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Guidance Document for Providing Alternate Water Supplies

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GUIDANCE DOCUMENT FOR PROVIDING ALTERNATE WATER SUPPLIES

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460

NOTICE

The information in this document has been funded, wholly or in part, by the United States Environmental Protection Agency under Contract No. 68-01-6939 to CDM Federal Programs Corporation. It has been subject to the Agency's peer and administrative review and has been approved for publication as an EPA document.

FOREWORD

Section 118(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 was amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) to "give a high priority to facilities where the release of hazardous substances or pollutants or contaminants has resulted in the closing of drinking water wells or has contaminated a principal drinking water supply." This guidance document was prepared to assist Superfund contractors and on-scene Federal, State, and local officials with the planning and implementation of alternate water supplies at uncontrolled hazardous waste sites. The term "alternate water supplies" includes, but is not limited to, drinking water and household water supplies.

Provision of an alternate water supply may be appropriate when existing supplies are contaminated or are threatened by contamination in the near future. The implementation of alternate water supplies can be performed under the removal program or the remedial program, depending on the specific conditions of the site and whether it is on the National Priorities List (NPL). The four implementation options available are as follows:

1. **Time-Critical Removal Actions** - These actions are performed at sites where numeric action levels established by removal authority are exceeded or site-specific factors indicate the presence of a serious health threat. These actions are only taken in cases where it is determined that action is required within 6 months.

2. **Non-Time-Critical Removal Actions** - These actions are performed at sites which meet the same criteria as above (numeric levels exceeded or site-specific factors) but do not require action within 6 months. These actions can be performed by removal personnel using Emergency Response Cleanup Services (ERCS) contractors or a site-specific contractor. These actions may also be performed as Expedited Response Actions (ERA). ERAs are conducted under removal authority by remedial contractors and personnel. ERAs are limited to sites listed on the National Priorities List (NPL).

3. **Operable Unit Remedial Action** - These actions are performed at NPL sites where short-term threats to the human population exist. These actions are performed under remedial authority using an abbreviated remedial investigation and feasibility study (RI/FS) process and require State cost-sharing. Operable units should be consistent with the final remedy for the site.

4. **Final Remedial Action** - These actions are performed at sites which may present a long-term health threat but no immediate or short-term threats. These actions are performed under the remedial program as part of a final remedy and are preceded by a full RI/FS.

This document provides guidance for those sites that do not require a time-critical removal action but do require provision of an alternate water supply as either a non-time-critical removal action or a remedial action before implementation of a final remedy can be achieved. Those actions are described in items two and three above. Items one and four are outside the scope of this guidance. The ability to implement alternate water supplies as non-time critical removal actions is subject to site-specific considerations and available resources, particularly at non-NPL sites. Further discussion of the appropriate authority for proposed actions is presented in Section 3.1.5. It is important to emphasize that this guidance does not provide direction for situations requiring an emergency or time-critical response. Such activities should be performed in accordance with *Superfund Removal Procedures* (EPA 1987) guidance.

The guidance presented in this document was developed using information from the National Oil and Hazardous Substances Contingency Plan (NCP), other EPA guidance documents, and experience gained in the implementation of the Superfund program.

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ACKNOWLEDGMENTS

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1.0 INTRODUCTION

Non-time-critical removal actions, ERAs, and operable unit remedial actions are used to provide faster response than can be achieved with normal remedial actions. In order to streamline the implementation of an alternate water supply, first operable unit remedial actions rely on an abbreviated form of the remedial investigation/feasibility study (RI/FS). For non-time-critical removal actions and ERAs, the process used to evaluate alternatives is referred to as the engineering evaluation/cost analysis (EE/CA). Figure 1-1 illustrates the decision-making process used in this guidance for determining alternate water supply needs, screening and evaluating alternatives, and designing and implementing the remedy. This process uses components of the EE/CA and RI/FS guidance combined with knowledge of alternate water supplies to provide the user with a complete and streamlined approach to developing these actions in the field. This guidance does not replace guidance on EE/CAs or RI/FSs and should not be used as an absolute reference.

This manual should be used in conjunction with other EPA guidance documents, technical reports and references. Selected applicable references are listed below.

- Superfund Amendments and Reauthorization Act of 1986 (SARA).
- Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 U.S.C. 9601-9657.
- Revised National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, 1985 (47 FR 31180).
- Guidance Document for Remedial Investigations under CERCLA. U.S. EPA OERR, OWPE, OSWER EPA/540/G-85/002, June 1985.
- Superfund Remedial Design and Remedial Action Guidance. U.S. EPA OERR, June 1986. OSWER Directive 9355.0-4A
- Compendium of Field Operations Methods. OERR, Planned August 1987. OSWER Directive 9355.0-14
- Superfund Removal Procedures, U.S. EPA OERR, ERD. July 1987.
- Engineering Evaluation/Cost Analysis Guidance, U.S. EPA OERR, ERD. Draft, June 1987.
- Guidance on Feasibility Studies under CERCLA. U.S. EPA OSWER and ORD. EPA/540/6-85/003. June 1985.
- Community Relations in Superfund: A Handbook. U.S. EPA, OSWER Directive 9230.0-3A. March 1986.
- State Participation in the Superfund Remedial Program, U.S. EPA, OERR, February 1984.

This manual serves as a planning and guidance tool and should not be substituted for the services of competent professionals.

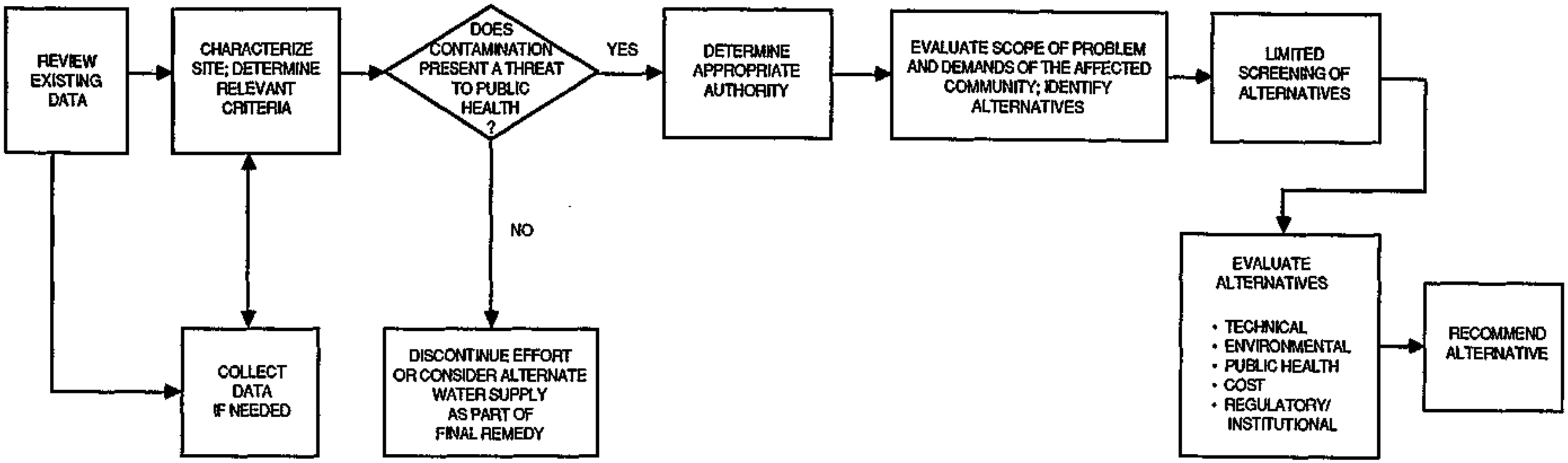


FIGURE 1-1
PROCESS FOR SELECTING ALTERNATE WATER SUPPLIES

2.0 APPROACH

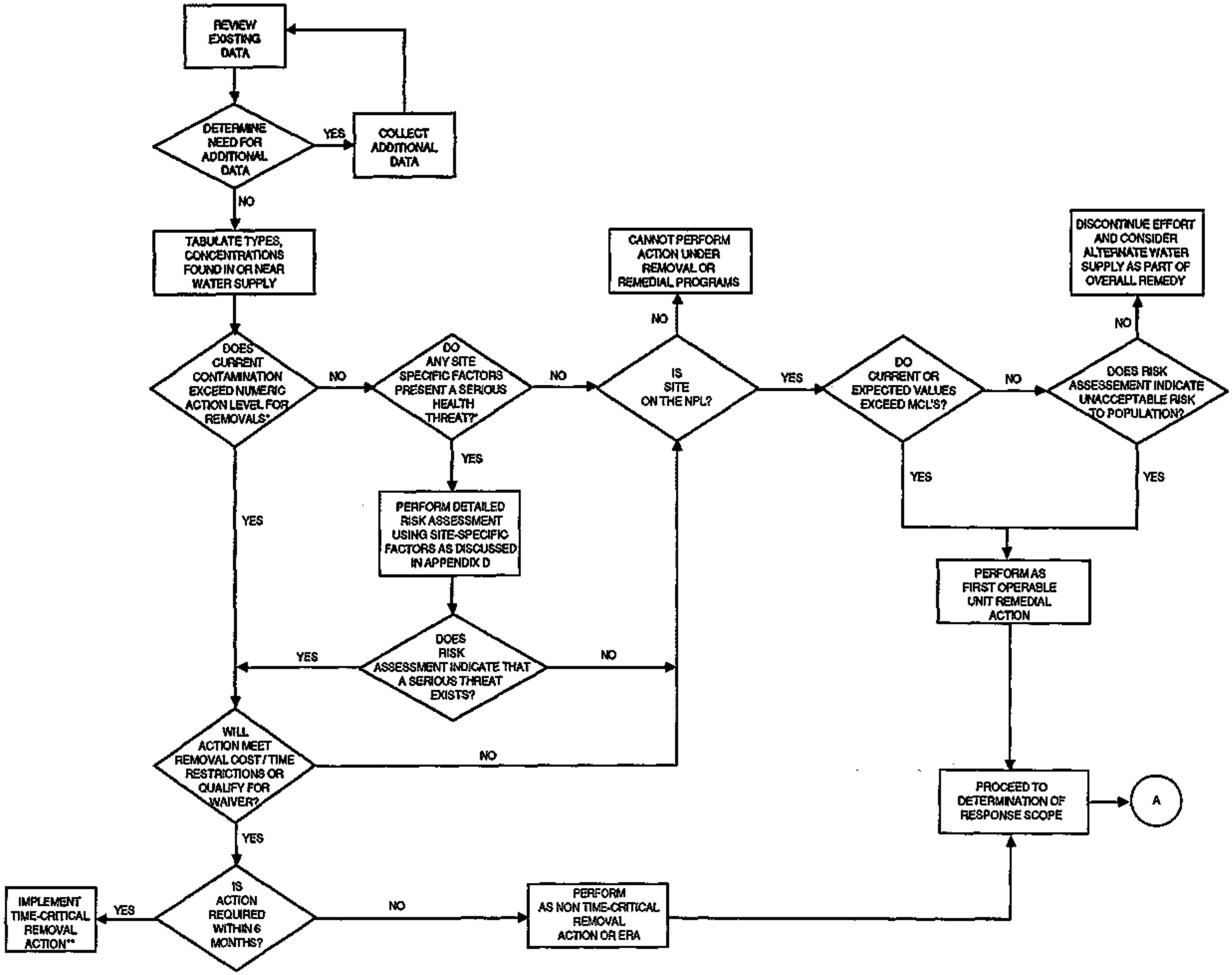
This document provides guidance at two levels of decision making. The first level is determining if an alternate water supply is needed. If needed, then the second level is selecting alternate water supplies and implementing the selected alternative. The term "alternate water supply" is used throughout this document to refer to both provision of new supplies and treatment or redistribution of existing supplies. The term "existing water supply" is defined in this document as any potable source, including a private well, public wellfield, or surface supply such as a lake, reservoir, or river, and the distribution system which connects it with users. A water supply can provide 200-300 gallons per day (for a small system) up to 10-20 million gallons per day for an average city or even more for a larger city.

This manual discusses techniques which have been derived from removal and remedial actions implemented under the Superfund program and provides a systematic approach to selecting and implementing these or other actions for sites with contaminated water supplies. Appendix A presents a list of sites where alternate supplies have been (or will be) installed and identifies the type of system selected. Based on the experience gained at these sites, the following types of alternate drinking water supplies have been identified and are given primary consideration in this document:

- Connection to existing public water supplies or private supplies and distribution systems
- Development of new water resources
- Treatment at well head or at each point of consumption
- Oversized community storage facilities to compensate for loss of existing system capacity in emergency demand situations (storage *will not* increase the actual capacity of the system)
- Blending of new and existing water supplies to achieve acceptable levels.

Figures 2-1, 2-2, and 2-3 illustrate the detailed methodology developed for selecting alternate water supplies. Figure 2-1 illustrates the decision components corresponding to site characterization and determination of response authority. Figure 2-2 illustrates the components corresponding to the determination of response scope. Finally, Figure 2-3 provides the components of the identification, screening, and analysis of alternatives.

A detailed discussion on the decision process is presented in Section 3.0. Once this process is completed and an alternate water supply is selected, the selected alternative will be designed and implemented. This design and implementation process is discussed in Section 4.0.



* DRINKING WATER ACTION LEVELS DESCRIBED IN APPENDIX D
** OUT OF THE SCOPE OF THIS DOCUMENT

Figure 2-1
Site Characterization And Determination Of Authority

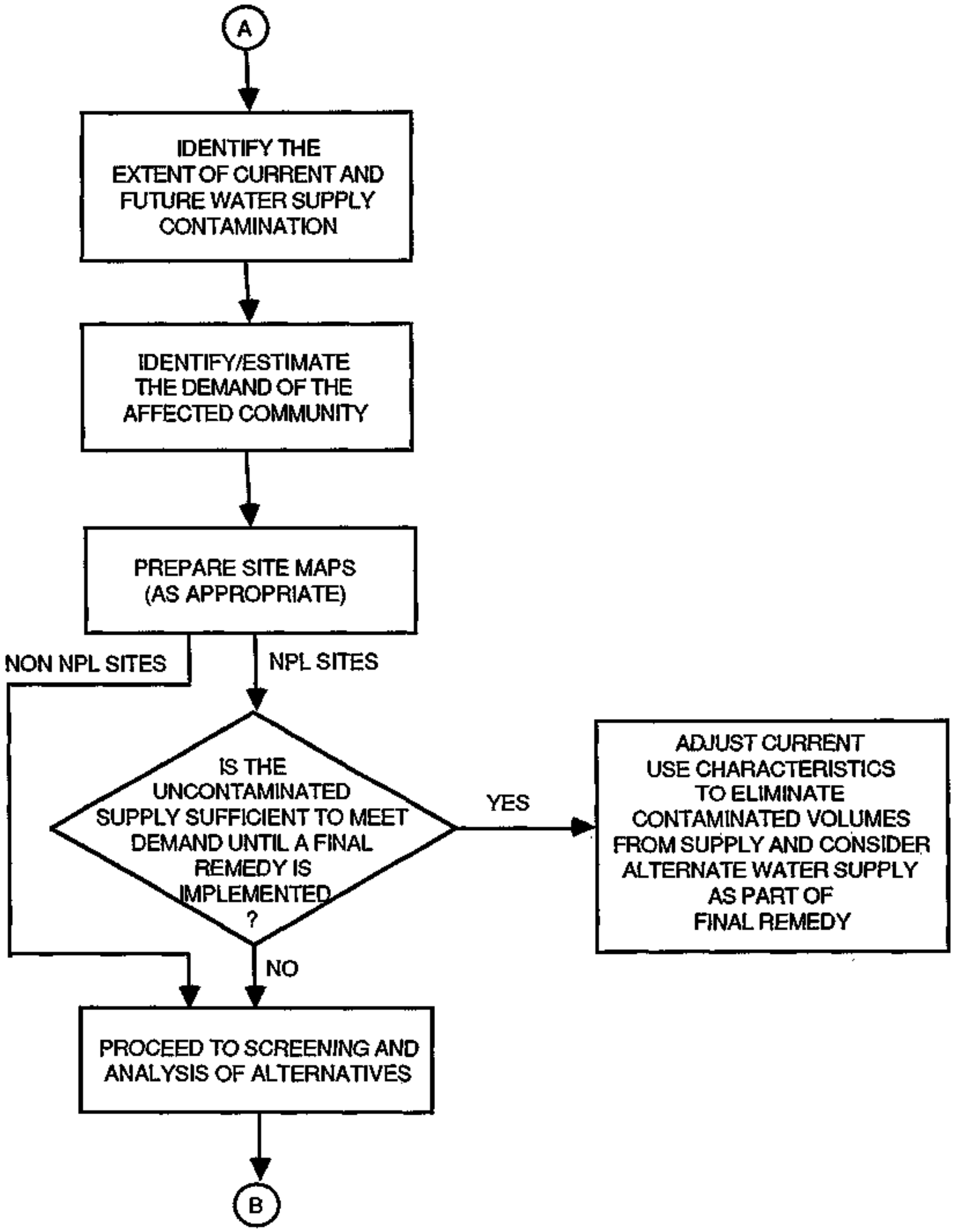


Figure 2-2
Determination Of Response Scope

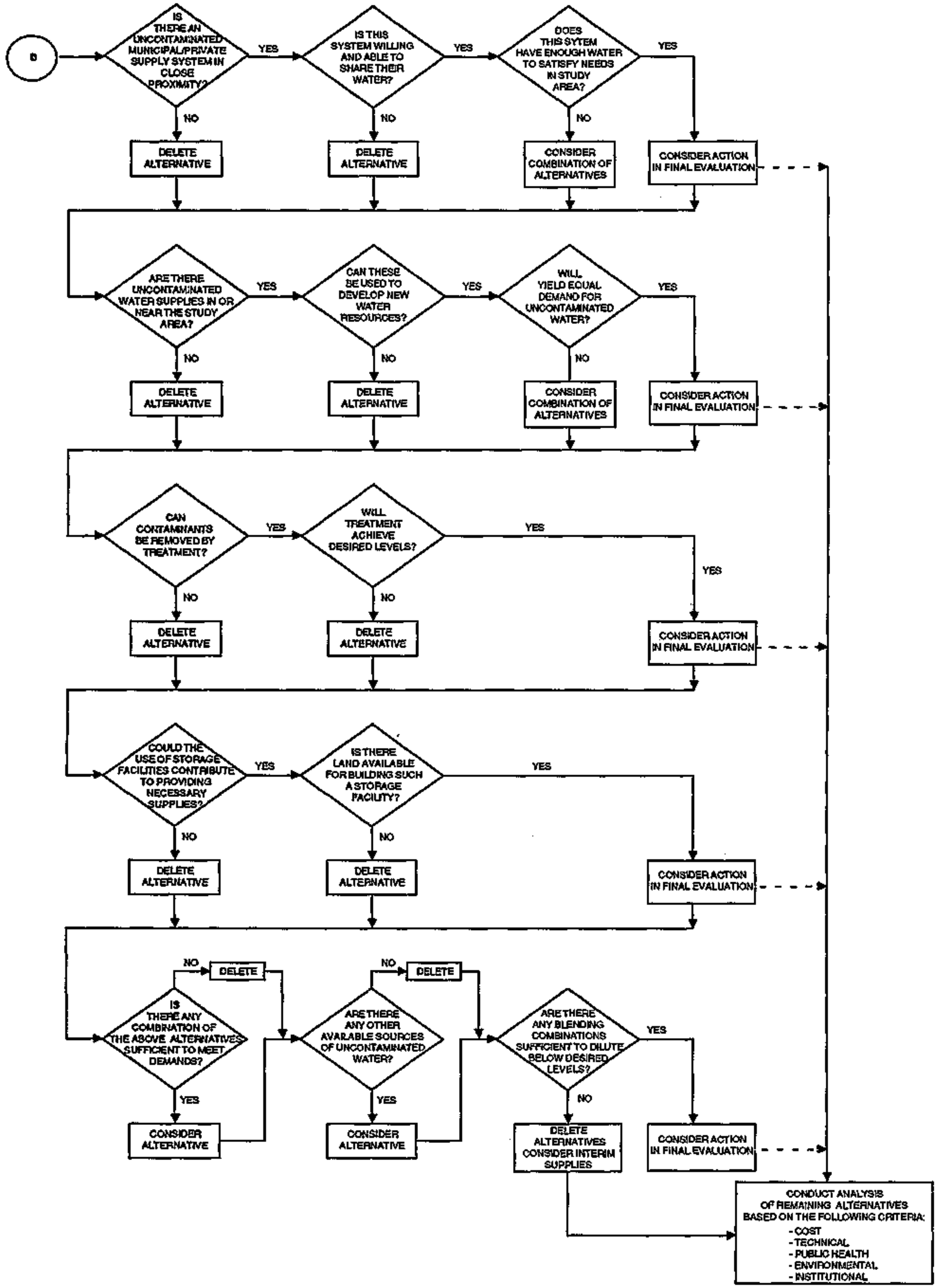


FIGURE 2-3
SCREENING AND ANALYSIS OF ALTERNATIVES

3.0 ALTERNATE WATER SUPPLY SELECTION PROCESS

3.1 SITE CHARACTERIZATION AND DETERMINATION OF AUTHORITY

The activities discussed in this section include the collection and review of data to determine the levels of contamination present and the determination of which response authority, if any, is appropriate. The information collected at this stage will be used throughout the selection and design processes to accurately define and effectively remediate the problem.

3.1.1 OBTAIN AVAILABLE DATA

Available data are collected to define water supply system conditions and provide a basis for a preliminary water supply system evaluation. Once collected and compiled, these data will also serve as the foundation of the data base that will eventually be assembled for evaluation of potential technologies and alternatives, and the design of any removal and/or remedial actions during the implementation phase. As part of this activity, a brief site history should be developed.

Information which may be needed is listed in Figure 3-1, along with potential sources. Although some information may need to be collected in each area to provide an accurate, broad perspective of site conditions, those topics at the top of the list are more critical to alternate water supply selection activities and should be the focus at this stage. The On-Scene Coordinator (OSC) or Remedial Project Manager (RPM) will determine which data are relevant depending on site-specific conditions and time constraints. As another important means of gathering information, the OSC or RPM may want to set up personal interviews with state or local authorities with jurisdiction over the site as well as any public or private water purveyors in the area. This is particularly important because of institutional concerns relating to water supplies.

Specific documents which may be investigated are listed below:

- Specifications, maps or other descriptions of the water supply system in question (if available)
- Records of average, daily, monthly or annual consumption and relationship between demand and safe yield
- Technical reports related to existing water supply system characteristics and contamination (including sample locations and analytical results, if possible)
- Results of previous surface and/or ground water sampling and monitoring programs
- Remedial Action Master Plan (RAMP) and other initial planning documents (if available, for NPL sites only)
- Site history, ownership, operations, and disposal practices (past and present) from past owners, operators, and generators
- RI/FS reports from prior site work (NPL sites only)
- Specifications or descriptions of other uncontaminated water supply systems in the vicinity of the study area (if present)
- Listing of legal or institutional constraints which may affect implementation of alternative water supply options
- Federal and State geological surveys
- Base map of study area (could be provided by local governmental agency)
- Records from local health department regarding complaints and testing of water supply
- Soil surveys or other published documents such as university agricultural extension soil data
- Aerial photographs (sequential/dated).

3.1.2 REVIEW AND EVALUATE AVAILABLE DATA AND IDENTIFY DATA GAPS

In this step, available data are summarized in formats that will facilitate their use to meet the objective of the project. In the process of reviewing and evaluating the available data, an understanding of study area conditions will be developed and data gaps will be identified. At this early stage it is important to compile information which is relevant to the existing

FIGURE 3-1
INFORMATION SOURCE MATRIX

	EPA Region	USGS	National & Oceanic Atmospheric Administration	Federal Emergency Management Agency	USDA-SCS	State Environmental Agency	State Health Department	State Water Supply Agency	State Geological Survey	Municipal/County Authorities	Local Water Authority	Other Regional Water Authorities	Local Press	Past and Present Contaminant Source Owners	Aerial Photos	Field Reconnaissance	Chem/Tox Handbooks	Local Drillers
Water Supply System Descriptions																		
System capacity						•	•	•			•							
Contamination problems	•					•	•	•	•	•	•					•		
Evaluation of water supply resource		•					•	•	•		•							
Ease of integration with other regional supply systems											•	•						
Contaminant Source																		
Wastes present	•					•								•		•		
Quantities of each waste	•					•								•	•	•		
Toxicity and persistence	•					•											•	
Current contaminant migration	•					•	•	•						•		•		
Other Regional Water Supply Systems																		
Distance from contaminated system							•	•			•	•						
Available excess capacity							•	•				•						
Ease of connection to contaminated supply's distribution system	•						•	•			•	•						
Groundwater																		
Water quality and use of local aquifers	•	•				•	•	•	•	•	•	•						
Potential for water supply development	•	•				•	•		•		•	•						
Flow direction and gradient	•	•				•	•		•		•	•						
Location of recharge areas	•	•				•	•		•		•	•						
Surface Water																		
Water quality, use and classification of area surface waters	•					•		•		•	•	•						
Drainage area and flow potential		•					•		•									
Potential for water supply development		•					•		•		•	•						
Regional and Local Geology																		
Geologic history		•					•		•									
Stratigraphy		•					•		•									
Structure and characteristics of formations		•					•		•						•			
Physiography/Topography																		
Study area slope orientation/drainage patterns		•					•		•						•	•		
Study area topography		•					•		•						•	•		
Soils																		
Soil types					•													
Extent and thickness					•													•
Hydraulic properties					•													•
Climatology and Meteorology																		
Net precipitation and evapotransportation			•															
One year 24-hour rainfall			•															
Local temperature regime			•															
Direction and magnitude of prevailing winds			•															
Infiltration potential			•															
Land Use																		
Study area land use	•					•		•		•					•	•		
Study area population density	•					•		•		•					•	•		
Study area development density	•					•		•		•					•	•		
Water Rights																		
Institutional and legal limitations	•					•		•		•	•	•						
Local restrictions, agreements, etc.								•		•	•	•						
Ecology																		
Ecologically sensitive areas in study area	•					•										•		
Significant habitats in study area						•										•		
Community Involvement																		
Community relations plan status	•					•												
Level and nature of community concerns	•					•							•			•		

water supply system, contamination problems associated with the present system, and factors affecting the applicability of alternate water supply systems. The status of information on the following areas should be determined:

- Condition of currently used water supply source including total capacity, existing treatment facilities, contamination problems, and potential for total or partial rehabilitation
- Condition of currently used water distribution system including contamination problems and potential for connection to an alternate water supply source
- Location and present condition of contamination source, if possible (e.g., are contaminants still leaving the source and entering the water supply?)
- Capabilities of other regional water supply systems including available excess capacity and ease of connection to the distribution system of the contaminated water supply system
- Hydrogeology and hydrology of water resources currently providing water supply and those which could potentially provide a water supply (ground water or surface water)
- Implications of continuing or discontinuing pumping of wells in the site area on plume movement.
- Construction details of wells in the site area (is there a potential for hydraulic conductance between two aquifers due to an existing well?)
- Geology and soils in the study area, with particular emphasis on areas between the contaminant source and water supply source.

An important part of reviewing and evaluating the available data is an assessment of its reliability (the extent to which the data represent site conditions) and quality (accuracy and precision). The dates of maps, drawings, and plans should be checked; sampling locations should be evaluated for representativeness. Analytical data should be checked, if possible, against internal laboratory QA/QC criteria (blanks, duplicates, spike/recovery) and the methods of sample collection, preservation, handling, and sampler decontamination should be examined for conformance with quality control protocols. If more than one laboratory tested samples from the same location in the study area, the results should be assessed for consistency and variations in the identified methodology.

It may also be beneficial to examine information relating to alternative response actions to ensure that available data are sufficient for the evaluation of each. Topics for which data of questionable accuracy and precision have been obtained may constitute data gaps because of the lack of reliability of the available data.

Summarizing data in graphical, tabular, or matrix formats usually provides a convenient means of evaluation. These formats are compact and allow for efficient presentation, comparison, and identification of gaps. Unless the amount of available data is quite small, some written documentation in the form of an "executive summary" should also be prepared. All summaries, whether graphical, tabular, or written, should identify both what is known, (e.g., conditions at the site), and what is not known (i.e., evident data gaps).

Following identification of data gaps, an effort should be made to evaluate the importance of the gaps and to find additional information if it is necessary for the decision making process. If additional information is unavailable, study area investigations may have to be undertaken to provide the necessary information, as discussed in the following section.

3.1.3 CONDUCT ADDITIONAL SAMPLING

Due to time involved in conducting additional sampling and analysis, existing data should be thoroughly reviewed to determine its sufficiency for use in evaluating the condition of the water supply. In many cases, the amount of available analytical data is not sufficient for decision making. In such cases, additional sampling will be necessary. Whenever possible, this sampling should include existing wells and taps in the affected area. Screening of samples for contaminants in the field or laboratory is an effective way to achieve results rapidly. Obtaining full laboratory results generally requires several weeks or more depending on the analyses performed. However, 7-day turnaround for analytical results is available through CLP Special Analytical Services. For sampling of private wells it is recommended to request low detection levels so that values below the Contract Required Detection Limits (CRDLs) are reported. Designing a strategy for siting new wells, drilling wells, sampling and analysis will take much longer. Certain portions of identifying and evaluating alternatives could be conducted simultaneously with sampling. It is important that the need for additional sampling be identified as early as possible in the selection process so that the data can be collected, analyzed, validated and interpreted with a minimum delay.

If sampling is necessary, certain documents must be prepared before initiating field activities. These documents are:

- Sampling and Analysis Plan (includes a field sampling plan and a quality assurance project plan)
- Health and Safety Plan.

The required contents of these documents may vary depending on the authority used. Guidance on the preparation of these plans has been published by EPA. The following references provide further information:

- U.S. EPA. Guidance Document for Remedial Investigations under CERCLA. OERR, OWPE, OSWER, EPA/540/G-85/002, June 1985.
- U.S. EPA. Data Quality Objectives for Remedial Response Activities, EPA/540/G-87/003 and EPA/540/G-87/004, March 1987.
- Sisk, S.W. NEIC Manual for Ground Water/Subsurface Investigations at Hazardous Waste Sites. EPA-330/9-81-002. July 1981.
- U.S. EPA. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans. QAMS-005/80. Office of Research and Development. December 1980.
- U.S. EPA. Guidance for Phase I - Fluid Quality Measurements. UIC Quality Assurance Program, Ground Water Protection Branch, Water Supply Branch. July 1984.
- U.S. EPA. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029. September 1982.
- U.S. EPA. Compendium of Field Operation Methods, OSWER Directive 9355.0-14 Office of Emergency and Remedial Response Planned August 1987.
- U.S. EPA. Safety Manual for Hazardous Waste Site Investigations (Draft), Office of Occupational Investigation Center, Denver, Colorado. 1979.
- U.S. EPA. Standard Operating Safety Guides, Office of Emergency and Remedial Response, Washington, DC. 1984.

3.1.4 DETERMINE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or relevant and appropriate requirements (ARARs) are determined on a site-specific basis.

There are a number of Federal and State standards which state specific hazard levels for contaminants in drinking water. State laws that are more stringent than Federal requirements may be ARARS. Local requirements are not potential ARARs but may be taken into consideration. The numeric values for the criteria discussed in this section are presented in Appendix C. Potentially applicable or relevant and appropriate Federal standards are described below.

In general, alternate water supplies are subject to the requirements of the National Environmental Policy Act (NEPA). Specifically, NEPA requires the production of an Environmental Impact Statement (EIS) and opportunity for public comment. Only time-critical removal actions qualify for a statutory exemption from NEPA requirements. However, providing alternate water supplies as non-time-critical removal or remedial actions may be exempt from NEPA based on categorical exclusions. OSWER Directive No. 9318.0-05 on "Environmental Review

Requirements for Removal Actions" (EPA 1987) contains more detailed guidance on the applicability of NEPA requirements to removal actions.

The EPA Office of Drinking Water has developed a series of numeric Health Advisory (HA) levels for contaminants in drinking water. Separate levels are identified for 1-day, 10-day, longer term, and lifetime health advisories. The lifetime health advisory is referred to as the drinking water equivalent level (DWEL). Under the Safe Drinking Water Act (SDWA) (P.L. 93-523) maximum contaminant levels (MCLs) for public water systems have been set for five classes of contaminants: microbiological, turbidity, inorganics, organics (including trihalomethanes) and radiological. MCLs are enforceable standards [See EPA's Guidance on Feasibility Studies under CERCLA (EPA 1985) for MCL calculations]. In addition to MCLs, EPA has set maximum contaminant level goals (MCLGs). MCLGs are health-based goals set at levels at which no adverse health effects may arise, with a margin of safety. EPA has established water quality criteria (WQC) for a number of metals and organics, many of which are associated with uncontrolled hazardous waste sites. In contrast to MCLs, WQC do not establish requirements, but instead provide guidance on the human health effects of carcinogenic and non-carcinogenic pollutants. WQC can be used where MCLs do not exist where appropriate under the circumstances.

EPA has also developed toxicity values for substances commonly found at Superfund sites based on Health Effects Assessments (HEAs). HEAs are not ARARs but are used to establish site-specific engineering design goals for remedial actions which involve hazardous substances most frequently found at CERCLA sites for which applicable or relevant standards do not exist. Compounds without HEAs will generally have a reference dose which gives a maximum intake value.

A list of available drinking water standards are presented in Appendix C. When MCLs, WQC, HAs or HEAs are not available, contact the Policy and Analysis Staff (PAS) of the Office of Emergency and Remedial Response (OERR) or the Toxics Integration Branch of the Hazardous Site Evaluation Division at OERR for guidance criteria or available advisories.

3.1.5 DETERMINE APPROPRIATE AUTHORITY

This section describes the process to be used to determine the appropriate authority to implement alternate water supplies. The removal and remedial authorities use different criteria for determining the need for action; the application of these criteria will determine which authority is to be used.

Removal Authority - The method used to determine drinking water action levels for removals is presented in Appendix D. The removal program model includes consideration of both numeric action levels and site-specific factors. The numeric action level is based on the Drinking Water Equivalent Level (DWEL) and, for carcinogens, the 10-4 Lifetime Excess Cancer Risk Level. Removal action can only be taken if the numeric level is exceeded or if site specific factors otherwise indicate that a serious threat exists. In general, removal actions to provide alternate water supplies can be performed on the basis of a future threat, if it can be determined that the numeric action level will be exceeded within 6 months. It is important to note that removal authority is invoked only in cases where no other party can respond in a timely manner. The appropriateness of using removal authority to implement non-time critical alternate water supplies will be judged on a site-by-site basis, depending on the priorities for removal resources in the region.

In general, removal actions are limited to $2 million and 12 months. Actions which will exceed these limits may not be performed under removal authority unless certain findings are made by the EPA in accordance with CERCLA 104(c), as amended by SARA. Although performed by remedial contractors, expedited response actions (ERAs) are performed under removal authority and are subject to the same requirements as all other removal actions. These statutory limits may be an important factor in determining whether to use removal or remedial authority. Responses lasting longer than 12 months and responses to widespread areas of low-level contamination may be too extensive for use of removal authority and therefore, may be more appropriately addressed by remedial authority. At non-NPL sites, removal personnel should refer such sites to the remedial program for further evaluation.

Remedial Authority - The criteria for taking action under remedial authority are more flexible than for removals; however, in order to qualify for fund-financed action under remedial authority, the site must be listed on the National Priorities List (NPL). This is not a constraint under removal authority. If an NPL site does not satisfy the criteria for initiating a removal action, it may still be possible to take action under remedial authority. Non-NPL sites, however, may not be considered for action under remedial authority.

The remedial program primarily uses MCLs or more stringent state standards where available to determine the need for action and these values are generally lower than the numeric criteria under the removal authority. In cases where these standards are not available, remedial authority will also consider reference doses, cancer potency factors, MCLGs, water quality criteria, health advisories, and state advisories. In addition, remedial action may be taken based on the threat of future contamination in cases where these criteria are not yet exceeded. If potable wells are not currently contaminated, it must be determined if they will be threatened with contamination before a final remedy addressing ground water contamination can be implemented. To make this determination, the rate of plume movement can be calculated (if the aquifer system is relatively simple) using a form of Darcy's Law. Appendix B describes the application of Darcy's Law and an approach which can be used to calculate ground water movement. Sufficient data on ground water hydrology may not be available to perform these calculations at all sites. An easier method of estimating future contamination and validating results of contaminated transport modeling is to monitor contamination levels in nearby upgradient wells. It may be beneficial to install new wells if suitable points do not exist. By considering the rate of contamination increase over time in these wells, it is possible to estimate expected impacts on the threatened water supply. In some cases, special circumstances may exist where protection of human health requires more stringent standards than MCLs. Where multiple contaminants or pathways of exposure present extraordinary risks, more stringent standards will be considered based on appropriate risk ranges for carcinogens, levels of quantification, and other pertinent guidelines.

In many cases, sufficient numeric criteria are not available and the need for remedial action will be determined by performing a risk assessment. As a rough estimate, the total maximum risk that a person would incur by drinking water contaminated with a number of chemicals for a lifetime can be estimated by calculating the excess carcinogenic risks associated with each chemical and then adding the risks together. This calculation assumes that risks are additive and that there are no synergistic or antagonistic effects. For example, production wells are contaminated with the following:

Compounds	Concentration	10^{-6} HEA or WQC
trichloroethylene	15 μg/l	1.84 μg/l
1,1-dichloroethylene	5 μg/l	.033 μg/l
1,2-dichloroethane	2 μg/l	.51 μg/l

To calculate the excess cancer risk:

Trichloroethylene

$$\frac{15}{1.84}\times 10^{-6} = 8.1\times 10^{-6}$$

1,1-dichloroethylene

$$\frac{5}{.033}\times 10^{-6} = 151.5\times 10^{-6}$$

1,2-dichloroethane

$$\frac{2}{0.51}\times 10^{-6} = \underline{3.9\times 10^{-6}}$$

TOTAL RISK = 163.5×10^{-6} = 1.6×10^{-4}

This example is presented as a possible approach for a situation where only two or three carcinogens are involved. For situations involving multiple carcinogens and/or noncarcinogens, consult the *Superfund Public Health Evaluation Manual* (EPA 1986) and seek the assistance of a competent health professional.

Direct ingestion is not the only pathway of concern in providing alternate water supplies. Other pathways such as inhaling volatile organic compounds during showers and direct dermal contact may also present risks. These pathways should be investigated. Consult the *Superfund Public Health Evaluation Manual* or contact a health professional for more information in calculating risk due to multiple pathways of exposure.

EPA uses a risk range of 10^{-4} to 10^{-7} when determining an acceptable risk level.

For more detailed information on risk assessment and criteria contact the Toxics Integration Branch, OERR. For enforcement sites, refer to the Office of Waste Programs Enforcement's *Endangerment Assessment Guidance* (EPA 1985) as well as the SPHEM.

3.2 DETERMINATION OF RESPONSE SCOPE

Previous activities established the presence of a health threat due to contamination of drinking water supplies. The purpose of activities described in this section is to determine the extent of contamination and identify the quantity of usable water available, if any. The volume of usable water is compared to the demands of the affected community to determine the need for further action. Under both the removal and remedial authority, the goal of cleanup will be to achieve MCLs at the tap. In cases where MCLs are not available, other criteria as described in Section 3.1.5, will be used.

EE/CA and FS activities will be performed using the available contractors under the removal and remedial programs according to standard contract procedures. Work will commence with either an EE/CA approval memorandum (removal) or an FS work plan (remedial).

3.2.1 EVALUATE PROBLEM EXTENT

The purpose of this task is to determine, over time, how much of the water supply will be contaminated beyond use and to what extent good quality water will be available for use. Determination of this information will involve quantifying the present level of contamination in the water supply. If ground water wells are used, determine how many wells are contaminated, how many wells are free from contamination, how many have low enough contamination for limited use, and what quantities are available for each of these categories.

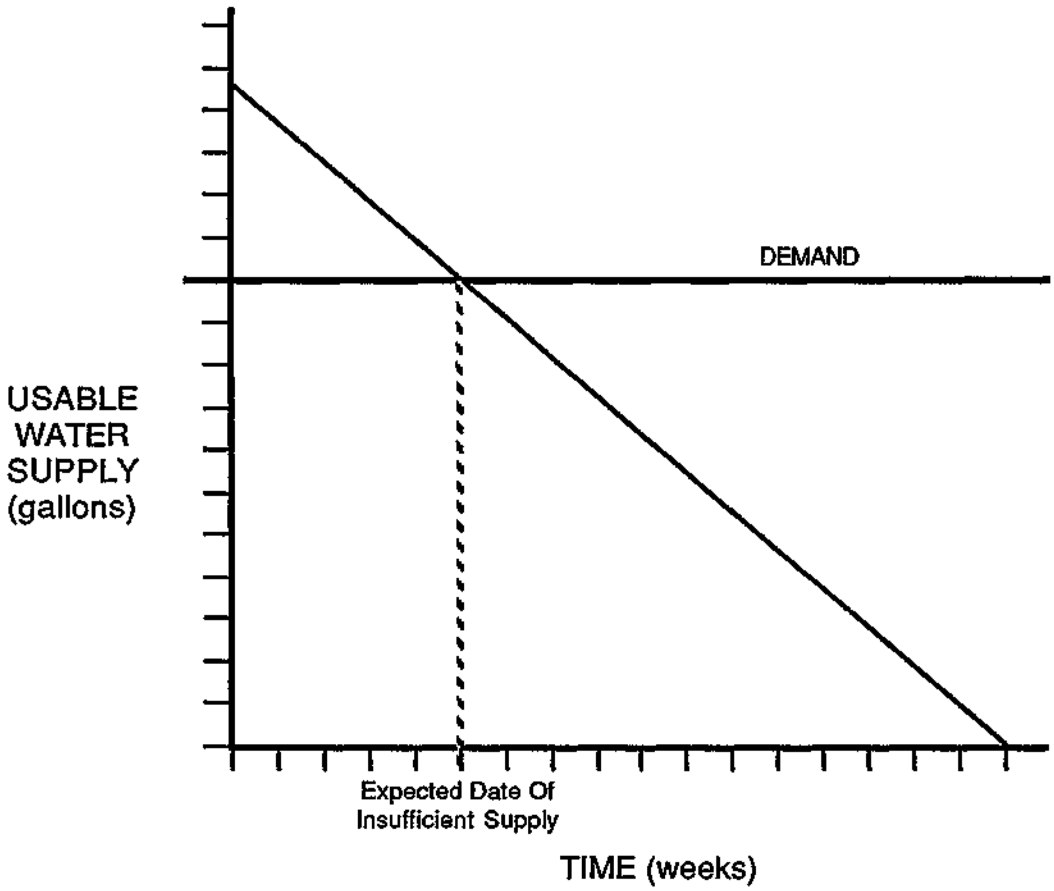
In addition to the extent of current contamination, the estimated levels of future contamination need to be considered. It is important to determine whether the amount of available uncontaminated water will be continually decreasing. The rate at which the contamination will increase can be estimated by contaminant transport modeling or monitoring of nearby wells as discussed in Section 3.1.5.

As a result of this task, a graph or table could be developed to show the presently available quantity of usable drinking water and the expected rate of change in water quality over time. An example is shown in Figure 3-2. The result is a simple curve showing the amount of usable water available over a given period of time. By overlaying the expected demand (as will be developed in the next section), it is possible to estimate when the usable supply of water will be insufficient. This information will be critical to determining the extent of alternate water supplies necessary.

3.2.2 DEVELOP DEMAND REQUIREMENTS

It is important to know the quantity of water which will have to be supplied to the affected area and if the available usable water supply can serve community needs. This information will provide the basis for subsequent design and cost criteria.

Water requirements can be calculated or estimated based on average daily, maximum daily, and peak hourly demand; however, water supplies are normally sized based on maximum instantaneous demand. These demand estimates should not include projection for future growth because Superfund does not provide for the expansion of a community and will only correct problems within an existing system. Fire protection provisions will comply with all Federal, State and local fire codes. These provisions should only require a small incremental cost, which generally would allow for providing hydrants, valves, and the means for providing adequate pressure. The National Fire Protection Association codes and Insurance Services



Availability Of Usable Drinking Water Versus Time FIGURE 3-2

Office (ISO) rates and durations should be considered during design. If an expanded remedy is desired by the State or locality for fund-financed remedial or removal actions, the State will generally have to pay the incremental cost and must have a defensible basis for dividing costs; the remedy must then be implemented as a State-lead action. This determination should be made as early as possible, usually prior to commencing the EE/CA or FS. *State Participation in the Superfund Remedial Program* (EPA 1984) contains detailed information on coordinating activities with States. Guidance for removal sites are discussed in Appendix W, *Guidance for State Lead Removals* (July 1987).

There are a number of methods which can be used to estimate the water demand. These include (in order of decreasing accuracy):

- Obtain metered consumption data for the community (both for residential and for commercial/industrial) based on historical usage
- Extrapolate from data on per capita water use rates observed by municipal supply facilities in the general area
- Estimate demand from general per capita rates. For residential use, an average daily consumption of 80-100 gallons per day per capita can be used (these values are inflated to account for system leakage). For industrial/ commercial uses the reader is encouraged to interview businesses in the area to obtain consumption data. Commercial usage is highly variable depending on the type of business. If data are not available, commercial/industrial usage can be estimated to average 2500 gallons/connection/day.
- Apply engineering judgment to estimate demand from published water use patterns and information on the size of existing equipment (Figure 3-3 indicates maximum and minimum consumption values which can be obtained if average daily consumption is known).

Metered consumption data is preferred because it is the most accurate data. However, in a small community using individual private wells, such information may not be available. In this situation, water use in areas of similar development (i.e., rural, suburban, urban) can be used to predict use in the affected community.

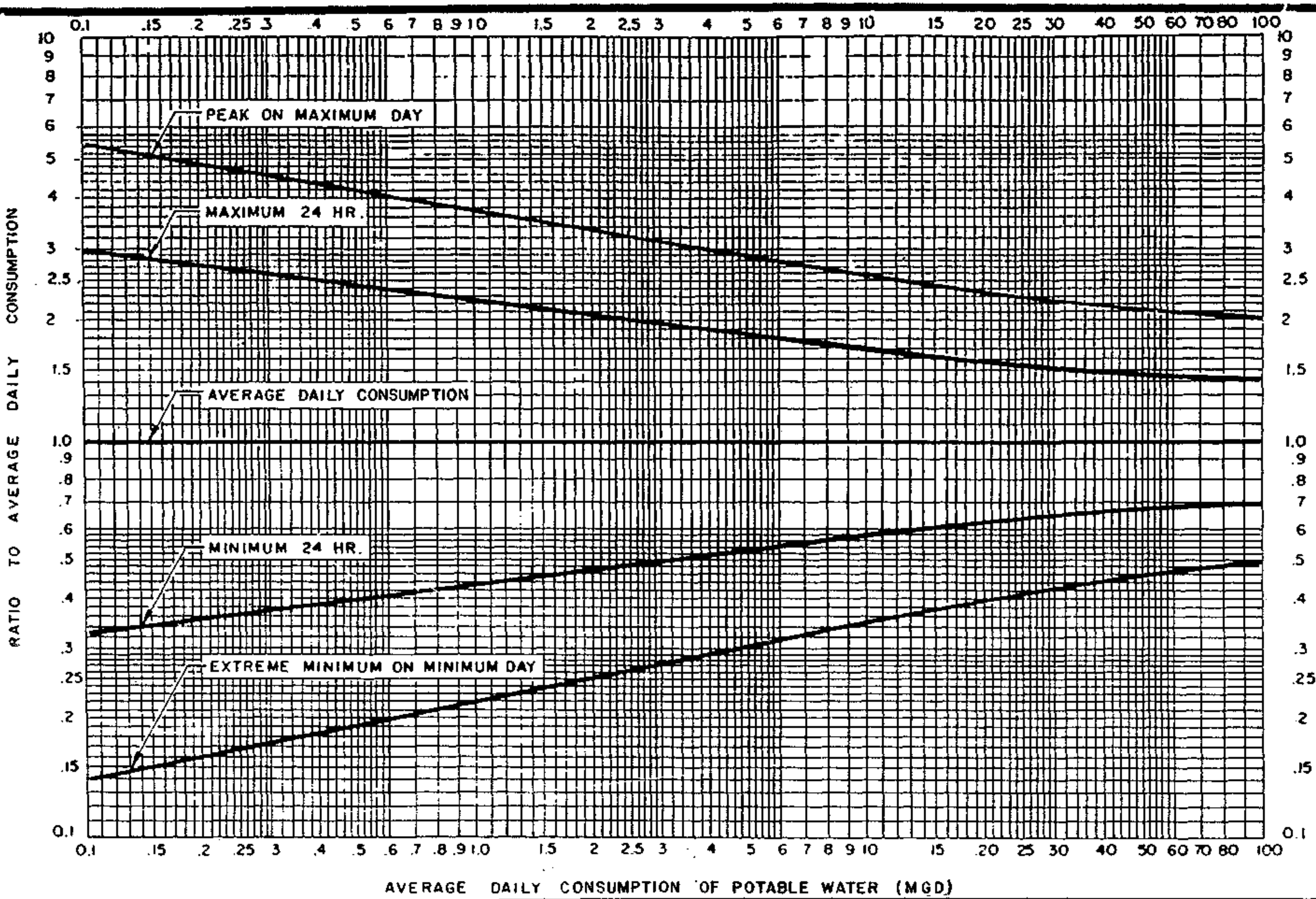
3.2.3 PREPARE MAPS

In order to accurately characterize the site, it may be beneficial to represent site conditions using maps. In instances where little data are available or where time is a constraint, the development of maps may not be warranted. They are intended only as an aid to performing the site evaluation and remedy selection.

Two types of maps may be useful in providing an accurate depiction of site conditions and the extent of contamination. Community base maps are used to show all of the relevant features of the study area that may affect design and implementation of alternate water supplies. The community base map should show all major surface features and identify areas of contamination. The map should show the affected study area, including the contaminant source and the horizontal extent of the contaminated plume. It should also show the relative location of potential sources of uncontaminated water (either existing public or private water systems and/or uncontaminated aquifers). The needs of the site should be considered in determining the degree of detail that will be required and the number and types of maps which should be drafted. Subsurface cross-sections provide an overview of soils and geology and a schematic representation of the extent of subsurface water contamination. Subsurface maps can be developed from existing site maps, soil and geologic publications, any existing soil boring and monitoring well installation reports, and analytical results of soil sampling and ground water sampling.

3.2.4 DETERMINE APPROPRIATE RESPONSE

At this point the response authority has been chosen and the health threat and amount of contamination have been quantified. If removal action criteria are met and removal authority is selected to implement action at the site, there is not a "no action" alternative. Selection of removal authority implies that timely response to the situation is required.



RELATION OF EXTREME CONSUMPTION ON MAXIMUM AND MINIMUM DAYS TO THE AVERAGE DAILY CONSUMPTION OF POTABLE WATER

FIGURE 3-3

SOURCE: WPCF and ASCE, 1970

Under remedial authority, however, no action may be taken if it can be documented that exposures to pollutants, as a result of consuming contaminated water, does not present a threat to public health. In cases where pollutants are only detected in isolated wells, an alternate water supply may not be required. This decision will be contingent upon the ability of the remaining supplies to meet the community's water needs and the assurance that these wells will not become contaminated beyond safe use before a final remedy can be implemented.

Even if no action with respect to alternate water supplies is justified, other remedial investigation and feasibility study activities may be needed to provide long term protection of public health. For example, other activities being taken at the site such as source or plume migration control may slow or alleviate contamination of drinking water. If an alternate water supply is necessary, the FS should focus solely on the provision of that water supply and not the complete mitigation of the contaminant source.

3.3 PREPARATION OF COMMUNITY RELATIONS PLAN

The details for producing a Community Relations Plan (CRP) are described in *Community Relations in Superfund: A Handbook*, (EPA 1986). Preparation of the CRP will coincide with the EE/CA or FS and should be completed prior to release of these documents.

The CRP is the planning document for managing the interaction between the community and the technical aspects of the response actions at a site. Community relations activities are an integral part of Superfund response actions and must be closely coordinated with all technical activities conducted at the site. All site related activities, all statements made to the public, and even statements not made, have the potential to affect the technical activities at the site and the community's willingness to cooperate with these activities. To expedite production of the CRP as well as to assure consistent and clear communication with the public and press, a community relations coordinator should be designated. A good community relations plan is particularly important to work related to correcting drinking water problems because such problems often involve significant community interest and concern.

If a CRP has not been prepared for the entire site, it will be necessary to prepare one which pertains specifically to provision of an alternate water supply. While this document is abbreviated, it must be consistent with CERCLA community relations policy.

3.4 IDENTIFICATION, SCREENING AND ANALYSIS OF ALTERNATIVES

Previous efforts focused on gathering data and assessing the existing contamination at the site. This section describes procedures for assessing the applicability of available alternate water supply options to the specific set of site conditions. The assessment includes, (1) the identification of the alternatives, (2) preliminary screening of water supply alternatives and (3) analysis of the alternatives which survive the screening.

3.4.1 IDENTIFY ALTERNATIVES

While there may be other possibilities, the following list covers the major categories of alternatives that have survived screening at other Superfund sites and that will be considered in this guidance document:

- No action (under remedial program only)
- Connection with an existing municipal or private supply
- Develop new uncontaminated water resources
- Removal of contaminants via treatment
- Oversized community storage facilities to compensate for loss of existing system capacity
- Blending contaminated portion of water supply with uncontaminated water supplies to reduce contaminants to safe levels.

In the development of each alternative, the efficiency of the current system or a potential existing system should be assessed. This assessment may be available from the utility or from previous work. In many cases, additional capacity may be created by taking steps to control leakage from the existing system, thus eliminating the high costs of implementing a new system. By such actions, it may be possible to increase the volume of safe water available from the current system or allow a neighboring system to provide the capacity needed.

Connection To Existing Municipal Or Private Supplies

If there is a public water supply with an uncontaminated water supply in close proximity, connection to the existing supply may be a viable alternative. It is strongly encouraged that existing supplies be used in implementing alternate water supplies wherever possible. In fact, some states have coordinated Public Water Supply Master Plans that discourage the proliferation of small public water systems in areas where existing systems have expansion capacity and a willingness to service new developments.

In general, public water supplies can be classified as publicly owned (municipally owned) or privately owned (investor owned). Private water suppliers are regulated by rates and franchise (service area) in each State, the District of Columbia, and the territories by a Public Utility Commission (PUC). Public water suppliers are generally not regulated by State PUCs; in some States, if a public water supplier sells water outside its corporate boundaries, its rates and/or franchise areas fall under the jurisdiction of PUCs.

Under the Safe Drinking Water Act, a community water supply is defined as having 15 or more service connections or serving 25 or more people substantially all year long. In general, all others are defined as non-community water supplies. Community water supplies are more strictly regulated under the Safe Drinking Water Act. Non-community water suppliers are required to monitor for acute hazards but less frequently than community suppliers. (For a complete discussion, the reader should refer to 40 CFR part 141.) Community water supplies may be either publicly or privately owned, therefore, the ownership of the water supply is not relevant when classifying community or non-community water supplies.

Depending on the type of water supply available, a number of factors must be considered to help determine the feasibility of using existing sources as follows:

Connections to a Private, Community Water Supply

- The rates charged to the new homes will be regulated by a PUC
- The more complete monitoring and reporting requirements for acute and non-acute materials under the Safe Drinking Water Act will be required
- The water company's franchise may have to be extended by the PUC.

Connections to a Private, Non-Community Water Supply

- The rates charged to the new houses will be regulated by a PUC
- The less stringent monitoring requirements under the Safe Drinking Water Act will apply (other criteria may still be relevant and appropriate, however)
- Too many new connections may cause the non-community supplier to become a community supplier
- The water company's franchise may have to be extended by the PUC.

Connections to a Public, Community Water Supply

- If the new connections are outside the community's corporate boundaries, rates may be regulated by the PUC. If the community becomes regulated because of the new connections, there may be opposition from the community. A wholesale supply arrangement where water is supplied in bulk at the townline, may preclude this problem. In addition, the community may not want to extend its system outside the corporate boundaries because such a provision could foster growth outside of the town, drawing business away from the town.
- If the community's rates to the new homes would be unregulated, there is no regulatory agency protecting the new connections from unfair charges.
- The more complete monitoring and reporting requirements for acute and non-acute materials under the Safe Drinking Water Act will be required.

Connections to a Public, Non-Community Water Supply

- If the new connections are outside the community's corporate boundaries, rates may be regulated by the PUC. If the community becomes regulated because of the new connections, there may be opposition from the community. A wholesale supply arrangement may preclude this problem. The community may not want to extend its system outside the corporate boundaries to foster outside growth.
- If the community's rates to the new homes would be unregulated, there is no regulatory agency protecting the new connections from unfair charges.
- The less stringent monitoring requirements under the Safe Drinking Water Act will apply (other criteria may still be relevant and appropriate, however).

In addition to the factors presented above, considerable institutional and political resistence may result due to the loss of autonomy caused by connection to another existing supply.

Development of New Sources

New ground water sources which may be available include shallow wells that can be drilled upgradient of the contamination source so that the ground water is unaffected by pollutants from the source. Such an approach may also serve to retard movement of the contaminant plume downgradient of the source if there is sufficient pumping. If an aquifer is located below the contaminated aquifer and is not hydraulically connected to it, new wells can be drilled in this deeper aquifer. It is difficult, however, to demonstrate conclusively the absence of hydraulic connections. Therefore, this option should only be used in cases where no other water supply is available. Finally, new wells can be drilled away from the source so that, with controls to prevent additional contaminant migration, a safe water supply can be guaranteed.

New surface water sources that may be available include streams, rivers, ponds, lakes, and reservoirs located upgradient from this site. If these surface supply sources have adequate watershed yield and quality, then they may be located downgradient of the source, provided that the surface supply is not hydraulically connected to the contaminated aquifer or, if downgradient, is a safe distance from the source.

In cases where the location of the source is unknown, it may be difficult to predict the locations of potential water supplies and detailed sampling and analysis may be required.

Removal Of Contaminants Via Treatment

Depending on the contaminants present, a treatment process can be designed to remove contaminants and reduce levels to comply with drinking water standards. Treatment of contaminated water supplies is used to provide drinkable water at the tap and not as a source remediation. The SARA preference for treatment in Section 121(b) is, therefore, not a primary consideration in providing alternate water supplies. Treatment should generally not be selected in cases where existing sources are available to meet the demands of the affected community. The treatment necessary to remove a variety of contaminants can be complex and can involve treatment trains consisting of various processes in series. Processes used can be physical, chemical, or a combination of these. Treatment alternatives require additional considerations to determine applicability to a site depending on suitable space and facilities to locate the treatment equipment. Environmental and public health assessments will need to be performed to assess any potential dangers of the treatment process itself. Many processes involve the release of hazardous gases or vapors which must be controlled as well as treatment media requiring disposal as a hazardous waste. Table 3-1 presents a matrix of potentially applicable treatment processes for a variety of pollutant types.

Physical Processes

Physical processes are those which separate the contaminants from the water stream by either applying physical forces or changing the physical form of the contaminants. In these processes, the chemical structure of the contaminants remains the same, and the

TABLE 3-1
TREATMENT PROCESS APPLICABILITY MATRIX

TREATMENT TECHNOLOGY	POLLUTANT TYPE																
	ALCOHOLS	ALIPHATICS	AMINES	AROMATICS	EHTERS	HALOCARBONS	METALS	PCB	PESTICIDES	PHENOLS	PHTHALATES	POLYNUCLEAR AROMATICS	CYANIDE	AMMONIA	TOTAL DISSOLVED SOLIDS	TOTAL SUSPENDED SOLIDS	GREASE AND OIL
CHEMICAL TREATMENT	E	V	V	V	G	P	P,F	N	N,P	G	G	N,P	F,G	G,E	N		
CHEMICAL OXIDATION	E	V	V	V	G	P	P,F	N	N,P	G	G	N,P	F,G	G,E	N		
ALKALINE CHLORINATION	N	N	N	N	N	N	N	N	N	N	N	N	E	N			
OXIDATION	G,E	P	N	F,G		F,G			E	E		G	E		N	-	
CHEMICAL REDUCTION	N	N	N	N	N	N	G	N	N	N	N	N	N	N	N		
NEUTRALIZATION	-	-	-	-	-	-	-	PH CONTROL		-	-	-	-	-	-	-	-
PRECIPITATION				F			E				G	R	N	N	N		
ION EXCHANGE							E							N	E		
WET AIR OXIDATION	X	X	X	X	X	X			X	X	X		X		N		
PHYSICAL TREATMENT																	
CARBON ADSORPTION	V	V	V	G,E	V	G,E	N,P	E	E	E	E	G,E	N	N	N		
DENSITY SEPARATION				-													
SEDIMENTATION							E									X	
FLOTATION							G										X
FILTRATION							E									X	
REVERSE OSMOSIS	V	V		C			E		E	V					E		
STRIPPING				E		E	N						N	G	N		
EQUALIZATION/DETENTION	-	-	-	-	-	-	-	PRETREATMENT		-	-	-	-	-	-	-	-

SOURCE: Adapted from Shuckrow et al, 1980

KEY
E - Excellent Performance Likely
G - Good Performance Likely
F - Fair Performance Likely
P - Poor Performance Likely

R - Reported to be Removed
N - Not Applicable
V - Variable Performance Reported for Different Compounds in the Class

X - Treatment is Applicable but not Specified in the Source Reference
- A Blank Indicates no Data Available

advantages of these systems are that the processes are usually simple, relatively inexpensive, and can be applied to a wide range of wastes. Below is a summary of these processes.

- Air Stripping - a process which removes volatile organic contaminants via mass transfer from the water phase to the gaseous (air) phase. This process is often used in combination with a vapor phase carbon system to remove the contaminants from the air before it is released.
- Steam Stripping - a process similar to air stripping used for less volatile compounds where the gaseous phase is water vapor
- Activated Carbon Adsorption - a process by which contaminated water is passed through activated carbon and soluble organic contaminants are removed from the water stream by adsorption onto the carbon
- Filtration - the removal of suspended solids from a fluid by passage through porous media
- Ion exchange - the process of exchanging toxic ions in solution for non-toxic ions using a solid ion exchange resin
- Membrane separation - the use of specifically constructed membranes to selectively reject contaminants as water passes through the membrane
- Phase Separation - physical separation of components with a specific gravity different from water, such as skimming oil and grease constituents off the top or settled solids sludge removal from the bottom of a clarifier

Chemical Processes

Chemical treatment processes alter the chemical structure of the contaminants to facilitate removal of the contaminants from the water stream. Below is a summary of some of these processes.

- Chemical reduction-oxidation (redox) treatment - this process makes use of oxidizing agents such as ozone, hydrogen peroxide, or UV/ozone to induce the oxidation of the contaminants in the water stream and to reduce or eliminate the toxicity of many toxic organics and heavy metals
- Neutralization - the additional of an acid or base to adjust the pH of the water to 7 (neutral)
- Precipitation/Flocculation - the process where coagulant chemicals such as lime or ferrous sulfate are added to the water to precipitate out dissolved solids and to agglomerate suspended solids so that they will settle out by gravity

Treatment processes are usually used in combination to remove several types of contaminants. For example, a typical treatment process could involve precipitation/flocculation with lime to remove suspended solids and metals in the water, a gravity filter to remove solids and colloidal residual material, an air stripper to remove volatile contaminants such as trichloroethylene or tetrachloroethylene, and a final polishing step with activated carbon to adsorb any organic contaminants which may not have been removed in the air stripper.

The decision on which treatment processes should be used and design criteria should be based on the type of contaminants present, data available on effective treatment processes, and (at times) on bench or pilot scale studies. For some well known and understood processes such as air stripping and carbon adsorption, enough data are available that a full bench and pilot scale study may not be necessary. However, for other lesser known processes, a properly designed study should be used to obtain removal efficiencies and design criteria.

Oversized Community Storage Facilities

If an alternate supply (or the portion of a community's supply which is not contaminated) does not have a sufficient yield to meet maximum demand, round-the-clock pumping and an oversized storage facility may provide adequate flows. It should be noted, however, that such facilities are commonly used only for demand fluctuations, fire flows, emergencies, or other situations in which the demand exceeds normal daily demand and cannot be used alone to overcome the loss of source capacity. Excessive pumping of single or multiple wells cannot be maintained for extended periods without loss of source capacity.

Blending Uncontaminated Water with Portion of Contaminated Water Supply to Achieve Safe Levels

At times, water obtained from uncontaminated or new sources (described above) may be mixed with existing supplies which result in a dilution of pollutants to levels within water quality standards or criteria. Such an approach requires daily monitoring and specialized control equipment to assure the quality of the contaminated supply remains consistently within standards or criteria. This alternative should only be used as a last resort.

3.4.2 PRELIMINARY SCREENING

The screening and analysis process was outlined in the flow chart shown in Figure 2-3. Preliminary screening indicates which of the identified alternatives may be suited for implementation, considering the specific site conditions and surrounding resources.

The alternatives in the flow chart are ordered from most desirable to least desirable. The flow chart is devised so that the user can move directly to detailed evaluation as soon as a feasible alternative is identified. In cases where time is very limited, a full scale evaluation of all potential alternatives may not be feasible. Generally, however, it is recommended that the flow chart be followed in its entirety. This is especially important because alternatives other than those considered in this guidance are not given consideration until the end of the process. The user should also note that the hierarchy of these alternatives will not be applicable to all sites and situations and all feasible alternatives should be given equal analysis before a recommendation is made.

3.4.3 ANALYSIS OF SELECTED ALTERNATIVES

An analysis is performed for each of the alternate water supply alternatives which have survived the preliminary screening. The analysis is data intensive and should only be performed for alternatives which are viable candidates.

There are five major elements of the alternative analysis:

- Engineering analysis - timeliness, performance, reliability, implementability/constructibility, and safety
- Cost analysis
- Environmental protection analysis
- Public health analysis
- Regulatory/institutional analysis.

Each of these topics is discussed briefly in the following paragraphs, however, the user is directed to the primary guidance documents referenced in Section 1.0 for supplementary information. The format presented in this guidance does not match either the EE/CA or FS process exactly. Rather, this document focuses on the information needed to prepare an EE/CA or FS specifically for alternate water supplies. In preparing an EE/CA or FS report, always use the format specified in those guidance documents.

Engineering Analysis

The user should characterize each response action alternative in terms of major equipment required (including sizes and specifications), personnel requirements, chemical and utility requirements, and specific waste disposal strategies. Using the information developed, the user should next compare alternatives using the following technical criteria:

- Timeliness - the speed with which the selected alternative can be implemented
- Performance - effectiveness and efficiency in accomplishing design objectives over the system's useful life including the ability to meet established drinking water criteria
- Reliability - operation and maintenance requirements, demonstrated performance of equipment over time, and level of operator training required

- Implementibility/constructibility - (site conditions and conditions external to the site) and availability of adequately trained operation and maintenance personnel
- Safety - on-site personnel, nearby communities, surrounding environment.

A significant degree of variation can exist between the success of techniques when applied for different wastes and in different hydrogeological settings. A tabular summary should be developed including a mechanism for presenting positive and negative features of each alternative according to engineering evaluation criteria.

Additional guidance is available in the literature on the details of potential technologies for inclusion in remedial or removal action alternatives and the use of technical comparison criteria. Specific information on particular technologies and procedures can be obtained from vendors, equipment manufacturers, and cleanup contractors.

Case studies concerning the actions which have been taken by other individuals who have faced the problem of contaminated water supplies should also provide information on potential technologies and their track records. Superfund sites with alternate water supplies are noted in Appendix A.

Cost Analysis

Costs consist of all capital outlays, general and administrative expenses, and other costs required for implementation of the remedial/removal action including engineering, design, and installation, as appropriate. Some cost data may be developed during the screening and analysis of remedial technologies and would be very useful and applicable for this more detailed analysis.

The cost analysis should take into consideration the demand requirements determined according to the guidelines discussed in Section 3.2.2. If an alternative includes a distribution system, the cost of constructing the distribution system should be included. The cost of connecting existing households to the alternate water supplies will also be included. EPA does not provide specific consideration for future development (e.g., while EPA will not preclude the owner of an empty lot from extending a service connection to buildings once the property is developed, EPA will not consider the possibility of such future connections in determining the size of the mains to be installed or the water supply necessary to provide an alternate water supply). Whenever possible EPA will use existing distribution systems or work with the public utility to provide new distribution systems so that the cost of constructing the distribution system is not borne by EPA.

The following list presents several costs that should be considered and quantified (discounted to present worth) during a cost analysis:

- Engineering expenses, such as technical services related to drilling, sampling, testing, designing, managing, and reviewing the response action
- Land-related expenses for the rent or purchase of right-of-ways easements, as well as expenditure for land/site preparation (if no other options are available for providing the distribution system)
- Construction costs including direct outlays for equipment, hardware, materials, and labor
- Transportation and other costs associated with the disposal of wastes (including soil and sediments generated from drilling operations if drilling occurs into contaminated soils) at an approved off-site facility
- Start-up costs including operator training, temporary professional services, additional testing, monitoring, processing contracts, and equipment and materials transport.

All known costs associated with construction should be included because these costs will be used for budgeting purposes. EPA does not provide the funds for operation and maintenance of the system; however, these costs should be included in preparing a budget to provide a total cost of the system.

The discount value for purposes of the present worth analysis should be 10 percent.

Environmental Analysis

Provision of an alternate water supply would generally not consider mitigation of environmental risk; however, selected technologies must be analyzed for possible increased risk to the environment. The analysis should focus on the adverse and beneficial impacts of each response alternative. Some alternatives involve elements requiring significant construction activities which may result in various negative environmental impacts; however, these impacts are typically short-term in nature. Other alternatives, such as operation of a treatment facility, may require the handling of hazardous materials. This situation may increase the risk of exposure or accident and these impacts are more long-term.

Potential adverse environmental impacts which may preclude the use of each alternative should be identified. Major actions required to implement each alternative must be identified and a determination made as to whether any of these actions will or could result in adverse environmental impacts.

Alternatives that cause significant adverse impacts or do not adequately protect the environment should be eliminated; the reasons the alternatives were eliminated should be documented. Beneficial impacts of a response action alternative should be balanced against any potential adverse impacts. The following issues must be considered:

- Discharges of contaminants to the air, land, ground water, or surface water
- Disruption of normal community activities due to construction- related impacts (e.g., subsurface construction)
- Characteristics of long-term system operation which may create a disruption or nuisance to the surrounding community
- Failure of alternative system to effectively and reliably remove contamination and provide potable water of adequate quality and quantity to the service area
- Processes which increase the area and/or level of contamination in the study area.

Public Health Analysis

Public health analyses must be addressed to ensure that the alternative mitigates the actual or potential threat to public health presented by the contaminated supply. Remedial alternatives are generally designed for risk level in the 10-4 to 10-7 range, consistent with 300.68(c) of the NCP revisions.

Impacts of the alternatives should also be considered. For instance, in very small communities, economies of scale may make central treatment a high cost response alternative. In such cases, use of home treatment devices (e.g. granular activated carbon) may represent a lower cost option. This option, however, would need to be considered with a centrally coordinated maintenance and monitoring program which complies with State and Federal policy, as activated carbon requires regular regeneration to provide adequate treatment and prevent the growth of microbes. Improperly constructed new wells can provide an effective conduit for wastes to move from a contaminated aquifer to an uncontaminated aquifer. Safety considerations (worker health and safety during construction and general safety features associated with the site, e.g., protection of personnel from moving parts of pumps) will include those that must be implemented both during and after implementation of the selected strategy/technology.

Regulatory and Institutional Analysis

An analysis of Federal and State applicable or relevant and appropriate requirements (ARARs) is necessary to understand the possible impacts of implementing the response action alternatives. These statutes and regulations may directly impact overall feasibility, technical feasibility, engineering, design, costs, and schedules associated with any or all of the alternatives. Local regulations may also require consideration. For example, a certain water district may be forbidden from selling water to an adjacent town. Thus, this analysis must be completed as early as is feasible so that regulatory constraints can be identified and incorporated into subsequent analyses. Any alternatives which would be precluded or prohibited because of regulatory restrictions may not warrant further consideration. It should be noted, however, that Section 121 of SARA specifies six situations in which ARARs may be waived. These waivers should be investigated prior to ruling out a desirable alternative. Appropriate officials at the Federal, Regional, State, and local levels should be contacted to review response actions being considered for providing the community with alternate water supplies. ARARs must be determined on a site-specific basis.

As described in Section 3.1.5, State standards and criteria must be considered in evaluating possible remedies for remedial authority sites. Generally, the remedial action selected will meet State standards that are applicable or relevant and appropriate when more strict than MCLs. If State standards are waived, the action must fit one of the waivers identified in section 121 of SARA. These waivers will be discussed in more detail in the proposed NCP. Removal actions will attain or exceed ARARs or other Federal and State environmental and public health laws to the maximum extent practicable considering the exigencies of the situation. Specific information on ARARs is presented in the *CERCLA Compliance with Other Laws Manual* (EPA 1987).

Information on the responsibilities, authorities, and potential roles of Federal agencies during the planning and implementation of a remedial action is presented in Guidance Document for Feasibility Studies under CERCLA (EPA 1985). The document also includes an extensive list of regulatory requirements which potentially apply to the implementation of a remedial action alternative.

Comparison of Alternatives.

A method for evaluating options is presented in Table 3-2. Alternatives with high costs and few public health or environmental benefits should be eliminated. Those options with unacceptable adverse environmental impacts or public health risks would be eliminated. In addition, alternatives with design limitations or which are marginally proven would be given a low priority due to the length of time generally required to implement such remedies. This evaluation process will result in selection of a recommended alternative or range of alternatives for presentation to EPA.

3.4.4 RECOMMENDED ALTERNATIVE

Based upon the results of the detailed analysis, a potential remedial action/removal action alternative will be selected by EPA that can be implemented in a cost-effective, technically feasible, and environmentally acceptable manner.

3.5 PREPARE EE/CA OR FS REPORT

Actions performed under removal authority (including ERAs) will require an EE/CA report; remedial authority activities will require an FS report. The purpose of the EE/CA and FS reports is to present the results of the study and to provide the community with an opportunity to review and comment on the Agency's alternatives and recommended response.

These reports should be consistent with the appropriate guidance. The EE/CA and Feasibility Study Guidance Documents contain information on the appropriate report format and specific contents of each report.

3.6 PUBLIC PARTICIPATION

Following completion of the EE/CA or FS report, a 21-day public comment period is conducted under both authorities. This is to provide the public with an opportunity to comment on proposed actions before the design and construction process begins. This public input is then considered in selecting the final remedy. A public hearing may also be conducted for local citizens to voice their concerns and opinions. Under both authorities, all relevant information pertaining to decisions made for the site is placed into an administrative record and a local information repository is established. Revisions under consideration for the NCP may extend the public comment period to 30 days.

3.7 SELECTION OF REMEDY

Following the public comment period, a remedy will be selected from among the alternatives for implementation at the site. The alternate water supply remedy should be consistent with the final remedy for the site and in accordance with the guidelines in the NCP for the respective program. The selected remedy should represent the best balance across all of the engineering,

Table 3-2 EXAMPLE OF DECISION MATRIX

Alternative	Cost ($1,000) Capital	Cost ($1,000) Present Worth	Public Health Concerns	Environmental Concerns	Technical Concerns	Community Response Concerns	Others
1. No action	----	----	Unacceptable exposure to PAH during summer or during fires.	Continued migration of contaminated groundwater.	----	High resistance.	
2. Connection to Minneapolis water system	250	8,102	Reduces public health threat to less than 10^{-6} (migration).	Does not control groundwater.	Relies on simple technology.	Acceptable.	Has significantly higher O&M and present worth cost.
3. Drill deeper wells to underlying formations	1,870	2,916	Reduces public health threat to less than 10^{-6}.	Does not control continued groundwater migration. Depletes limited water resources in deeper aquifer.	Relies on proven technology.	Acceptable.	Has second highest present worth cost.
4. Aquifer treatment							
A. Ozone	374	1,618	Removes taste and odor but results in 10^{-5} to 10^{-6} risk (2,000 ug/L for noncarcinogenic PAH).	Blocks migration and allows additional wells to be opened.	Not used on wide scale. o Less responsive than granular activated carbon to slug loading. o Would be expensive to retrofit if treatment goals change. Certainty that target risk levels will not be consistently met is low due to operational inflexibility.	Acceptable.	Present worth is less than GAC at low treatment level, but greater at recommended (lowest risk) level.
	459	2,109	Results in 10^{-5} to 10^{-6} risk (1,000 ug/L for noncarcinogenic PAH).				
	709	2,434	Results in 10^{-6} or less risk (280 ug/L for noncarcinogenic PAH).				
B. Granular activated carbon (GAC)	633	2,150	Removes taste and odor but results in 10^{-5} to 10^{-6} risk (2,000 ug/L for noncarcinogenic PAH).	Blocks migration and allows additional wells to be opened.	Considered best available technology. Proven over a wide range of operating conditions. Responds well to slug loading.	Acceptable.	
	633	2,263	Results in 10^{-5} to 10^{-6} risk (1,000 ug/L for noncarcinogenic PAH).		Likely to meet risk target consistently.		
	633	24,050	Results in 10^{-6} or less risk (280 ug/L for noncarcinogenic PAH).				Present worth is at recommended treatment level.

* SOURCE: U.S. EPA. 1985. Guidance Document for Feasibility Studies Under CERCLA.

protectiveness, and cost factors examined in the analysis as presented in Section 3.4.3.

Under remedial authority, the selected remedy will be developed and presented in the Record of Decision (ROD). The ROD will contain an accurate and complete summary of the site, the threat it poses, the selected remedy, as well as the relative strengths and weaknesses of each alternative considered and a clear justification for the final decision that is made. Under removal authority, the selected remedy will be developed and presented in an Action Memorandum. The Action Memorandum also provides a site description, threat characterization, and justification for the final removal action selected.

4.0 ALTERNATE WATER SUPPLY DESIGN AND IMPLEMENTATION

This section outlines procedures for designing and implementing an alternate water supply system. The procedures and requirements for selection, design, and implementation will vary according to the lead agency involved. This document discusses the general procedures involved in Federal-lead cases. For more complete guidance on developing State Superfund contracts, cooperative agreements, contract documents and implementing remedial actions, the user should consult EPA's *Superfund Remedial Design and Remedial Action Guidance* (June 1986) and other appropriate documents. For removal sites, consult the *Technical Assistance Team (TAT) Contract Users Manual* (Draft, August 1987) and the *Emergency Response Cleanup Services (ERCS) Users' Manual* (Draft, August 1987).

4.1 DESIGN AND IMPLEMENTATION PROCEDURES

Source, treatment, and distribution facilities are the principal components of an alternate water supply system. Previous sections have discussed the identification and investigation of potential new sources for an alternate water supply. This section will discuss design and implementation procedures.

4.1.1 GENERAL CONSIDERATION

Most states require the approval of plans and specifications for public water supply facilities before construction begins. System additions, major alternations and new installations come under this provision. Over the years, the review agencies have established minimum design requirements and standards. New facilities should be in compliance with these standards where possible.

The design engineers are advised to meet with regulatory agencies in the early stages, preferably during preparation of the predesign reports. State or local engineers are often able to contribute helpful information to assist designers because of their experience and knowledge of local conditions. Consultation with agencies such as the U.S. Geological Survey and U.S. Public Health Service is also recommended to obtain as much basic information concerning the proposed project as possible.

A safety factor is usually considered on the basis of system capacity. The rated or nominal capacity of the water supply system should exceed the maximum daily water demand. For systems comprising more than one system, the combined capacities should exceed the maximum daily demand.

Careful survey work is recommended to eliminate expensive changes and revisions in the design stage, during construction, and after completion. Investigation of soil conditions is necessary to determine protective coating requirements, excavation procedures, permissible foundation pressures, design of anchor or thrust blocks and level of water tables.

4.1.2 TREATMENT PROCESSES AND FACILITIES

The quality of the source, its variations and possible future changes, and the cleanup levels form the basis for selecting a treatment process. The proven and simple processes are preferred, especially for actions with time constraints. Alternative and innovative technologies, though preferred by SARA, generally require longer periods of time for implementation and are not as reliable as proven technologies and thus may not be appropriate for alternate water supplies. For highly contaminated water, a more conservative allowance for standby units should be applied than might be required for a single contaminant, as reliability becomes more difficult to attain.

Site selection and acquisition for new treatment and storage facilities are likely to be time consuming. An accurate estimate of area required is important. This can be determined by a preliminary layout of tanks, buildings, and pumping and storage structures. Physical characteristics of new treatment facilities site will affect construction. Flooding, foundation conditions, ground water level, and site preparation, including clearing, grading, and drainage, are factors which directly influence the cost of construction. Flood records should be carefully examined because protection against flooding is essential.

The availability of electric power must be ascertained. A site for treatment facilities linked to more than one source of outside power is favored with respect to continuity of operation.

4.1.3 TRANSMISSION AND DISTRIBUTION FACILITIES

Surveying and laying out of pipelines are affected by both the size of the line and its location. More details and care are necessary as the size increases and as a line passes from rural to urban areas.

In general, a plan and profile, together with certain other details, are necessary for any water pipeline. The AWWA Manual of Water Supply Practices recommends including the following:

- Horizontal and vertical distances, either directly or by survey station and elevation
- Location of angles or bends, both horizontal and vertical (point of intersection preferred)
- Degree of bends, degree or radius of curves, tangent distances for curves, or external distances if clearance is required
- Points of intersection with pipe centerline for tees, wyes, crosses, or other branches, together with direction--right or left hand, up or down--or angle of flow, viewed from inlet end
- Location and covering length of all valves, pumps, meters or other fittings
- Location of adjacent or interfering installations or structures
- Tie-ins with property lines, curb lines, road or street centerlines, and other pertinent features necessary to define right-of-way and locate pipe centerline clearly
- Details or descriptions of all specials, together with other data required to supplement AWWA standards
- Details, dimensions, and class designation or other description of all flanges and mechanical field joints
- Any special requirements affecting the manufacture of the pipe or installation procedures.

4.1.4 STORAGE FACILITIES

Present and future storage requirements are to be considered for the design of the storage facilities. The required storage capacity must provide for the following:

- Hourly fluctuations--total volume required to meet hourly consumption fluctuations on days of maximum demands (generally taken to be a percentage of the maximum daily demand). Fluctuation volumes above the maximum daily demand rate are estimated using the projected peak hour to maximum daily demand ratios. This consideration helps to dampen hourly demand fluctuations at pumping stations, thus reducing operation costs.
- Fire Flow--based on the rates and durations established by the ISO. This consideration helps to reduce pumping station capacity and construction cost.
- Emergencies--A volume of water for emergencies in case of pipeline breaks, mechanical equipment malfunctions, or power failure. Emergency storage is not required if full standby power and a back-up water supply is provided. However, if standby power is not provided, and/or a back-up water supply is not provided, the volume of active storage that is generally recommended is equivalent to the average daily demand volume.

4.2 TREATABILITY STUDIES

Before designing an alternate water supply system, treatability studies and pilot testing may be required if water treatment is the selected alternative. Performing treatability studies will delay the implementation of alternate water supplies and should only be performed if necessary. Sites with standard types of contaminants and using proven treatment technologies will not generally require studies to be performed. The following sections discuss the purposes and procedures of bench-scale and pilot-scale testing.

4.2.1 BENCH SCALE

Treatability studies may be required to evaluate the effectiveness of a treatment scheme. If treatment is recommended, studies should be conducted as soon as practicable. Treatment of both toxic organic and inorganic contaminants may be considered. Appendix E (adapted from Shuckrow et al. 1980) presents the applicability of various treatment processes to the hazardous substance list. For more details, review *Concentration Technologies for Hazardous Aqueous Waste Treatment*, (Touhill 1981). Depending on the number and type of pollutants found in the water supply, two or three treatment technologies are generally selected for possible use. The process which will remove the worst contaminants most effectively will be the first examined during the bench-scale studies.

To monitor the effectiveness of the bench-scale testing, representative compounds are selected from each pollutant group and are traced through the system. The representative compound should generally be the most difficult to remove by the selected treatment process. For example, if carbon adsorption is the chosen treatment process, the compound with the lowest adsorbability should be analyzed. The selection of representative indicator compounds should be made, however, on a site-by-site basis; this will promote high quality response activities.

Once the carbon adsorption system reaches equilibrium, a complete priority pollutant scan (if appropriate) can be run to determine if the removal of contaminants was successful. If the water is still above cleanup levels, additional treatment may be required. Other processes may also have to be tested.

4.2.2 PILOT SCALE

Before final design of a treatment process is completed, pilot testing may be necessary. Because of budget and schedule constraints, proven conventional technologies are often favored for alternate water supplies. There may be sufficient data available on these technologies that pilot testing would not be required. The goal of such studies is to verify the applicability of processes previously tested on a bench scale, to refine the design criteria, and to obtain an estimate of O&M costs. If bench scale testing cannot be conducted (e.g., air stripping of volatile compounds), pilot studies may be required. Data are usually available for predicting size requirements without pilot testing for common processes such as air stripping and GAC treatment. Such data may be obtained by consulting equipment manufacturers or EPA personnel responsible for implementation of treatment alternatives at previous sites (see Appendix A).

Bench scale testing can provide adequate data for conventional treatment plant design and processes. A conventional treatment process includes chemical addition, mixing, flocculation, sedimentation and filtration. Pilot testing is often appropriate for non-conventional treatment processes or for conventional plants which treat waters containing multiple contami nants. The time required to conduct pilot testing depends on the selected process and the water quality. The following requirements should be considered for pilot studies.

Operating Conditions - Once a treatment alternative is chosen, the purpose of a pilot study is to collect operating data and to refine the design parameters for full scale design of the treatment system. Due to limitations in time and money, a pilot test typically investigates a small range of operating conditions. These conditions are often chosen based on previous bench scale test results, on other full-scale plant operating data, or on literature information. As a general rule, all pilot processes should be tested at two significant loading concentrations of the influent water, at normal or "average" conditions, and at high or "stressed" conditions.

Design parameters typically refined in pilot studies include chemical dosages for precipitation/flocculation systems, air to water ratios in air strippers, and carbon usage rates for activated carbon adsorption. To save time and money in the laboratory analyses, a few compounds are selected as the indicator compounds and are analyzed for during the study, typically hose which are the most toxic or the most difficult to remove by the treatment process. However, extensive analyses should be done for all known contaminants on occasion to confirm that the effluent meets the drinking water standards.

Duration of Testing - The length of time required to conduct a pilot study is dependent on various factors. Certain processes require time to stabilize before steady state operating data can be collected. For example, an air stripping process will stabilize after several minutes (e.g., an air flotation process will stabilize within 30-60 minutes). Once the process is stable, data should be collected for at least a few weeks to assure that the process is achieving the desired results. Another factor affecting the duration of the test is the number of parameters studied. An increase in the number of parameters which are varied and analyzed will result in a longer period of process stabilization and require more time in which to collect data. A third consideration is the variability of the contaminants in the water source. This can be accounted for by operating the pilot facility, either continuously or intermittently, as appropriate, for sufficient time to cover the variation in raw water quality. State requirements for duration and time of year for pilot testing should be taken into consideration.

It is possible, in some cases, such as in carbon adsorption studies, to reduce the time required to obtain test results by using small, highly loaded units. This type of bench-scale study can be done in a laboratory rather than in the field.

Installation and Configuration - Since the goal of a pilot study is to obtain design parameters and to confirm process effectiveness, the pilot plant should simulate as closely as possible the full-scale process. As a rule of thumb, a pilot plant should operate at a flow of 5 percent of the full scale plant. However, the actual flow of the pilot plant may be determined by economics, equipment availability, and the extent to which scale up difficulties are present (i.e., processes which do not scale up well should have pilot plant flow rates as high as economically feasible).

It is also possible to have various units in a pilot plant which do not treat the same flow. In this case, the flows through the plant can be split into various streams testing multiple processes or operating conditions simultaneously.

Mobile and Prepackaged Pilot Plants - For many applications, it may be more economical and feasible to lease a mobile pilot plant. Various manufacturers offer mobile treatment systems which include air strippers, carbon adsorption, reverse osmosis, filtration, metals removal, neutralization and biological processes. Also, if a specialized or proprietary process is being considered, it may be necessary to use a manufacturer's pilot system to determine the technology's effectiveness.

The use of these services may include sampling, analyses and report preparation, or the manufacturer may just provide the equipment and the contractor would design and operate the entire pilot study.

4.3 CONTRACT DOCUMENTS

In general, an alternate water supply design will contain the General Condition section which contains contractual language similar to most construction projects. The next section, the Technical Specifications, outlines how the work will be conducted. Table 4-1 represents a typical table of contents in the Technical Specifications section. Much of the material under Division 1 presents the project requirements. Divisions 2 through 17 focus on the special conditions and detail how these conditions are handled. The drawings for an alternate water supply system have the same purpose as drawings for construction-related projects. These drawings include the following:

- Cover sheet with project name, location map, agency, engineer, etc.
- Grading, landscaping, and drainage plan around any major structures
- Plan and profile of all pipelines
- Structural, architectural, mechanical, plumbing, HVAC, and electrical drawings, detail sheets
- Typical installation drawings for individual home treatment devices.

Table 4-1 TYPICAL TABLE OF CONTENTS FOR TECHNICAL SPECIFICATIONS

Section No.	Description
	DIVISION 1 - GENERAL REQUIREMENTS
01010	Summary of Work
01030	Special Project Procedures
01060	Regulatory Requirements
01340	Submittals
01510	Temporary Facilities
01590	Support Area Facilities
01601	Control of Materials
01671	Temporary Site Utilities
01700	Contract Closeout
	DIVISION 2 - SITE WORK
02100	Site Preparation
02221	Trenching, Backfilling, Compaction and Grading
02223	Granular Fill and Clay Materials
02444	Chain Link Fence
02585	Loaming and Hydroseeding
02596	Sheeting and Filter Fabric
02611	Concrete Pipe
02612	Reinforced Concrete Pipe
02615	Cast-Iron Pipe
02616	Ductile Iron Pipe and Fittings
02617	Steel Pipe
02618	Corrugated Metal Pipe
02622	High Density Polyethylene Pipe and Fittings
02625	Concrete Cylinder Pipe Fittings
02640	Valves, Cocks and Hydrants
02660	Water Wells
02734	Groundwater Monitoring Wells
	DIVISION 3 - CONCRETE
03200	Concrete Reinforcement
03250	Concrete Accessories
03300	Concrete
	DIVISION 5 - METALS
05500	Miscellaneous Metal
	DIVISION 6 - WOODS AND PLASTICS
06100	Carpentry Work
	DIVISION 11 - EQUIPMENT
11201	Sluice Gates
11202	Slide Gates and Weir Gates
11240	Liquid Alum Feed System
11241	Liquid Alum Storage Tanks
11242	Polymer System
11312	Pumps
11313	Automatic Pump Assembly
11372	Compressed Air Supply Equipment
11373	Trench and Sump Ventilation and Heating
	DIVISION 13 - SPECIAL CONSTRUCTION
13122	Prefabricated Metal Building
13124	Treatment Trailer
13411	Steel Tanks
13416	Trailer Mounted Storage Tank
13573	Treatment Operation Protocol
13574	Bulking and Consolidation Protocol
13575	Waste Material
13576	Transport of Hazardous Materials
13577	Disposal of Chemical Wastes
13600	Instrumentation

Table 4-1 (Continued)

Section No.	Description
13700	Materials and Equipment Decontamination
	DIVISION 15 - MECHANICAL
15061	Steel Pipe and Fittings
15062	Cast Iron Pipe
15064	Plastic Pipe
15101	Gate Valves
15102	Butterfly Valves
15103	Ball Valves
15107	Pressure Regulating Valves
15108	Solenoid Valves
15113	Valve Operators
15100	Valves and Appurtenances
	DIVISON 16 - ELECTRICAL
16000	Electrical - General Provisions
16110	Raceways and Fittings
16310	Unit Substations
16460	Tranformers
16470	Panel Boards
16480	Motor Control Center

4.4 CONTRACTING PROCEDURE

Design and construction of an alternate water supply for a non-time critical removal action or an operable unit remedial action is usually performed by contractors who can successfully compete with other firms during the selection process. Removal authority may also use Emergency Response Cleanup Services (ERCS) in cases where there is not sufficient time to perform site specific contracting. Site specific contracts are encouraged whenever possible. A contractor that meets the technical re quirements of the job responsibly and cost-effectively is selected. Sepa rate firms will be selected for design and construction. The design firm may provide construction management services and perform the contracting functions required to obtain a construction contractor. It is essential that contract documents completely and accurately define all the work required and comply with the Construction Specification Institute (CSI) format and any State requirements.

The bidding and contract requirements define the conditions under which the contractor must perform the work. A number of financial options may apply to a particular contract, such as lump sums and unit prices. The contract bid may be based upon one or a combination of these options. The purpose of these contracting options is to provide a mechanism by which numerous bids may be compared.

A brief discussion of these contract bid options is presented below.

- Lump Sum Contract - A lump sum contract requires the bidder to determine project costs and to undertake the services outlined in the project plans. This method requires the contractor to accurately interpret the plans and specifications, as well as unusual conditions. This will help estimate project cost; one price covers all work involved. A complete design is also required which identifies project risks.
- Unit Price - A unit price contract requires bidders to estimate the materials required to prepare the site, install pipelines and appurtenances. The contractor then determines the project costs on a per unit basis; this number is extrapolated to the estimated number of units. The sum of these costs is the bid price. The contractor is paid for the number of units completed during the work assignment. This allows for flexibility and insures that the contractor will be paid for all work actually accomplished. This contract balances the risk between the contractor and EPA.

A combination of the described bid options above can be used.

4.4.1 LUMP SUM CONTRACT

The lump sum contract, is most applicable for pricing the well-defined elements of the work. These elements include:

- Mobilization - up front costs such as insurance, bonding requirements, obtaining project-specific licenses and permits, and the development of site-specific contingency and health and safety plans.
- Site Preparation - typical construction related activities such as roadways, clearing, and grading.
- Structures and Equipment - building and vault foundations, superstructures and equipment including pumps, generators, treatment units, electrical, and HVAC.
- Temporary Facilities - support facilities such as trailers, laboratory and utility hook-ups.
- Demobilization - payment for decommissioning utilities, final grading and reporting requirements.

4.4.2 UNIT PRICE CONTRACT

Unit pricing provides a fixed unit price (e.g., per linear foot, per cubic yard and/or tons), at the time of bid. This unit price is determined for an estimated quantity of units rather than a set quantity, because specific conditions, such as number of drums to be handled, may not be known. The unit price system provides contractors with a mechanism that will pay for *all* work completed, regardless of original estimates.

Unit pricing requires that the price quoted for each unit include the cost for all required labor and equipment. Typical unit cost items include: excavations, piping (including trench excavation), concrete, paving, hydrants, individual home treatment units, wells, drilling and associated piping, house connections, and water treatment units. These price quotes are generally considered firm unless there is a significant change in conditions or if there is a major increase or decrease in the original estimate; a 15 percent margin around the price quote is standard. Deviations above or below this margin lead to renegotiation. The unit price concept can accommodate changes and provides a mechanism by which bids can be compared.

4.5 CONTRACT PROVISIONS

The contract must contain provisions which address the scope of the project. A "Change of Conditions" refers to those activities which do not coincide with the scope of project but are still billable. In addition, the contract should comply with State and local requirements.

4.5.1 CHANGE ORDERS

As discussed previously, different types of contracts are available that divide the risk between EPA and the contractor; this provision modifies the terms of the contract and lowers the risk to the owner and contractor in order to obtain the best possible price. When this occurs, the work is more strictly defined. Therefore, a change of conditions is defined as unspecified or unanticipated additional work which is paid separately. This method, called a change order, is defined below:

Without invalidating the Agreement and without notice to any surety, OWNER may, at any time from time to time, order additions, deletions or revisions in the Work; these will be authorized by a Written Amendment, a Change Order, or a Work Directive change. Upon receipt of any such document, CONTRACTOR shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Document (except as otherwise specifically provided).

General Conditions are the provisions contained in the contract that outline change order conditions and the accounting procedures that apply.

4.5.2 SPECIAL PROVISION

Some aspects of the project are unique to the site and are not necessarily unknown but fall under the term "considerations." There are "considerations" in each project that the owner expects the contractor to consider when preparing the bid. These could include provisions for the following:

- Coordination with government agencies
- Storage and handling of equipment
- Coordination with utilities
- Control of erosion and runoff
- Services of manufacturers' representatives for start-up, training, operation manuals, lubrication schedules
- Connections to existing systems
- Disposal of materials
- Providing adequate plant (i.e., support equipment)
- Inclement weather.

Experienced contractors will be familiar with these and other standard operating conditions. However, it is in the Agency's best interest to include such items.

In addition, there may be conditions that are not known during a particular stage of the work. These conditions may be included in the contract and priced on a unit basis in the event that they occur. Such provisions are referred to as "Control of Work" and may include the following:

- Relocation of existing utilities
- Removal/replacement of unsuitable materials
- Removal/replacement of rocks and boulders
- Dewatering via well points
- Wood or steel sheeting
- Test pits.

If any of these conditions were encountered, the contractor would be bound to the price specified in the proposal.

5.0 POST IMPLEMENTATION ACTIVITIES

Alternate water supplies may be installed to provide an interim remedy until the existing water supply is cleaned up or as a final remedy to permanently replace the existing water supply. At non-NPL sites and at most NPL sites, alternate water supplies will be considered a final remedy with regard to the drinking and household water pathway. Further remedial action may be needed at the NPL site.

EPA's responsibility for the alternate water supply system ends upon completion of construction, when responsibility for operation and maintenance of the system is transferred to the appropriate utility or State agency. EPA will seek transfer of control as soon as construction is complete. In cases where EPA implements an alternate water supply and no utility exists, the State Superfund contract must provide assurances under Section 104 for provision of operation and maintenance services for the system. In cases where EPA or another party implements the alternate water supply for inclusion in an existing utility, the OSC or RPM should work closely with OGC to develop means for transfer of control.

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APPENDIX A
LOCATIONS WHERE ALTERNATE SUPPLIES HAVE BEEN INSTALLED

Site	Location	Selected Remedy for Water Supply
South Valley Site	Albuquerque, NM	New wells
New Brighton	New Brighton, MN	Connection to existing system
Milltown	Milltown, MT	New wells
San Gabriel	San Gabriel, CA	Connection to existing system
Western Sand and Gravel	Burrillville, RI	Home treatment units, new wells
Charles George Landfill	Tyngsboro, MA	Connection to existing system
Tacoma Well 12A	Tacoma, WA	Extraction well, aeration towers
Verona Well Field	Battle Creek, MI	Barrier wells with air stripping, new wells
Charlevoix Municipal Well	Charlevoix, MI	New surface water supply
Krysowaty Farm	Hillsborough, NJ	Connection to existing system
Bridgeport	Bridgeport, NJ	Connection to existing system
Price Landfill	Pleasantville, NJ	New well field
Eau Claire	Eau Claire, WI	Packed tower air stripping
Caldwell Trucking	Fairfield, NJ	Ground water treatment, alternate water supply
Combe Fill South Landfill	Chester Township, NJ	Ground water pump and treat, alternate water supply
Chisman Creek	York County, VA	Ground water pump and treat, ground water diversion, alternate water supply
Heleva Landfill	North Whitehall Township, PA	Extension of existing water supply
Lehillier/Mankato Site	Lehillier/Mankato, MN	Ground water extraction and treatment, extension of municipal water system
Main Street Well Field	Elkhart, IN	Ground water treatment with discharge to municipal distribution system
Old Mill	Rock Creek, OH	Ground water extraction and treatment, alternate water supply

APPENDIX B
AN ANALYTICAL APPROACH TO DETERMINING A CONTAMINANT TRANSPORT REGIME

It is necessary to assess the contamination rate at a site to determine how quickly alternate water supplies should be provided. Many factors must be considered during an evaluation including defining the local lithology and aquifer parameters. Complicated lithologies which involve multiple aquifers require digital modeling to approximate contaminant movement. In less complex systems, however, Darcy's equation may be adapted to provide an estimate of contaminant transport.

It is necessary to establish the radius of the water supply well; groundwater velocity may increase within these areas. Therefore, it is important to know the size of the water supply and the groundwater velocity when pumping is not occurring.

The size of the well may be determined graphically if there are existing observation wells within the pumping well. This may be accomplished by plotting drawdown(s) vs log r, where r equals the distance between the pumping and observation well. The zero drawdown intercept represents the radius of the pumping well during the discharge rate test. If no observation wells exist, the size of the well may be estimated from a series of equations using known or estimated aquifer parameters.

The average velocity of groundwater movement may be estimated using a form of Darcy's Law:

$$\bar{v} = -\frac{K\,dh/dl}{\theta}$$

where:

$\bar{v}$ = average velocity (feet/day)
K = hydraulic conductivity (feet/day)
dh/dl = hydraulic gradient (dimensionless)
θ = effective porosity, as a decimal fraction

Parameter Determination

Hydraulic Conductivity (K) - Pump test data for the production well may be available. A hydraulic conductivity may have been calculated for the aquifer of concern. This value may be substituted into the Darcy equation or a hydraulic conductivity may be estimated based on the soil description. Tables comparing hydraulic conductivity and soil type can be found in Freeze and Cherry's (1979) text, *Groundwater*. Aquifers capable of sustaining a production well generally have K values ranging from 10^2 to 10^4 feet/day.

Hydraulic Gradient (dh/dl) - The regional hydraulic gradient may be derived from potentiometric surface maps developed for the site. The hydraulic gradient must be established from data available outside the area of influence of the pumping well. In gently sloping areas the hydraulic gradient usually ranges from 1 to 10 feet per 1,000 feet.

Porosity (θ) - The porosity of an aquifer may be determined from laboratory test or may be estimated based on the soil type. Most aquifer materials have porosities of 30 to 35%. Tables comparing soil type and porosity can also be found in Freeze and Cherry's (1979) Groundwater text.

Example

In this example, a landfill is located approximately 6,500 feet upgradient from a production well which is releasing contaminants. If the production well was not releasing contaminants, the distance from the edge of the contaminant plume to the production well would be used. An aquifer test was performed when the well was put into service. The radius of the well was approximately 1,500 feet. The aquifer is composed of sand and gravel with a hydraulic conductivity of feet/day and a porosity of 35%. The hydraulic gradient is 10 feet/1,000 feet. Substituting these values into the Darcy equation:

$$\bar{v} = -\frac{K\,dh/dl}{\theta}$$

$$\bar{v} = \frac{(350\,(-0.01)}{0.35}$$

$$\bar{v} = 10\,feet/day$$

Groundwater is moving with a velocity of 10 feet/day. To calculate the travel time of contaminants to intercept the radius of influence of the production well the distance of travel in feet is divided by the velocity in feet/day. Therefore:

$$\frac{5{,}000\,(feet)}{10\,feet/day} = 500\ days$$

The contaminant may be expected to intercept the radius of influence of the production well in 500 days.

Limitations and Considerations

This simplified model must be used with caution. It assumes that the aquifer is homogeneous and isotropic. It does not consider contaminant retardation, effects of contaminant dispersion or the additional stresses placed on the aquifer system. The fraction of the total discharge derived from the direction of the contaminant plume would effect the water quality in the production well. The source of groundwater in the production well may be decreased if surface water is close by. Complex aquifer systems may require more sophisticated analytical or digital modeling. However, a simplified analytical approach may provide the necessary information required to assess contaminant transport in groundwater. The user is strongly encouraged to seek the assistance of a competent hydrogeologist to determine an appropriate modeling approach.

APPENDIX C
EPA AMBIENT STANDARDS AND CRITERIA

Chemical	Safe Drinking Water Act, MCLs, (mg/L unless otherwise noted)	Clean Water Act, Water Quality Criteria for Human Health Drinking Water Only [a]	Health Effects Assessments [b]			
			AIC[c]		Carcinogenic Potency	
			Intake (mg/kg/day)	Conc. (mg/L)	Intake $(mg/kg\text{-}day)^{-1}$	10^{-6} risk
Acenaphthene		20 µg/L (organoleptic)[d]				
Acrolein		540 µg/L				
Acrylonitrile		0 (63 ng/L)[e]				
Aldrin		0 (1.2 ng/L)				
Antimony		146 µg/L				
Arsenic	0.05	0 (2.5 ng/L)				
Asbestos		0 (30,000 fibers/L)				
Barium	1					
Benzene		0 (0.67 µg/L)	2.9×10^{-4}	0.01	0.045	0.77 µg/L
Benzidine		0 (0.15 ng/L)				
Benzo(a)pyrene					11.5	3.0 ng/L
Beryllium		0 (3.9 ng/L)				
Cadmium	0.01	10 µg/L				
Carbofuran						
Carbon monoxide						
Carbon tetrachloride		0 (0.27 µg/L)[f]			0.13	0.27 µg/L
Chlordane	0 (22 ng/L)				1.6	0.22 µg/L
Chlorinated benzenes						
Hexachlorobenzene	0 (21 ng/L)				1.7	0.21 µg/L
1,2,4,5-Tetra-chlorobenzene		180 µg/L				
Pentachlorobenzene		570 µg/L				
Trichlorobenzene		Insufficient data				
Monochlorobenzene		488 µg/L				
Chlorinated ethanes						
1,2-Di-chloro-ethane	0 (0.5 µg/L)[f]				0.069	0.51 µg/L
1,1,1-Trichloroethane		19 mg/L	0.54	19		
1,1,2-Trichloroethane		0 (0.6 µg/L)			0.057	0.61 µg/L
1,1,2,2-Tetra-chloroethane		0 (0.17 µg/L)			0.2	0.175 µg/L
Hexachloroethane		0 (2.4 µg/L)				
Monochloroethane		Insufficient data				
1,1-Dichloroethane		Insufficient data				
1,1,1,2-Tetrachloroethane		Insufficient data				
1,1,1,2-Tetrachloroethane		Insufficient data				

APPENDIX C (Continued)

Chemical	Safe Drinking Water Act, MCLs, (mg/L unless otherwise noted)	Clean Water Act, Water Quality Criteria for Human Health Drinking Water Only a)	Health Effects Assessments b)			
			AIC c)		Carcinogenic Potency	
			Intake (mg/kg/day)	Conc. (mg/L)	Intake $(mg/kg\text{-}day)^{-1}$	10^{-6} risk
Pentachloroethane		Insufficient data				
Chlorinted naphthalenes		Insufficient data				
Chlorinated phenols						
3-Chlorophenol		0.1 µg/L (organoleptic)				
4-Chlorophenol		0.1 µg/L (organoleptic)				
2,3-Dichlorophenol		0.04 µg/L (organoleptic)				
2,5-Dichlorophenol		0.5 µg/L (organoleptic)				
2,6-Dichlorophenol		0.2 µg/L (organoleptic)				
3,4-Dichlorophenol		0.3 µg/L (organoleptic)				
2,3,4,6-Tetrachlorophenol		1.0 µg/L (organoleptic)				
2,4,5-Trichlorophenol		2600 µg/L				
2,4,6-Trichlorophenol		0 (1.8 µg/L)	0.05	1.8	0.02	1.75 µg/L
2-Methyl-4-chlorophenol		1800 µg/L (organoleptic)				
3-Methyl-4-chlorophenol		3000 µg/L (organoleptic)				
3-Methyl-6-chlorophenol		20 µg/L (organoleptic)				
Chlorophenoxys						
2,4-Dichloro-phenoxyacetic acid	0.1					
2,4,5-Trichloro-phenoxy-propionic (Silvex)	0.01					
Chloroalkyl ethers						
bis-(Chloromethyl) ether		(0.0039 ng/L)				
bis-(2-Chloroethyl) ether		0 (30 ng/L)				
bis-(2-Chloroisopropyl) ether		34.7 µg/L				
Chloroform	0.1g)	0 (0.19 µg/L)			.07	0.50 µg/L
2-Chlorophenol		0.1 µg/L (organoleptic)				
Chromium Cr+6		50 µg/L				
Cr+3		170 mg/L	1.6	56		
TOTAL	0.05					

APPENDIX C (Continued)

Chemical	Safe Drinking Water Act, MCLs, (mg/L unless otherwise noted)	Clean Water Act, Water Quality Criteria for Human Health Drinking Water Only [a]	Health Effects Assessments [b]			
			AIC[c]		Carcinogenic Potency	
			Intake (mg/kg/day)	Conc. (mg/L)	Intake (mg/kg-day)$^{-1}$	10^{-6} risk
Copper		1 mg/L (organoleptic)				
Cyanide		200 µg/L				
DDT		0 (>1.2 ng/L)			8.4	4.17 ng/L
Dichlorobenzenes (all isomers)		470				
Dichlorobenzidines		0 (20.7 ng/L)				
Dichloroethylenes						
1,1-Dichloroethylene		0 (33 ng/L)				
1,2-Dichloroethylene		Insufficient data				
Dichloromethane		See Halomethanes				
2,4-Dichlorophenol		0.3 µg/L (organoleptic)				
Dichloropropanes/						
Dichloropropenes						
Dichloropropanes		Insufficient data				
Dichloropropenes		87 µg/L				
1,2-Dichloro-propane						
Dieldrin		0 (1.1 ng/L)				
2,4-Dimethylphenol		400 µg/L (organoleptic)				
2,4-Dinitrotoluene		0 (0.11 µg/L)				
p-Dioxane						
1,2-Diphenylhydrazine		0 (46 ng/L)				
Endosulfan		138 µg/L				
Endrin	0.0002	13 µg/L				
Ethylbenzene		2.4 mg/L	0.097	3.4		
Ethylene glycol						
Formaldehyde						
Fluoranthene		188 µg/L				
Fluoride	1.4-2.4					
Haloethers		Insufficient data				
Halomethanes		0 (0.19 µg/L)				
Heptachlor		0 (11 ng/L)				
Hexachlorobutadiene		0 (0.45 µg/L)			0.078	0.45 µg/L
Hexachlorocyclohexanes						
Lindane (99% gamma-HCH)	0.004				1.3	0.27 µg/L
alpha-HCH		0 (13 ng/L)				
beta-HCH		0 (23.2 ng/L)				
gamma-HCH		0 (26.4 ng/L)				

APPENDIX C (Continued)

Chemical	Safe Drinking Water Act, MCLs, (mg/L unless otherwise noted)	Clean Water Act, Water Quality Criteria for Human Health Drinking Water Only a)	Health Effects Assessments b)			
			AIC c)		Carcinogenic Potency	
			Intake (mg/kg/day)	Conc. (mg/L)	Intake $(mg/kg\text{-}day)^{-1}$	10^{-6} risk
delta-HCH		Insufficient data				
epsilon-HCH		Insufficient data				
Technical-HCH		0 (17.4 ng/L)				
Hexachlorocyclopentadiene		206 µg/L				
n-Hexane						
Hydrocarbons (non-methane)						
Isophorone		5.3 mg/L				
Kerosene						
Lead	0.05	50 µg/L	0.0014	0.05		
Mercury (inorganic)	0.002	10 µg/L	0.002	0.07		
Mercury (alkyl)			$2.9x10^{-4}$	0.01		
Methoxychlor	0.1					
Methyl Ethyl Ketone						
Naphthalene		Insufficient data				
Nickel		15.4 µg/L				
Nitrate (as N)	10					
Nitrobenzene		19.8 mg/L				
Nitrogen dioxide						
Nitrophenols						
2,4-Dinitro-o-cresol		13.6µg/L				
Dinitrophenol		70 µg/L				
Mononitrophenol		Insufficient data				
Trinitrophenol		Insufficient data				
Nitrosamines						
n-Nitrosodimethylamine		0 (1.4 ng/L)				
n-Nitrosodiethylamine		0 (0.8 ng/L)				
n-Nitrosodi-n-butylamine		0 (6.4 ng/L)				
n-Nitrosodiphenylamine		0 (7.0 µg/L)				
n-Nitrosophyrrolidine		0 (16 ng/L)				
Ozone						
Particulate Matter						
Pentachlorophenol		1.01 mg/L	0.03	1.05		
Phenol		3.5 mg/L	0.1	3.5		
Phthalate esters						
Dimethylphthalate		350 mg/L				
Diethylphthalate		434 mg/L				
Dibutylphthalate		44 mg/L				
Di-2-ethylhexyl-phthalate		21 mg/L				

APPENDIX C (Continued)

Chemical	Safe Drinking Water Act, MCLs, (mg/L unless otherwise noted)	Clean Water Act, Water Quality Criteria for Human Health Drinking Water Only a)	Health Effects Assessments b)			
			AIC c)		Carcinogenic Potency	
			Intake (mg/kg/day)	Conc. (mg/L)	Intake $(mg/kg\text{-}day)^{-1}$	10^{-6} risk
Polychlorinated biphenyls						
(PCBs)		0 (> 12.6 ng/L)			4.3	8.14 ng/L
Polynuclear aromatic						
hydrocarbons (PAHs)		0 (3.1 ng/L)			11.5	3.0 ng/L
Radionuclides						
Radium-226 and 228	5 pCi/L					
Gross alpha activity	15 pCi/L					
Tritium	20,000 pCi/L					
Strontium-90	8 pCi/L					
Other man-made	h					
Selenium	0.01	10 µg/L				
Silver	0.05	50 µg/L				
Sulfur dioxide						
2,3,7,8-TCDD		0 (0.00018 ng/L)			$1.6x10^{-5}$	$2.2x10^{-4}$ng/L
Tetrachloroethylene		0 (1.8 µg/L)f)			0.04	0.88 µg/L
Thallium		17.8 µg/L	0.29	10		
Toluene		15 mg/L				
Toxaphene	0.005	0 (25.8 mg/L)				
Trichloroethylene		(2.8 µg/L)			0.019	5.8 µg/L
Trihalomethanes (total)i)	0.1					
Vinyl chloride		(0.015 µg/L)f)				
Xylenes						
Zinc		5 mg/L (organoleptic)	0.21	7.4		

Footnotes:
a) These adjusted criteria, for drinking water ingestion only, were derived from published EPA Water Quality Criteria (45 FR 79318-79379, November 28, 1980) for combined fish and drinking water ingestion and for fish ingestion alone. These adjusted values are not official EPA Water Quality Criteria, but may be appropriate for Superfund sites with contaminated ground water. In the derivation of these values, intake was assumed to be 2 liters/day for drinking water and 6.5 grams/day for fish; human body weight was assumed to be 70 kilograms.
b) Health Effects Assessments (HEA's) - interim toxicity values developed by EPA's Environmental Criteria and Assessment office for substances commonly found at Superfund sites.
c) Acceptable Intake Chronic (AIC) - the highest long-term exposure level not expected to cause adverse effects.
d) Organoleptic criteria are based on taste and odor effects, not human health effects.
e) The criterion for all carcinogens is zero; the concentration given in parentheses corresponds to a carcinogenic risk of 10-6. Water Quality Criteria documents present concentrations resulting in risks from 10-5 to 10-7. To obtain concentrations corresponding to risks of 10-4 and 10-5, the 10-6 concentrations should be multiplied by 100 and 10, respectively. To obtain concentrations corresponding to risk of 10-7, 10-6 concentrations should be divided by 10.
f) These values are based on updated calculations performed by EPA's Carcinogen Assessment Group.
g) Chloroform is one of four trihalomethanes whose sum concentration must be less than 0.1 mg/L.
h) Activity corresponding to total body or any internal organ dose of 4 mrem/year.
i) Total trihalomethanes refers to the sum concentration of chloroform, bromodichloromethane, dibromochloromethane and bromoform.

APPENDIX D
INTERIM FINAL GUIDANCE ON REMOVAL ACTION LEVELS AT CONTAMINATED DRINKING WATER SITES

REMOVAL ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES

Introduction

The purpose of this guidance is to establish "action levels" for providing alternate water supplies under Superfund removal authority at contaminated drinking water sites. The action level is the primary criterion that must be met for a site to qualify for removal response. The action levels established in this guidance must generally be satisfied before removal authority can be used at either National Priorities List (NPL) sites or non-NPL sites.

Under the 1982 National Contingency Plan (NCP), removal actions were taken in response to "immediate and significant" threats to human health or the environment. The removal program used the 10-Day Health Advisory as the principal benchmark to identify those drinking water contamination incidents that posed the most acute threats to human health. The November 1985 NCP broadened removal authority by authorizing response in situations that present a "threat" to human health or the environment. Therefore, removal actions may now be taken in less urgent situations than under the 1982 NCP.

In response to this expansion of removal authority, the Office of Emergency and Remedial Response (OERR) is revising removal program action levels for contaminated drinking water sites. This guidance expands the previous policy in a number of ways. First, the numeric action levels are now based on levels that are protective for a lifetime exposure rather than a 10-day exposure. Second, both carcinogenic and non-carcinogenic health effects are considered. Third, a reduction factor is used for volatiles to account for exposure due to inhalation. Finally, additional guidance is provided on the use of site-specific factors to trigger removal actions.

The action levels established in this guidance allow a site to qualify for removal response if either: 1) the numeric trigger is exceeded at the tap, or 2) site-specific factors otherwise indicate that a significant health threat exists. The guidance also discusses information sources on health threats from drinking water contamination, factors to consider in determining the extent of action, action levels vs. cleanup standards, prioritizing removal sites, and obtaining exemptions to the statutory limits for alternate water supply sites.

Action Level Based on Numeric Trigger

The numeric trigger is calculated using a model that establishes four different action levels, depending on whether the substance is also a potential human carcinogen and/or volatile. The model is explained below and summarized in *Exhibit 1*. Based on this model, *Exhibit 2* lists the numeric action level for various substances that may be found in drinking water at Superfund sites. A site may qualify for removal response if the numeric trigger for the drinking water contaminant is exceeded at the tap of at least one residence ("residence" includes schools, businesses, etc.). (Note that the decision to initiate a removal action is based on other factors as well, such as the availability of other response mechanisms to initiate action in a timely manner.)

The first step in calculating the numeric trigger is determining whether the substance of concern is also a potential human carcinogen and/or volatile. For purposes of this guidance, a substance is a *carcinogen* if it falls into categories A, B, or C of EPA's carcinogen classification guidelines. (A substance should be considered a non-carcinogen if it is in categories D or E.) Volatile organic chemicals (VOCs) are generally of low molecular weight, high vapor pressure, and low solubility. For purposes of this guidance, VOCs include those chemicals identified as volatiles in the following documents: Test Methods for Evaluating Solid Waste, Vol. 1A, SW-846, 3rd ed., November 1986 (Chapter 2); Contract Lab Program Statement of Work, October 1986 (Exhibit C); Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water, September 1986 (available from Regional water program offices); and 40 CFR Part 264, Appendix IX (analytical methods 8010 and 8240 designate volatiles).

With the substance thus classified, the second step is to determine the appropriate action level in accordance with the categories below:

1. *Non-volatile non-carcinogens* -- Action level equals the Drinking Water Equivalent Level (DWEL).*
2. *Volatile non-carcinogens* -- Action level equals 50 percent of the DWEL.
3. *Non-volatile carcinogens* -- Action level is determined by comparing the DWEL to the 10^{-4} Lifetime Upperbound Cancer Risk Level, and choosing the lower of the two.
4. *Volatile carcinogens* -- Action level is determined by comparing 50 percent of the DWEL to the 10^{-4} Lifetime Upperbound Cancer Risk Level, and choosing the lower of the two.

The action level for methylene chloride, for example, is calculated as follows. Methylene chloride is a

*DWEL equals Reference Dose (RfD) times 70 kg ÷ 2 liters/day volatile and a potential human carcinogen (classified as a "B2" under EPA guidelines). The DWEL for methylene chloride equals 1750 ppb and the 10^{-4} Cancer Risk Level equals 48 ppb. The action level is determined by comparing 50 percent of the DWEL, or 875 ppb, to the 10^{-4} Cancer Risk Level, or 48 ppb, and choosing the lower of the two, which is *48 ppb*. If at least one residence has methylene chloride levels that exceed 48 ppb at the tap, the site may qualify for removal response.

This model will provide an action level for many of the substances commonly encountered in drinking water at Superfund sites, including many solvents. However, OERR is still working on establishing an appropriate action level for certain substances in the two situations described below. Until action levels are developed, most decisions regarding these substances will be made in OERR. The modifications discussed below have been incorporated into Exhibits 1 and 2.

- *The calculated action level for a substance is lower than or equal to the Maximum Contaminant Level (MCL) established under the Safe Drinking Water Act (SDWA).* For example, for vinyl chloride, a volatile carcinogen, the calculated action level under this model is 1.5 ppb (1.5 ppb is the 10^{-4} Cancer Risk Level, which is lower than 50% of the DWEL). However, 1.5 ppb is lower than the MCL for vinyl chloride, which is 2 ppb. Given the limited scope of the removal program, it may not be appropriate for the removal program to trigger removal action at levels equal to or below the MCL. Therefore, OERR is currently examining whether it would be appropriate to establish an alternate action level for these substances that is above the MCL. Until an action level is established for these substances, removal action may be initiated if contaminant levels exceed the 10-Day Health Advisory. However, if contaminant levels are between the calculated action level and the 10-Day Health Advisory, OERR will review individual site conditions to determine if removal action should be taken.

- *The calculated action level is based on the DWEL, but the 10-Day Health Advisory is lower than the DWEL.* For most substances, the 10-Day Health Advisory is higher than the DWEL. In some cases, however, the 10-day advisory is lower than,the DWEL. (This situation occurs primarily where 10-day exposure data were not available, so the 10-Day Health Advisories were based on other studies.) For example, the action level for barium (a non-volatile non-carcinogen) is based on the DWEL of 1800 ppb, but the 10-Day Health Advisory for barium is 1500 ppb. OERR is currently examining whether it would be appropriate to use the lower 10-day advisories as the removal action level. Until OERR determines if an alternate action level is appropriate for these substances, removal action may be initiated if contaminant levels exceed the DWEL. However, if contaminant levels are between the (lower) 10-Day Health Advisory and the DWEL, OERR will review individual site conditions to determine if removal action should be taken.

Action Level Based on Site-Specific Factors

A significant health threat may exist even though the numeric action level has not been exceeded. A removal action may be initiated if the health risk at a site has been *analyzed in detail* and the analysis indicates that a serious health risk is present due to site-specific factors. Examples of such factors include evidence that a contaminated groundwater plume is moving, contaminant levels will likely increase (e.g., increased pumping from an aquifer anticipated during summer months), people have been drinking contaminated water for a long period of time, multiple contaminants are likely to result in synergistic effects, there are sensitive members in the population at risk, etc.

With regard to a threat based on future contamination, as a general rule, removal action may be warranted where it can be projected that the numeric action level will be exceeded within 6 months. It is important to note that this 6 month period *is not* related to the definition of time-critical/non-time-critical removal actions. For example, where contaminant levels will likely exceed the DWEL by a *significant amount within 6 months*, a time-critical removal action would be appropriate. However, if contaminant levels will only exceed the DWEL by a *minimal amount within 6 months*, a non-time-critical removal action may be more appropriate. Future threat may therefore warrant either a time-critical *or* non-time-critical removal action.

When conditions such as those described above are present, the site may qualify for removal action even though a numeric indicator has not been exceeded. Decisions will be made on a case-by-case basis. OERR concurrence must be obtained before approving Action Memoranda for contaminated drinking water sites where the removal action decision is based solely on site-specific factors, even where site cost or time projections do not exceed the statutory limits on removal actions. However, if an *emergency* exists based on site-specific factors, action may be initiated immediately and OERR should be contacted as soon as possible.

Information Sources

DWELS, as well as RfDs and other relevant standards and advisories, are available to the Regions through the Integrated Risk Information System (IRIS). IRIS can be accessed on-line through E-mail; type in "IRIS" at the prompt rather than "mail." The EPA Office of Drinking Water has also established a Safe Drinking Water Hotline, which can provide information about relevant standards and criteria, and treatment techniques for contaminated drinking water. The Hotline telephone number is 800-426-4791 (in the Washington D.C. area, 382-5533).

Additional advice and information on health assessments at drinking water contamination sites may be obtained from the Agency for Toxic Substances and Disease Registry (ATSDR) and the Superfund Public Health Evaluation Manual Directive #9285.4-01). ATSDR may be particularly helpful in providing advice on threats posed by site-specific factors.

OERR should be contacted if a substance of concern does not have a DWEL, RfD, and/or cancer risk level.

Determining the Extent of Action

Once it has been determined that a site qualifies for removal response based on a numeric trigger or site-specific factors, the Region must determine how many residences (including businesses, schools, etc.) will receive alternate water supplies. First, the area of impact should be estimated (both extent and magnitude of the threat) by considering factors such as the hydrogeology of the site, plume movement, and the likelihood of contaminant levels increasing. For sites where removal action is warranted because the numeric trigger has been exceeded at certain residences, the area of impact may be defined to include neighboring residences which are at risk, but do not exceed the numeric trigger.

After the area of impact is defined, the number of residences to be provided with alternate water supplies must be determined by considering cost vs. benefits received, the statutory limits on removal actions, and the availability of other response mechanisms. For example, response to widespread low-level contamination may be too extensive for removal action, and therefore, may be addressed more appropriately by the remedial program. In another case, a contaminated aquifer may affect a public water supply system and private wells, but Superfund resources may only be needed to address the private wells.

Determining the appropriate extent of action therefore involves analysis of both the area of impact and programmatic factors.

Action Levels vs, Cleanup Standards

The numeric action levels established in this guidance are not intended to be used as cleanup standards. The MCL, if available, will *generally* be the appropriate cleanup standard. (For guidance on the use of MCLs and MCLGs as cleanup standards, see "Interim Guidance on Compliance with Applicable or Relevant and Appropriate Requirements," July 9, 1987, OSWER Directive 9234.0-05. Final guidance will be issued in the CERCLA Compliance with ARARs Manual.) This means that for any residence provided with an alternate water supply, the goal will generally be to meet MCLs. For example, if carbon filter units will be provided to treat drinking water contaminated with trichloroethylene (TCE), treated water should achieve 5 ppb TCE, the MCL.

Prioritizing Removal Sites.

Sites may qualify for removal action under either the numeric indicator or site-specific factor approaches. For the purpose of *prioritizing* those site that qualify for removal action, response should be initiated as soon as possible if contaminant levels exceed the 10-Day Health Advisory or site-specific factors otherwise indicate that an emergency exists.

Exemption to the Statutory Limits

To obtain an exemption to the $2 million/12 month limits on removal actions based on a continuing *emergency*, it will generally not be adequate to show that contaminant levels exceed the numeric action level by some minimal amount. An exemption may be justified if contaminant levels exceed the 10-Day Health Advisory, significantly exceed the numeric action level, or an emergency exists based on site-specific factors. A finding that contaminant levels exceed the numeric action level by a minimal amount may be appropriate, however, in "non-emergency" situations where an exemption is based on the new *consistency waiver*.

Summary of Policy

A contaminated drinking water site may qualify for removal response if: 1) the numeric action level (based on the DWEL and/or the 10^{-4} Lifetime Upperbound Cancer Risk Level) is exceeded, or 2) site-specific factors otherwise indicate the presence of a serious health threat. In prioritizing those sites that qualify for response under this model, Regions should give priority to sites where contaminant levels exceed the 10-Day Health Advisory or site-specific factors otherwise indicate that an emergency exists.

Exhibit 1: Summary of Action Level Decision Model

Do contaminant levels exceed the NUMERIC action level?

Is the substance a volatile and/or potential human carcinogen?

- Non-volatile non-carcinogens -- Action level equals the DWEL.
- Volatile non-carinogens -- Action level equals 50% of the DWEL.
- Non-volatile carcinogens -- Action level is determined by comparing the DWEL to the 10-4 Lifetime Upperbound Cancer Risk Level, and choosing the lower of the two.
- Volatile carcinogens -- Action level is determined by comparing 50% of the DWEL to the 10^{-4} Lifetime Upperbound Cancer Risk Level, and choosing the lower of the two.

Do either of the two modifications to the numeric action level apply?

Is the numeric action level lower than or equal to the MCL, if available? If yes:

- If contaminant levels are between the numeric action level and the 10-day Health Advisory, contact OERR to determine appropriate action.
- If contaminant levels exceed the 10-Day Health Advisory, action be taken if the site otherwise qualifies for removal response.

If the action level is based on the DWEL, is the 10-day Health Advisory lower than the DWEL? If yes:

- If contaminant levels are between the (lower) 10-day Health Advisory and the DWEL, contact OERR to determine appropriate action.
- If contaminant levels exceed the DWEL, action may be taken if the otherwise qualifies for removal response

If contaminant levels do not exceed the numeric trigger, can the site quality for removal response based on SITE-SPECIFIC FACTORS?

A site can qualify for removal response if the health risk at a site has been analyzed in detail and the analysis indicates that a serious health risk is present due to site-specific factors.

- ATSDR may be particularly helpful in providing advice on health due to site-specific factors.
- OERR concurrence must be obtained before approving Action Memoranda based on site-specific factors, even where the site will not exceed the statutory limits on removal actions.

Exhibit 2

Removal Numeric Action Levels for Contaminated Drinking Water Sites (μg/L)

Chemical	Volatile (Y/N)	EPA Carcinogen Group[a]	MCL	10-Day HA	DWEL[b]	10^{-4} Cancer Risk Level	Removal Action Level
Alachlor	N	B2	None	100	350	44	44
Barium	N	D	1000	1500[c]	1800	NA	1800[d]
Benzene	Y	A	5	235	NA	120	120
Cadmium	N	D	10	43[c]	17	NA	17
Carbofuran	N	E	None	50[c]	175	NA	175[d]
Carbon tetrachloride	Y	B2	5	160	24	27	12
Chlordane	N	B2	None	63	1.6	2.7	1.6
Chlorobenzene	Y	D	None	4300[c]	1505	NA	753
Chromium (total)	N	D	50	1400	168	NA	168
Cyanide	N	D	None	220[c]	770	NA	770[d]
o-Dichlorobenzene	Y	D	None	8930[c]	3115	NA	1558
p-Dichlorobenzene	Y	C	75	10700[c]	3500	175	175
1,2-Dichloroethane	Y	B2	5	740[c]	None	38	38
1,1-Dichloroethylene	Y	C	7	1000[c]	350	None	175
Cis-1,2-Dichloroethylene	Y	D	None	1000[c]	350	NA	175
Trans-1,2-Dichloroethylene	Y	D	None	1430[c]	350	NA	175
Dichloromethane/ Methylene chloride	Y	B2	None	1500	1750	480	480
Endrin	N	E	0.2	5	1.6	NA	1.6
Ethylbenzene	Y	D	None	3200[c]	3395	NA	1698[d]
Heptachlor	N	B2	None	10	17	7.6	7.6
Lindane	N	C	4	1200	10	None	10
Mercury (inorganic)	N[e]	D	2	1.6[c]	5.5	NA	5.5[f]
Methoxychlor	N	D	100	2000	1750	NA	1750
Methyl ethyl ketone (MEK)	Y	D	None	7500[c]	864	NA	432
Nickel	N	D	None	1000	350	NA	350
Pentachlorophenol (PCP)	Y	D	None	300[c]	1050	NA	525[d]
Styrene	Y	C	None	2000[c]	7000	None	3500[d]
Tetrachloroethylene (PCE)	Y	B2/C	None	2000	500	66	66
Toluene	Y	D	None	3460[c]	12100	NA	6050[d]
Toxaphene	N	B2	5	40	None	3.1	40[g]
1,1,1-Trichloroethane	Y	D	200	35000[c]	1000	NA	500
Trichloroethylene	Y	B2	5	None	257	280	128
Vinyl chloride	Y	A	2	2600	None	1.5	1300[h]
Xylenes (total)	Y	D	None	7800[c]	2157	NA	1078

(Continued)

Exhibit 2 (Continued)

Chemical	Volatile (Y/N)	EPA Carcinogen Group[a]	MCL	10-Day HA	DWEL[b]	10^{-4} Cancer Risk Level	Removal Action Level

a Carcinogen group designation is from EPA carcinogen classification guidelines for effects from ingestion.
b DWEL equals RfD times 70kg divided by 2 l/day. (Note that the DWEL in health advisory documents produced by EPA's Office of Drinking Water may be slightly different due to rounding.)
c Because no suitable studies of appropriate duration were available, these 10-day Health Advisories were based on Health Advisories of greater or lesser duration, e.g., 1-Day, Longer-term, and lifetime Health Advisories.
d Removal action level is an interim value. OERR is examining whether it would be appropriate to use the lower 10-Day Health Advisory (50% for volatiles) as the action. Until that time, if contaminant levels exceed the action level shown in the table, removal action may be taken. If contaminant levels exceed the 10-day advisory (50% for volatiles), but not the DWEL (50% for volatiles), consult OERR.
e. Not soluble in water.
f. Removal action may be initiated if mercury levels exceed the DWEL of 5.5 µg/L. If mercury levels exceed the 10-day advisory of 1.6 µg/L, but not 5.5 µg/L, consult OERR.
g Removal action may be initiated immediately if toxaphene levels exceed the 10-Day Health Advisory of 40 µg/L. If toxaphene levels exceed the 10^{-4} Cancer Risk Level of 3.1 µg/L, but not 40 µg/L, consult OERR.
h Removal action may be initiated immediately if vinyl chloride levels exceed 1300 µg/L, which is 50% of the 10-Day Health Advisory. If vinyl chloride levels exceed the 10^{-4} Cancer Risk Level of 1.5 µg/L, but not 1300 µg/L, consult OERR.

NA = Not appropriate.

APPENDIX E
TREATABILITY CLASSIFICATION OF PRIORITY POLLUTANTS

NAME	TREATABILITY CLASS	SYNONYMS
Acenaphthene	Aromatics	1,2-Dihydroacenaphthylene
Acenaphthlyene	Aromatics	
Acetone	Ketones	
Acrolein	Miscellaneous	2 Propenal
Acrylonitrile	Miscellaneous	2 Propenenitrile
Aldrin	Pesticides	
Aluminum	Metals	
Aniline	Aromatics	
Anthracene	Aromatics	
Antimony	Metals	Stibium
Arsenic	Metals	
Asbestos	Miscellaneous	Amianthus
Barium	Metals	
Beryllium	Metals	
Benzene	Aromatics	Benzol
Benzidine	Substitute Aromatics	
Benzo(a)anthracene	Aromatics	
Benzo(b)fluoranthene	Aromatics	
Benzo(k)fluoranthene	Aromatics	
Benzoic Acid	Aromatics	
Benzo(ghi)perylene	Aromatics	
Benzo(e)pyrene	Aromatics	
Benzyl Alcohol	Aromatics	
BHC-Alpha	Pesticides	
BHC-Beta	Pesticides	
BHC-Gamma	Pesticides	Lindane
BHC-Delta	Pesticides	
Bis (2-chloroethoxy)methane	Halocarbon	
Bis(2-chloroethyl)ether	Chlorinated Ethers	
Bis(chloromethyl)ether	Chlorinated Ethers	
Acenaphthene	Aromatics	1,2-Dihydroacenaphthylene
Acenaphthlyene	Aromatics	
Acetone	Ketones	
Acrolein	Miscellaneous	2 Propenal
Acrylonitrile	Miscellaneous	2 Propenenitrile
Aldrin	Pesticides	
Aluminum	Metals	
Aniline	Aromatics	
Anthracene	Aromatics	
Antimony	Metals	Stibium
Arsenic	Metals	
Asbestos	Miscellaneous	Amianthus
Barium	Metals	
Beryllium	Metals	
Benzene	Aromatics	Benzol
Benzidine	Substitute Aromatics	
Benzo(a)anthracene	Aromatics	
Benzo(b)fluoranthene	Aromatics	

SOURCE: adapted. from Shuckrow et al. 1980

APPENDIX E (Continued)

NAME	TREATABILITY CLASS	SYNONYMS
Benzo(k)fluoranthene	Aromatics	
Benzoic Acid	Aromatics	
Benzo(ghi)perylene	Aromatics	
Benzo(e)pyrene	Aromatics	
Benzyl Alcohol	Aromatics	
BHC-Alpha	Pesticides	
BHC-Beta	Pesticides	
BHC-Gamma	Pesticides	Lindane
BHC-Delta	Pesticides	
Bis (2-chloroethoxy)methane	Halocarbon	
Bis(2-chloroethyl)ether	Chlorinated Ethers	
Bis(chloromethyl)ether	Chlorinated Ethers	
Bis(2-chloroisopropyl)ether	Chlorinated Ethers	
Bis(2-ethylhexyl)phthalate	Phthalate Esters	
Bromoform	Halocarbon	Tribromomethane
4-Bromophenyl Phenyl Ether	Chlorinated Ethers	
2-Butanone	Ketones	Methyl Ethyl Ketone
Butyl Benzyl Phthalate	Phthalate Esters	
Cadmium	Metals	
Calcium	Metals	
Carbon disulfide	Miscellaneous	
Carbon Tetrachloride	Halocarbon	Tetrachloromethane
Chlordane	Pesticides	
4-Chloroaniline	Chlorated Aromatics	
Chlorobenzene	Chlorinated Aromatics	Monochlorobenzene
Chlorodibromomethane	Chlorinated Alkanes	
Chloroethane	Chlorinated Alkanes	
2-Chloroethyl Vinyl Ether	Chlorinated Ethers	(2-Chloroethoxy)Ethane
Chloroform[1]	Halocarbon[1]	Trichloromethane[1]
2-Chlorophenol	Phenols	
4-Chlorophenyl Phenyl Ether	Chlorinated Ethers	
2-Chloronaphthalene	Chlorinated Aromatics	
Chromium	Metals	
Chrysene	Aromatics	1,2-Benzphenanthrene
Cobalt	Metals	
Copper	Metals	
Cyanide	Miscellaneous	
4,4'-DDD	Pesticides	
4,4'-DDE	Pesticides	
4,4'-DDT	Pesticides	
Dibenzo(a,h)anthracene	Chlorinated Aromatics	
Dibenzofuran		
1,3-dichlorobenzene	Chlorinated Aromatics	
1,2-Dichlorobenzene	Chlorinated Aromatics	
1,4-Dichlorobenzene	Chlorinated Aromatics	
3,3'-Dichlorobenzidine	Substitute Aromatics	
Dichlorbromomethane	Halocarbon	
Dichlorodifluromethane	Halocarbon	

SOURCE: adapted. from Shuckrow et al. 1980

[1]Trihalomethanes can be found in a water supply either due to direct contamination, or formation during treatment or distribution. The treatment approach for this latter situation strives for prevention of formation, rather than removal via treatment.

APPENDIX E (Continued)

NAME	TREATABILITY CLASS	SYNONYMS
1,1-Dichloroethane	Halocarbon	
1,2-Dichloroethane	Halocarbon	
1,1-Dichloroethylene	Halocarbon	
2,4-Dichloro Phenol	Phenolts	
1,2-Dichloropropane	Halocarbon	
1,3-Dichloropropylene	Halocarbon	
Dieldrin	Pesticides	
Diethylphthalate	Phthalate Esters	
2,4-Dimethylphenol	Phenols	
Dimethyl Phthalate	Phthalate Esters	1,2-Benzenedicarboxylic Acid
Di-N-Butyl Phthalate	Phthalate Esters	
4,6-Dinitro-O-Cresol	Phenols	2-Methyl-4, 6-Dinitrophenol
4,6-Dinitro-2-methylphenol	Phenols	
2,4-Dinitrophenol	Phenols	Aldifen
2,4-Dinitrotoluene	Substituted Aromatics	
2,6-Dinitrotoluene	Substituted Aromatics	
Di-N-Octyl Phthalate	Phthalate Esters	
1,2-Diphenyl Hydrazine	Substitute Aromatics	
A-Endosulfan-Alpha	Pesticide	
B-Endosulfan-Beta	Pesticide	
Endosulfan Sulfate	Pesticide	
Endrin	Pesticide	
Endrin Ketone	Pesiticide	
Endrin Aldehyde	Pesticide	
Ethylbenzene	Aromatics	
Fluoranthene	Aromatics	
Fluorene	Aromatics	
Heptachlor	Pesticides	
Heptachlor Epoxide	Pesticides	
Hexachlorobenzene	Chlorinated Aromatics	Perchlorobenzene
Hexachlorobutadiene	Halocarbon	
Hexachlorocyclopentadiene	Halocarbon	
Hexachloroethane	Halocarbon	
2-Hexanone	Ketones	
Indeno (1,2,3-c,d)Pyrene	Aromatics	
Iron	Metals	
Isophorone	Miscellaneous	
Lead	Metals	
Magnesium	Metals	
Manganese	Metals	
Mercury	Metals	
Methoxychlor	Pesticides	Hydrargyrum
Methyl Bromide	Halocarbon	Bromomethane;Monobromo-methane; Embafume
Methyl Chloride	Halocarbon	Chloromethane
Methylene Chloride	Halocarbon	Dichloromethane
2-Methylnaphthalene	Aromatics	
2-Methylphenol	Phenols	
4-Methylphenol	Phenols	
4-Methyl-2-pentanone	Ketones	(Methyl Isobutyl Ketone)
Nickel	Metals	

SOURCE: adapted. from Shuckrow et al. 1980

APPENDIX E (Continued)

NAME	TREATABILITY CLASS	SYNONYMS
2-Nitroaniline	Aromatic	
3-Nitroaniline	Aromatic	
4-Nitroaniline	Aromatic	
Nitrobenzene	Substituted Aromatics	Nitrobenzol
2-Nitrophenol	Phenols	
4-Nitrophenol	Phenols	
N-Nitrosodimethylamine	Miscellaneous	
N-Nitrosodiphenylamine	Miscellaneous	
N-Nitrosodipropylamine	Miscellaneous	
Para-Chloro-Meta-Cresol	Phenols	
PCB-1016	Polychlorinated Biphenyls	
PCB-1221		
PCB-1232		
PCB-1242		
PCB-1248		
PCB-1254		
PCB-1260		
Pentachlorophenol	Phenols	Penta; PCP; Penchloro; Santophen
Phenanthane	Aromatics	
Phenol	Phenols	Carbolic Acid; Phenic Acid
Potassium	Metals	
Pyrene	Aromatics	Benzo(def)Phenanthrene
Selenium	Metals	
Silver	Metals	
Sodium	Metals	
Styrene	Aromatic	
2,3,7,8-Tetrachlorodibenzo-p-Dioxin		
1,1,2,2-Tetrachloroethane	Halocarbon	
Tetrachloroethylene	Halocarbon	Perchlorothylene; Ethylene Tetrachloride
Thallium	Metals	
Tin	Metals	
Toluene	Aromatics	Methylbenzene
Toxaphene	Pesticides	
1,2-Trans-Dichloroethylene	Halocarbon	
1,2,4-Trichlorobenzene	Chlorinated Aromatics	
1,1,1-Trichloroethane	Halocarbon	
1,1,2-Trichloroethane	Halocarbon	Vinyl Trichloride
Trichloroethylene	Halocarbon	Trichloroethene; Ethinyl Trichloride
Trichlorofluoromethane	Halocarbon	Fluorotrichloromethane
2,4,5-Trichlorophenol	Chlorinated Aromatics	
2,4,6-Trichlorophenol	Phenols	Dowicide 25; Omal
Vanadium	Metals	
Vinyl Acetate		
Vinyl Chloride	Halocarbons	Chloroethylene
Xylenes	Aromatics	
Zinc	Metals	

SOURCE: adapted. from Shuckrow et al. 1980

APPENDIX F

GLOSSARY OF ACRONYMS

ACI	Acceptable Chronic Intake, developed by EPA's Environmental Criteria and Assessment office.
ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980.Also known as Superfund.
CLP	Contract Laboratory Program
CRDL	Contract Required Detection Limit
CRP	Community Relations Plan
DWAL	Drinking Water Action Levels
DWEL	Drinking Water Equivalent Levels
EE/CA	Engineering Evaluation and Cost Analysis
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ERCS	Emergency Response Cleanup Services
ERA	Expedited Response Action
FS	Feasibility Study
GAC	Granular Activated Carbon
HA	Health Advisory
HEA	Health Effects Assessment
ISO	Insurance Services Office
MCL	Maximum Contaminant Level, established under the Safe Drinking Water Act.
MCLG	Maximum Contaminant Level Goal
NCP	National Oil and Hazardous Substance Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priorities List
OERR	Office of Emergency and Remedial Response, U.S. EPA
OSC	On-Scene Coordinator
PAS	Policy Analysis Staff
RAMP	Remedial Action Management Plan
RI	Remedial Investigation
RPM	Remedial Project Manager
ROD	Record of Decision
SARA	Superfund Amendments Reauthorization Act
SDWA	Safe Drinking Water Act
USGS	U.S. Geological Survey
USPHS	U.S. Public Health Service
WQC	Water Quality Criteria

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