)	ID-6.2.09	ID-97-0005	Ex-situ treatment of Ca/Mg rich groundwater contaminated with radionuclides	PE17SS51
Idaho	Idaho National Engineering Laboratory (INEL)	WAG 3 (OU 3-07) and WAG 1(OU 1-07)	ID-6.2.11	ID-97-0006	In-situ immobilization of radionuclides in groundwater	PE17SS51

Field Office	Site Location	Operable Unit	STCG ID Number	SCFA ID Number	NEED Statement	TTP Assignment
Nevada	Nevada Test Site, Tonopah Test Range, Nellis Air Force Range	Soils	NV0005 (former NV0002)	NV-97-0007	Precision soil excavation	ID77SS41
Nevada	Area 3 and Area 5 Radioactive Waste Management Sites	Waste Management	NV0011(former NV0006)	NV-97-0002	Long-term stability of waste forms	ID77SS42-TASK A ID77SS43
Nevada	Nevada Test Site, Area 3, Area 5	Waste Management	NV0012 (former NV0007)	NV-97-0005	Arid site closure cover	AL27SS27, TASK A,B,C
Nevada	Nevada Test Site	Underground Test Areas	NV0014 (former NV0014)	NV-97-0004	Subcritical testing areas remediation or in-situ stabilization	NONE
Oak Ridge	Oak Ridge National Laboratory (ORNL), Y-12 Plant, K-25 Site, Paducah Gaseous Diffusion Plant (PGDP)	ORNL WAGs, 1,3,4,5,6,7; Y-12 Bear Creek Burial Ground; K-25 K-1070 A, B, C/D, F, G Burial Grounds; PGDP WAG 22	BW-01	OR-97-0001	Advanced technologies for in situ treatment of highly toxic and long-life hazardous, radioactive, and/or mixed wastes	ID77SS21-TASK A AL27SS21-TASKB
Oak Ridge	Oak Ridge National Laboratory (ORNL), Y-12 Plant, K-25 Site, Paducah Gaseous Diffusion Plant (PGDP)	ORNL WAGs 1,3,4,5,6; Y-12 Bear Creek Valley Burial Grounds; K-25: K-1070 A,B,C/D, F, G Burial Grounds; PGDP: WAG 2 and others	BW-03	OR-97-0002	Non-intrusive or slightly intrusive in situ assay systems	RL17SS41

Field Office	Site Location	Operable Unit	STCG ID Number	SCFA ID Number	NEED Statement	TTP Assignment
Oak Ridge	Oak Ridge National Laboratory (ORNL), Y-12 Plant, K-25 Site, Paducah Gaseous Diffusion Plant (PGDP)	ORNL WAGs 1,3,4,5,6; Y-12 Bear Creek Valley Burial Grounds; K-25 K-1070 A, B, C/D, F, G Burial Grounds; PGDP WAG 22 and others	BW-04	OR-97-0003	Placement of horizontal and/or vertical subsurface barriers and drains in or adjacent to buried waste disposal areas to limit the migration of contaminants.	ID77SS21-TASK A PE17SS21-TASKA
Oak Ridge	Oak Ridge National Laboratory (ORNL), Y-12 Plant, K-25 Site, Paducah Gaseous Diffusion Plant (PGDP)	ORNL WAGs 1,3,4,5,6; Y-12 Bear Creek Valley Burial Grounds; K-25 K-1070 A, B, C/D, F, G Burial Grounds; PGDP WAG 22 and others	BW-08	OR-97-0004	Predictive capabilities for long-term performance assessment to ensure that performance can be reliably determined and monitored for periods long enough to achive remedial objectives (I.e., ranging from decades to centuries)	AL27SS21-TASK B OH17SS21 SF17SS22 SR17SS21 PE17SS21
Oak Ridge	Oak Ridge National Laboratory (ORNL), Y-12 Plant, K-25 Site, Paducah Gaseous Diffusion Plant (PGDP)	ORNL WAGs 1,3,4,5,6; Y-12 Bear Creek Valley Burial Grounds; K-25 K-1070 A, B, C/D, F, G Burial Grounds; PGDP WAG 22 and others	BW-12	OR-97-0005	Methods are needed to allow remedial actions in the presence of reactive wastes.	NONE

Field Office	Site Location	Operable Unit	STCG ID Number	SCFA ID Number	NEED Statement	TTP Assignment
Oak Ridge	Oak Ridge National Laboratory (ORNL), Y-12 Plant, K-25 Site, Paducah Gaseous Diffusion Plant (PGDP)	ORNL WAGs 1,3,4,5,6; Y-12 Bear Creek Valley Burial Grounds; K-25 K-1070 A, B, C/D, F, G Burial Grounds; PGDP WAG 22 and others	BW-13	OR-97-0006	Selective excavation of high risk buried materials	ID77SS42-TASK A
Oak Ridge	Oak Ridge National Laboratory (ORNL) and the K-25 Site	ORNL WAGs, 1,3,4,5,6; K-25 K-1070 A,B,C/D,F,G Burial Grounds	BW-16	OR-97-0007	Limit subsidence within the buried waste matrix. At the K-25 Site Burial Grounds consideration may also be given to methods to limit buried waste release to the water table in the event of subsurface collapse.	ID77SS42 CH37SS21
Oak Ridge	ORNL, Y-12, K-25, PGDP	ORNL: WAGs 1,3,4,5,6; Y-12: BCV,UEFPC; K-25: 1070A,B,C/D,F,G, burial grounds; PGDP: WAG22 & others	BW-19	OR-97-0008	Technologies for the characterization and remediation of soil contaminated with radionuclides, heavy metals, and/or volatile organic compounds	NONE

Field Office	Site Location	Operable Unit	STCG ID Number	SCFA ID Number	NEED Statement	TTP Assignment
Oak Ridge	ORNL, Y-12, K-25, Paducah Gaseous Diffusion Plant, Portsmouth Gaseous Diffusion Plant	ORNL: WAGS 1,4,5,6; Y-12:BCV, UEFPC;K-25: Mitchell Branch, K-27-29 Peninsula, K-1070A Burial Ground; PAD: DNAPL Sources; PORTS: X-701B, X-749, Five SWMA Area	HY-01	OR-97-0009	New technologies to cost effectively delineate DNAPL sources and to either contain sources or to in-situ treat or remove the source	OR17SS56 OR17SS31-TASK B,C,D,E PE17SS53 PE17SS32-TASK 1,2
Oak Ridge	ORNL, Y-12, K-25, Paducah Gaseous Diffusion Plant, Portsmouth Gaseous Diffusion Plant	Y-12: BCV,UEFPC;K-25: K-1070A Burial Ground & Mitchell Branch; PAD: NE & NW plumes, WAGS 6,22,27,28; PORTS: X-701B, X-749, Five SWMU Area	HY-11	OR-97-0010	Ability to cost-effectively bore, jack, or drill and make installations in an oriented or horizontal configuration	NONE

Field Office	Site Location	Operable Unit	STCG ID Number	SCFA ID Number	NEED Statement	TTP Assignment
Oak Ridge	Y-12 Plant, K-25, Paducah Gaseous Diffusion Plant, Portsmouth Gaseous Diffusion Plant	Y-12:BCV, UEFPC;K-25: Mitchell Branch, K-27-29, K-1070A Burial Ground; PAD: NE and NW Plumes; PORTS: X-701B, X-749, Five-SWMU Area	HY-12	OR-97-0011	In situ treatment by horizontal wells or oter robust collection and recirculation systems augmented by various forms of in-situ treatment wherein a reactive treatment zone is created across a selected portion of the aquifer or within major fractures in a	OR17SS31-TASK D ID77SS31 AL37SS31 RL37SS38
Oak Ridge	ORNL, Y-12, K-25, Paducah Gaseous Diffusion Plant, Portsmouth Gas Diffusion Plant	ORNL: WAGs 1,4,5,6; Y-12: BCV, EUFPC; K-25: Mitchell Branch, K-27-29 Peninsula, K-1070A Burial Ground;PAD: WAGs 6,22,27,28; Ports: X-701B,X-749, Five SWMU Area	HY-13	OR-97-0012	Treatment of groundwater plumes and seeps by allowing or guiding groundwater to flow through a reactive material that prevents clogging of the reactive material and allows effective installation w/in the subsurface so that it may efficiently and cost-effectively	NONE

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Oak Ridge	ORNL, Paducah Gaseous Diffusion Plant, PORTS	ORNL WAGS 1,4,5,6; PGDP WAGs 22 & 23; PORTS five SWMU Area	HY-14	OR-97-0013	Containment and stabilization techniques that are inexpensive, easy to accomplish, and will assure minimal release from the contaminated area, as well as minimal damage to the environment	NONE
Oak Ridge	ORNL, Y-12, K-25, Paducah Gaseous Diffusion Plant	ORNL WAGs 1,4,5,6; Y-12 BCV, UEFPC; K-25: Mitchell Branch; PGDP: 27	HY-16	OR-97-0014	Methods and equipment to cost effectively install large-scale hydrologic controls including: barriers and cutoffs and diversions, french drains and trench drain collector systems; reactive barriers	NONE
Oak Ridge	ORNL, Y-12 plant	ORNL WAG 1, Hydrofracture facilities	HY-17	OR-97-0015	Methods and equipment to stabilize or plug and abandon deep highly contaminated bore holes and wells, that minimize waste production, assure worker safety, and are effective on a variety of well size and construction configurations	NONE
Oak Ridge	ORNL	ORNL WAGS 4,5,6	HY-18	OR-97-0016	Methods to address seepage releases of tritium-contaminated groundwater from burial trenches. Cost effective hydraulic containment systems to prevent or minimize release of tritium must be refined and optimized to provide long-term containment of tritium	NONE
Oakland	Lawrence Livermore National Laboratory (LLNL)	Treatment Facilities	OAK-1 (oakneed 2)	SF-97-0002	Need innovative in-situ destruction technologies to aggressively remediate source areas (groundwater contaminated with VOCs)	OR17SS31-TASK E SF27SS31 SR17SS31

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Oakland	Lawrence Livermore National Laboratory (LLNL) Main Site T5475, Bldg. 331, Bldg. 419, Bldg. 292 Areas	Main Site Groundwater Plume (Trailer 5475 Area, Bldg. 331 Area, Bldg. 419 Area, Bldg. 292 Tritium Spill Area)	OAK-1 (oakneed 5)	SF-97-0003	Cost effective way of separating tritium from VOC in groundwater	OR17SS31-TASK D
Oakland	Lawrence Livermore National Laboratory (LLNL)	LLNL Site 300, OU2 – Building 834	OAK-2 (oakneed 1)	SF-97-0006	Need innovative technologies for characterization and remediation of DNAPLs in soil and groundwater	RL37SS38 RL37SS57 ID77SS31 OR17SS31 SR17SS21 SF17SS31-TASK B,C,D,E
Ohio	Fernald	OU5	OH-F001	FR-97-0002	Enhanced groundwater pump & treat process/system	PE17SS57-NOT FUNDED OH17SS57-TASK A,B
Ohio	Fernald	OU2, 5	OH-F019	FR-97-0001	Geochemical barrier/immobilization mechanism for U in low permeability soils	AL27SS56
Richland	Hanford	200-ZP-1	RL-SS01	RL-97-0006	In situ remediation of carbon tetrachloride in groundwater	AL37SS38 OR17SS31-TASK D,E RL37SS57
Richland	Hanford	100-NR-1	RL-SS010	RL-97-0003	In situ remediation of radioactive and inorganic contaminants from the near surface "concentrated layer" at 1301-N and 1325-N	AL27SS51-TASK B AL27SS56

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Richland	Hanford	200 Area Remedial Action and Waste Management Units including Tank Farms	RL-SS011	RL-97-0005	Long-life waste isolation surface barrier	NONE
Richland	Hanford	100-HR-3, 100-KR-4	RL-SS02	RL-97-0002	In situ remediation of hexavalent chromium in the groundwater and vadose zone	RL37SS57 RL37SS38
Richland	Hanford	100-BC-5, 100-KR-4, 100-NR-2, 100-HR-3, 100-FR-3, 200-BP-5	RL-SS03	RL-97-0001	In situ remediation of strontium-90 in groundwater	RL37SS56-TASK A,C AL27SS56 AL27SS21-TASK B CH37SS21
Richland	Hanford	All burial sites	RL-SS06	RL-97-0007	Detection/delineation of burial ground contents	ID77SS41-TASK A
Richland	Hanford	100-NR-2	RL-SS09	RL-97-0004	Cost-effective, environmentally safe and compliant method to release strontium-90 currently absorbed to the soil within the aquifer	NONE
Rocky Flats	Rocky Flats Environmental Technology Site	Trench T-1	RF-ER01	RF-97-0003	Excavation of buried drums containing unoxidized depleted uranium chips	RL17SS41 ID77SS41
Rocky Flats	Rocky Flats Environmental Technology Site	Industrial Area IHSS 118.1	RF-ER02	RF-97-0002	Treatment technology for groundwater contaminated with carbon tetrachloride as dense nonaqueous phase liquids in the industrial area	RL37SS38
Rocky Flats	Rocky Flats Environmental Technology Site	Buffer Zone OU	RF-ER03	RF-97-0004	Passive remediation of chlorinated aliphatic solvents in groundwater	RF17SS51 OR17SS56

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Rocky Flats	Rocky Flats Environmental Technology Site	N/A	RF-ER05	RF-97-0005	Stabilization methods for contents of capped areas/subsidence prevention for three capped areas.(Solar Ponds, 700 industrial area, 300 industrial area)	ID77SS42-TASK A CH37SS21
Rocky Flats	Rocky Flats Environmental Technology Site	N/A	RF-ER08	RF-97-0006	Capping to effect reduction of natural groundwater recharge and prevent further contaminant migration. (Three areas - Solar Ponds, 700 industrial area, 300 industrial area)	AL27SS27-TASK A,B
Savannah River	Savannah River	Multiple	SR-0002	SR-97-0002	Demonstrate field effectiveness of in situ stabilization systems for radiological contamination, using alternative grout formations in moist sandy clay soils	ID77SS42-TASK A ID77SS43
Savannah River	Savannah River	Multiple	SR-0003	SR-97-0003	Long term closure cover system configuration for low-level and radiological waste layer for sandy soil in a humid climate	AL27SS27
Savannah River	Savannah River	Multiple	SR-0004	SR-97-0009	Demostrate cost-effectiveness/superior performance of in situ and ex situ vitrification when compared to conventional remediation technologies for both radiologically and radiological/chemically contaminated soil	NONE
Savannah River	Savannah River	Multiple	SR-0006	SR-97-0004	Tritium hydrogeological control and/or treatment technologies	NONE

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Savannah River	Savannah River	Multiple	SR-0007	SR-97-0005	In situ or ex situ groundwater treatment technologies for radionuclides, VOCs and hazardous constituents in unconsolidated subsurface sediments; i.e., sandy/clayey soils	RL37SS56 PE17SS21 OR17SS56 AL27SS56 SF17SS21 OR17SS31- TASK B,C,D,E AL27SS21- TASK B SF17SS22 AL27SS26
Savannah River	Savannah River	A/M Area Groundwater	SR-0008	SR-97-0006	DNAPL remediation technologies in deep unconsolidated subsurface sediments; i.e., sandy/clayey soils	OR17SS31- TASK B RL37SS57 ID77SS31 SF27SS31 OR17SS31- TASK B,C,D,E
Savannah River	Savannah River	Multiple	SR-0009	SR-97-0007	Develop in situ barrier technologies for immobilization, containment and treatment of VOCs, metals and/or radionuclides in unconsolidated subsurface sediments; i.e., sandy/clayey soils	RL37SS56- TASK A,C PE17SS21 OR17SS56 AL27SS56 SF17SS21 OR17SS31- TASK D
Savannah River	Savannah River	Multiple	SR-0010	SR-97-0008	In situ or ex situ groundwater interim removal action/containment technologies for radionuclides, VOCs, and metals in unconsolidated subsurface sediments; i.e., sandy/clayey soil	NONE