United States
Environmental Protection Agency

Office of Solid Waste
Washington, DC 20460

EPA 530-R-99-005
December 1998

EPA

Industrial Waste Air Model (IWAIR) User's Guide

Table of Contents

Table of Contents (continued)

List of Figures

List of Tables

1.0 Introduction

This document describes how to use the Industrial Waste Air Model (IWAIR). A companion document, the *Industrial Waste Air Model (IWAIR) Technical Background Document*, provides technical background information. This section provides an overview of IWAIR, its purpose, operation, and application. The three major components of the system, the emissions, dispersion, and results models, are described, and an overview of the remainder of this User's Guide is provided.

1.1 Guide for Industrial Waste Management and IWAIR

EPA and representatives from 12 state environmental agencies have developed a voluntary *Guide for Industrial Waste Management* to recommend a baseline of protective design and operating practices to manage industrial non-hazardous waste throughout the country. The guidance is designed for facility managers, regulatory agency staff and the public and reflects four underlying principles:

- Adopt a multimedia approach to protect human health and the environment;
- Tailor management practices to risk in this enormously diverse universe of waste, using the innovative user friendly modeling tools provided in the *Guide;*
- Reaffirm state and tribal leadership in ensuring protective industrial waste management and use the *Guide* to complement their programs;
- Foster partnerships among facility managers, the public and regulatory agencies.

The *Guide* recommends best management practices and the key factors to take into account to protect groundwater, surface water and ambient air quality in siting, operation, design, monitoring, corrective action, closure and post closure care. In particular the guidance recommends risk-based approaches to choose liner systems and waste application rates for groundwater protection and to evaluate the need for air controls. The CD ROM version of the *Guide* includes user friendly air and ground-water models to conduct these risk evaluations.

The chapter of the *Guide* entitled "Protecting Air Quality" highlights several key recommendations:

- Adopt controls to minimize particulate emissions.
- Determine whether waste management units at a facility are addressed by Clean Air Act requirements and comply with those requirements.

- If waste management units are not specifically addressed by Clean Air Act requirements, use IWAIR to assess risks associated with volatile air emissions from units.

- Implement pollution prevention, treatment or controls to reduce volatile air emission risks.

EPA developed the Industrial Waste Air Model (IWAIR) and this User's Guide to accompany the *Guide* to evaluate inhalation risks. Workers and residents in the vicinity of a unit may be exposed to volatile chemicals from the unit in the air they breathe. Exposure to some of these chemicals at sufficient concentrations may cause a variety of cancer and noncancer health effects (such as developmental effects in the fetus or neurological effects in an adult). With a limited amount of site-specific information IWAIR can estimate whether specific wastes and management practices may pose an unacceptable risk to human health.

1.2 Model Design

IWAIR is an interactive computer program with three main components: an emission model; a dispersion model to estimate fate and transport of constituents through the atmosphere and determine ambient air concentrations at specified receptor locations; and a risk model to calculate either the risk to exposed individuals or waste constituent concentrations that can be protectively managed in the unit. The program requires only a limited amount of site-specific information, including facility location, WMU characteristics, waste characteristics, and receptor information. A brief description of each component follows. The *IWAIR Technical Background Document* contains a more detailed explanation of each.

1.2.1 Emission Model

The emission model uses waste characterization, WMU, and facility information to estimate emissions for 95 constituents identified in Table 1-1. The emission model selected for incorporation into IWAIR is EPA's CHEMDAT8 model. This model has undergone extensive review by both EPA and industry representatives and is publicly available from EPA's Web page (http://www.epa.gov/ttn/chief/software.html).

To facilitate emission modeling with CHEMDAT8, IWAIR prompts the user to provide the required waste- and unit-specific data. Once these data are entered, the model calculates and displays chemical-specific emission rates. If users decide not to develop or use the CHEMDAT8 rates, they can enter their own site-specific emission rates (g/m^2-s).

Table 1-1. Constituents Included in IWAIR

Chemical Abstracts (CAS) Number	Compound Name	Chemical Abstracts (CAS) Number	Compound Name
75070	Acetaldehyde	77474	Hexachlorocyclopentadiene
67641	Acetone	67721	Hexachloroethane
75058	Acetonitrile	78591	Isophorone
107028	Acrolein	7439976	Mercury
79061	Acrylamide	67561	Methanol
79107	Acrylic acid	110496	Methoxyethanol acetate, 2-
107131	Acrylonitrile	109864	Methoxyethanol, 2-
107051	Allyl chloride	74839	Methyl bromide
62533	Aniline	74873	Methyl chloride
71432	Benzene	78933	Methyl ethyl ketone
92875	Benzidine	108101	Methyl isobutyl ketone
50328	Benzo(a)pyrene	80626	Methyl methacrylate
75274	Bromodichloromethane	1634044	Methyl tert-butyl ether
106990	Butadiene, 1,3-	56495	Methylcholanthrene, 3-
75150	Carbon disulfide	75092	Methylene chloride
56235	Carbon tetrachloride	68122	N,N-Dimethyl formamide
108907	Chlorobenzene	91203	Naphthalene
124481	Chlorodibromomethane	110543	n-Hexane
67663	Chloroform	98953	Nitrobenzene
95578	Chlorophenol, 2-	79469	Nitropropane, 2-
126998	Chloroprene	55185	N-Nitrosodiethylamine
10061015	cis-1,3-Dichloropropylene	924163	N-Nitrosodi-n-butylamine
1319773	Cresols (total)	930552	N-Nitrosopyrrolidine
98828	Cumene	95501	o-Dichlorobenzene
108930	Cyclohexanol	95534	o-Toluidine
96128	Dibromo-3-chloropropane, 1,2-	106467	p-Dichlorobenzene
75718	Dichlorodifluoromethane	108952	Phenol
107062	Dichloroethane, 1,2-	85449	Phthalic anhydride
75354	Dichloroethylene, 1,1-	75569	Propylene oxide
78875	Dichloropropane, 1,2 -	110861	Pyridine
57976	Dimethylbenz[a]anthracene, 7,12-	100425	Styrene
95658	Dimethylphenol, 3,4-	1746016	TCDD, 2,3,7,8 -
121142	Dinitrotoluene, 2,4-	630206	Tetrachloroethane, 1,1,1,2-
123911	Dioxane, 1,4-	79345	Tetrachloroethane, 1,1,2,2-
122667	Diphenylhydrazine, 1,2-	127184	Tetrachloroethylene
106898	Epichlorohydrin	108883	Toluene
106887	Epoxybutane, 1,2-	10061026	trans-1,3-Dichloropropylene
111159	Ethoxyethanol acetate, 2-	75252	Tribromomethane
110805	Ethoxyethanol, 2-	76131	Trichloro-1,2,2-trifluoroethane, 1,1,2-
100414	Ethylbenzene	120821	Trichlorobenzene, 1,2,4-
106934	Ethylene dibromide	71556	Trichloroethane, 1,1,1-
107211	Ethylene glycol	79005	Trichloroethane, 1,1,2-
75218	Ethylene oxide	79016	Trichloroethylene
50000	Formaldehyde	75694	Trichlorofluoromethane
98011	Furfural	121448	Triethylamine
87683	Hexachloro-1,3-butadiene	108054	Vinyl acetate
118741	Hexachlorobenzene	75014	Vinyl chloride
		1330207	Xylenes

1.2.2 Dispersion Model

IWAIR's second modeling component estimates dispersion of volatilized contaminants and determines air concentrations at specified receptor locations, using default dispersion factors developed with EPA's Industrial Source Complex, Short-Term Model, version 3 (ISCST3). ISCST3 was run to calculate dispersion for a standardized unit emission rate (1 $\mu g/m^2$ - s) to obtain a unitized air concentration (UAC), also called a dispersion factor, which is measured in $\mu g/m^3$ per $\mu g/m^2$ -s. The total air concentration estimates are then developed by multiplying the constituent-specific emission rates derived from CHEMDAT8 (or from another source) with a site-specific dispersion factor. Running ISCST3 to develop a new dispersion factor for each location/WMU is very time consuming, and requires extensive meteorological data and technical expertise. Therefore IWAIR incorporates default dispersion factors developed using ISCST3 for many separate scenarios designed to cover a broad range of unit characteristics, including:

- 29 meteorological stations, chosen to represent the nine general climate regions of the continental U.S.;
- 4 unit types;
- 14 surface area sizes for landfills, land application units, and surface impoundments, and 7 surface area sizes and 2 heights for waste piles;
- 6 receptor distances from the unit (25, 50, 75, 150, 500, 1000 meters);
- 16 directions in relation to the edge of the unit.

The default dispersion factors were derived by modeling each of these scenarios, then choosing as the default the maximum dispersion factor for each waste management unit/surface area/meteorological station/receptor distance combination.

Based on the size and location of a unit, as specified by a user, IWAIR selects an appropriate dispersion factor from the default dispersion factors in the model. If the user specifies a unit surface area that falls between two of the sizes already modeled, a linear interpolation method will estimate dispersion in relation to the two closest unit sizes.

Alternatively, a user may enter a site-specific dispersion factor developed by conducting independent modeling with ISCST3 or with a different model and proceed to the next step, the risk calculation.

1.2.3 Risk Model

The third component combines the constituent's air concentration with receptor exposure factors and toxicity benchmarks to calculate either the risk from concentrations managed in the unit or the waste

concentration (C_w) in the unit that must not be exceeded to protect human health. In calculating either estimate, the model applies default values for exposure factors, including inhalation rate, body weight, exposure duration, and exposure frequency. These default values are based on data presented in EPA's *Exposure Factors Handbook* (U.S. EPA, 1997a) and represent average exposure conditions. IWAIR maintains standard health benchmarks (cancer slope factors for carcinogens and reference concentrations for noncarcinogens) for 95 constituents. These health benchmarks are from the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1998a, 1997b). IWAIR uses these data to perform either a forward calculation to obtain risk estimates or a backward calculation to obtain protective waste concentration estimates.

1.3 Estimation Process

Figure 1-1 provides an overview of the stepwise approach the user follows to calculate risk or protective waste concentration estimates with IWAIR. The seven steps of the estimation process are shown down the right side of the figure, and the user input requirements are specified to the left of each step. As the user provides input data, the program proceeds to the next step. Each step of the estimation process is discussed below.

1. **Select Calculation Method.** Select one of two calculation methods. Use the forward calculation to arrive at chemical-specific and cumulative risk estimates if the user knows the concentrations of constituents in the waste. Use the backward calculation method to estimate protective waste concentrations not to be exceeded in new units.

2. **Identify Waste Management Unit.** Four WMU types can be modeled: surface impoundments (SIs), land application units (LAUs), active landfills (LFs), and wastepiles (WPs). For each WMU, you will be asked to specify some design and operating parameters such as waste quantity, surface area and depth for surface impoundments and landfills, height for wastepiles, and tilling depth for LAUs. The amount of unit-specific data needed as input will vary depending on whether the user elects to develop CHEMDAT8 emission rates. IWAIR provides default values for several of the operating parameters that you may use, if appropriate.

3. **Define Waste Managed.** Specify constituents and concentrations in the waste if you choose a forward calculation to arrive at chemical specific risk estimates. If you choose a backward calculation to estimate protective waste concentrations, then specify constituents of concern.

4. **Determine Emission Rates.** You can elect to develop CHEMDAT8 emission rates or provide your own site-specific emission rates for use in calculations. IWAIR will also ask for facility location information to link the facility's location to one of the 29 IWAIR meteorological stations. Data from the meteorological stations provide wind speed and temperature information needed to develop emission estimates. In some circumstances, you may already have emissions information from monitoring or a previous modeling exercise. As an alternative to using the CHEMDAT8 rates, you may provide your own site-specific emission rates developed with a different model or based on emission measurements.

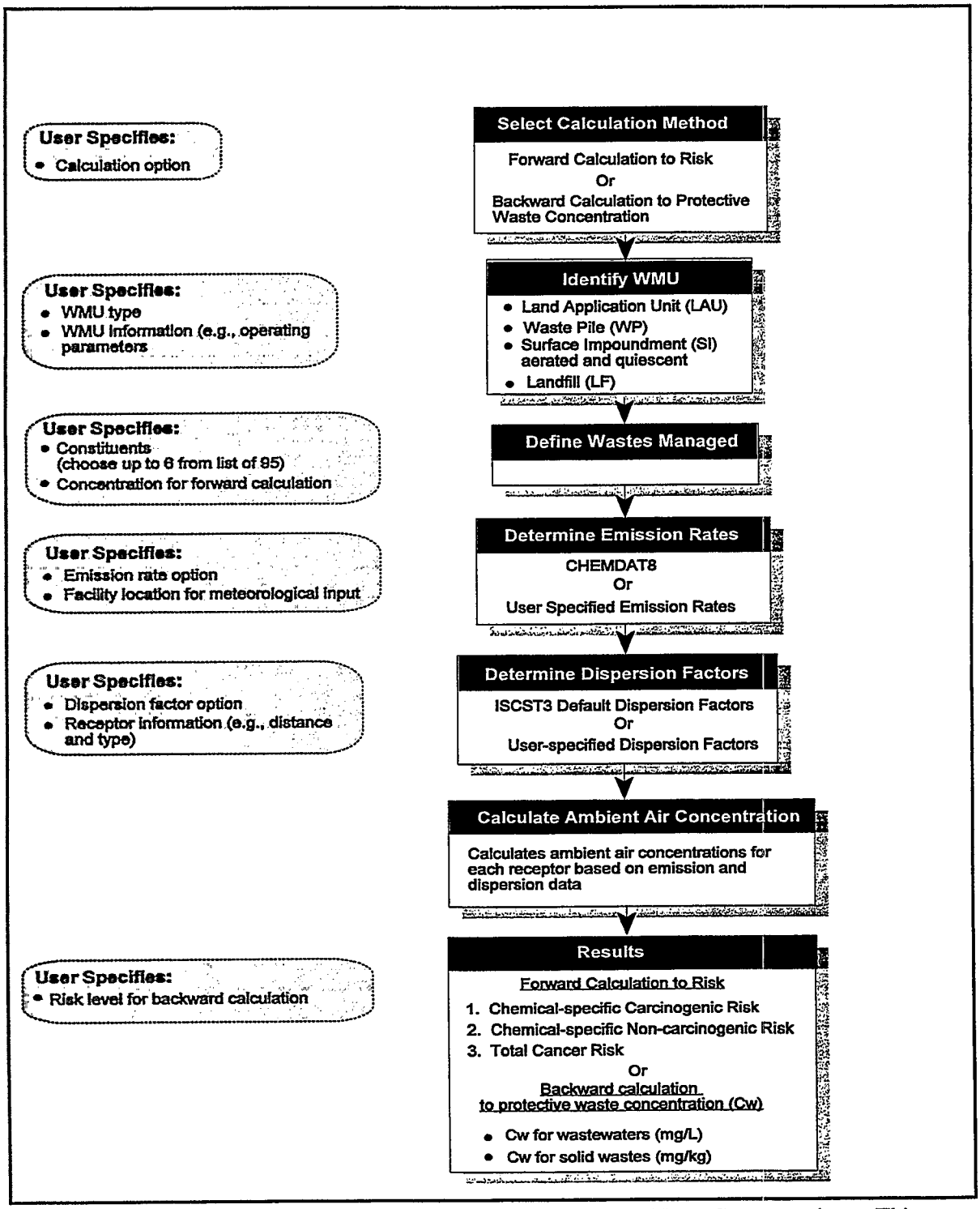


Figure 1-1. IWAIR Approach for Developing Risk or Protective Waste Concentrations: This figure shows the steps in the tool to assist the user in developing risk or protective waste concentration estimates.

4. **Determine Dispersion.** You can provide site-specific unitized dispersion factors ($\mu g/m^3$ per $\mu g/m^2$-s) or have the model develop dispersion factors based on user-specified WMU information and the IWAIR default dispersion data. Because a number of assumptions were made in developing the IWAIR default dispersion data (for example, flat terrain was assumed), you may elect to provide site-specific dispersion factors which can be developed by conducting independent modeling with ISCST3 or with a different model. Whether you use IWAIR or provide dispersion factors from another source, specify distance to the receptor from the edge of the WMU and the receptor type (i.e., resident or worker). These data are used to define points of exposure.

5. **Calculate Ambient Air Concentration.** For each receptor, the model combines emission rates and dispersion data to estimate ambient air concentrations for all waste constituents of concern.

6. **Calculate Results.** The model calculates results by combining estimated ambient air concentrations at a specified exposure point with receptor exposure factors and toxicity benchmarks. Presentation of results depends on whether you chose a forward or backward calculation:

   Forward calculation: Results are estimates of cancer and non-cancer risks from inhalation exposure to volatilized constituents in the waste. If risks are too high, options are: 1) implement unit controls to reduce volatile air emissions; 2) implement pollution prevention or treatment to reduce volatile organic compound (VOC) concentrations before the waste enters the unit; or 3) conduct a full site-specific risk assessment to more precisely characterize risks from the unit.

   Backward calculation: Results are estimates of constituent concentrations in waste that can be protectively managed in the unit so as not to exceed a defined risk level (e.g., 1×10^{-6} or hazard quotient of 1) for specified receptors. This information should be used to determine preferred characteristics for wastes entering the unit. There are several options if it appears that planned waste concentrations may be too high: 1) implement pollution prevention or treatment to reduce VOC concentrations in the waste; 2) modify waste management practices to better control VOCs (for example, use closed tanks rather than surface impoundments); or 3) conduct a full site-specific risk assessment to more precisely characterize risks from the unit.

1.4 Capabilities and Limitations of the Model

In many cases, IWAIR will provide a reasonable alternative to conducting a full-scale site-specific risk analysis to determine if a WMU poses unacceptable risk to human health. However, because the model can accommodate only a limited amount of site-specific information, it is important to understand its capabilities and recognize situations when it may not be appropriate or when another model would be a better choice.

Capabilities

- The model provides a reasonable, conservative representation of VOC inhalation risks associated with waste management units.
- The model is easy to use and requires a minimal amount of data and expertise.
- The model is flexible and provides features to meet a variety of user needs:
  - You can enter emission and/or dispersion factors derived from another model (perhaps to avoid some of the limitations below) and still use IWAIR to conduct a risk evaluation.
  - The model can run a forward calculation from the unit or a backward calculation from the receptor point.
  - You can modify health benchmarks (HBNs) and target risk level, when appropriate and in consultation with other stakeholders.

Limitations

- *Chemicals of Concern.* If waste contains chemicals that (1) are not included in the model (see Table 1-1) and (2) have human health effects and may be present in concentrations sufficient to pose a risk to public health via inhalation exposure, the model will not fully characterize risks for that WMU since these additional chemicals would be excluded from consideration.
- *Release Mechanisms and Exposure Routes.* The model considers exposures from breathing ambient air. It does not address potential risks attributable to particulate releases nor does it address risks associated with indirect routes of exposure (i.e, noninhalation routes of exposure). Additionally, in the absence of user-specified emission rates, volatile emission estimates are developed with CHEMDAT8 based on unit- and waste-specific data. The CHEMDAT8 model was developed to address only volatile emissions from waste management units. Competing mechanisms such as runoff, erosion, and leaching are not accounted for in the model. In so much as these competing processes actually occur, the model would tend to slightly overestimate the volatile emissions. On the other hand, one could interpret this situation as being representative of WMUs that have leachate controls, such as liners, or erosion and runoff controls. Such controls would tend to inhibit these processes and result in more volatile emissions.
- *Waste Management Practices.* The user specifies a number of unit-specific parameters that significantly impact the inhalation pathway (e.g., size, type, and location of WMU, which is important in identifying meteorological conditions). However, the model cannot

accommodate information concerning control technologies such as covers that might influence the degree of volatilization (e.g., whether a wastepile is covered immediately after application of new waste). In this case, it may be necessary to generate site-specific emission rates and enter those into IWAIR.

- *Terrain and Meteorological Conditions.* If a facility is located in an area of intermediate or complex terrain or with unusual meteorological conditions, it may be necessary to either (1) generate site-specific air dispersion modeling results for the site and enter those results into the program, or (2) use a site-specific risk modeling approach other than IWAIR. The model will inform the user which of the 29 meteorological stations is used for a facility. If the local meteorological conditions are very different from the site chosen by the model, it would be more accurate to choose a different model.

  The terrain type surrounding a facility can impact air dispersion modeling results and ultimately risk estimates. In performing air dispersion modeling to develop the IWAIR default dispersion factors, it was assumed that the facility was located in an area of simple or flat terrain. The *Guideline on Air Quality Models* (U.S. EPA, 1993) can assist users in determining whether a facility is in an area of simple, intermediate, or complex terrain.

- *Receptors Type and Location.* IWAIR has predetermined worker and resident receptors, six receptor locations, and predetermined exposure factors. The program cannot be used to characterize risk for other possible exposure scenarios. For example, the model can not evaluate receptors that are closer to the unit than 25 meters or those that are further from the unit than 1000 meters.

1.5 About This User's Guide

The focal point of this User's Guide is to encourage management practices that are protective of human health and the environment. The remainder of this document is organized into five sections:

- Section 2, *Getting Started,* identifies system requirements for running IWAIR, provides stepwise guidance for installing the program, and introduces the user to program screens and navigational tools (e.g., menu tabs, toolbar, and buttons). It also includes the troubleshooting guide.

- Section 3, *Selecting Calculation Method, WMU Type, and Modeling Pathways*, assists you, in selecting the appropriate calculation method (i.e., forward calculation to risk estimates or backward calculation to protective waste concentration), waste management unit type, and modeling pathway. After selecting a calculation mode, the WMU type is selected. This section describes the types of units addressed by the model.

  With both forward and backward calculation, you can select from four modeling pathways. These four pathways are:

Pathway 1: Using CHEMDAT8 emission rates and ISCST3 default dispersion factors
Pathway 2: Using CHEMDAT8 emission rates and user-specified dispersion factors
Pathway 3: Using user-specified emission rates and ISCST3 default dispersion factors
Pathway 4: Using user-specified emission rates and dispersion factors.

Depending on the calculation method, you will be directed to follow the detailed guidance provided in Section 4 for completing a forward calculation or Section 5 for completing a backward calculation. Each of these sections provides pathway-specific guidance as needed.

- Section 4, *Completing Forward Calculations to Risk*, provides detailed guidance to develop risk estimates for wastes of known chemical concentration(s). Follow the screen-by-screen guidance to arrive at risk estimates.

- Section 5, *Completing Backward Calculation to Protective Waste Concentration*, provides detailed guidance to predict protective waste levels based on a user-specified risk level. Again follow the screen-by-screen guidance to complete a backward calculation.

- Section 6, *Example Calculation*, provides a detailed example of how the program can be used to perform forward calculations to estimate inhalation risk or backward calculations to estimate protective waste concentrations.

A separate document, *Industrial Waste Air Model Technical Background Document*, provides detailed discussions on the CHEMDAT8 emission model, the ISCST3 model and modeling efforts conducted to develop the IWAIR default dispersion factors, and health benchmarks included in IWAIR.

2.0 Getting Started

2.1 Hardware and Software Requirements

The IWAIR tool is a 16-bit Visual Basic application designed to run on an IBM®-compatible machine with Windows® 3.1 or Windows® 95 operating systems. It is recommended that the computer on which this program is installed have at least 16 megabytes (preferably 32 MB) of RAM and a 486 CPU processor (preferably Pentium® processor). About 10 Mb of free hard drive space is required. The program does not require any additional software.

2.2 Installing the Program

The IWAIR computer program is provided to the user on the Guidance CD ROM. Instructions for installing and uninstalling the program on a computer running either the Windows 3.1 or Windows 95 operating system are provided below.

Installing from Windows 3.1:

1. Insert CD ROM into your CD ROM drive.
2. Open **File Manager**.
3. Select the CD ROM drive.
4. Double click on **Setup.exe**.
5. The setup program will prompt you to enter a name for the directory in which IWAIR 1.0 will be installed.
6. Follow the instructions on the screen.

OR

1. Insert CD ROM into your CD ROM drive.
2. From the Windows **FILE** menu, select *Run*.
3. Type 'D:\SETUP' or, as appropriate, replace D: in this command with the correct drive designation.
4. Press Enter or select OK.
5. The setup program will prompt you to enter a name for the directory in which IWAIR 1.0 will be installed.
6. Follow the instructions on the screen.

Uninstalling from Windows 3.1:

1. Open **File Manager**.
2. Open IWAIR directory folder.
4. Double click on **Uninstall.exe (or Unwise.exe)**.
5. The uninstall program will navigate you through removing the program from your computer.
6. Follow the instructions on the screen.

Installing from Windows 95

1. Insert CD ROM into your CD ROM drive.
2. Open **My Computer.**
3. Select the CD ROM drive.
4. Double click on **Setup.exe**.
4. The setup program will prompt you to enter a name for the directory in which IWAIR 1.0 will be installed. If no directory is specified, the program will automatically be installed in a directory called IWAIR under the Windows 95 Program Files subdirectory.
5. Follow the instructions on the screen.

OR

1. Insert CD ROM into your CD ROM drive.
2. Select Start, Run.
3. Type 'D:\SETUP' or, as appropriate, replace D: in this command with the correct drive designation.
4. Press Enter or select OK.
5. The setup program will prompt you to enter a name for the directory in which IWAIR 1.0 will be installed. If no directory is specified, the program will automatically be installed in a directory called IWAIR under the Windows 95 Program Files subdirectory.
6. Follow the instructions on the screen.

Uninstalling from Windows 95

1. Select **Start**.
2. Navigate system and select **Windows Explorer**.
3. Open IWAIR directory folder.
4. Double click on **Uninstall.exe (or Unwise.exe)**.
5. The uninstall program will navigate you through removing the program from your computer.
6. Follow the instructions on the screen.

2.3 Running IWAIR

To run the program from Windows 3.1, double click on the IWAIR icon. From Windows 95, navigate the Windows 95 Start menu to find and select the IWAIR folder and double-click the IWAIR.exe file, or double click on the IWAIR icon on the desktop.

2.4 Starting the Program

Start IWAIR by clicking on the START button of the program title page. During a single run, the program can be used to conduct modeling for one unit (choice of four unit types: surface impoundment, land application unit, active landfill, and wastepile) and will simultaneously evaluate up to six chemicals of concern and up to five different receptors. Once the START button is selected, the program automatically opens the Method, Met Station, WMU menu tab.

2.5 Navigating the Tool

The following tools facilitate user interaction with the IWAIR program:

- Menu tabs
- Menu bar
- Command buttons
- Message prompts.

Each of these tools is explained in more detail in this section.

Menu Tabs

Menu tabs facilitate navigation between the different screens in the program. Clicking a tab opens the screen associated with it. You can enter information and edit data on an opened screen. There are six menu tabs, one for each of the following screens:

- Method, Met. Station, WMU
- Wastes Managed
- WMU data for CHEMDAT8
- Emission Rates
- Dispersion Factors
- Results.

At any time in the program, you can return to a screen that has already been visited by clicking the tab associated with the screen. You can view information entered on the screen and can also change any information entered on a previously visited screen. Changing data on a previously visited screen has no effect on screens before the changed screen, but does affect screens following the changed screen. Specifically, all calculated values on subsequent screens will be lost, as will any entered data on the Emission Rates, Dispersion Factors, and Results screens if those are after the changed screen. Entered

data on the Wastes Managed and WMU Data for CHEMDAT8 screens will be retained if they are still relevant. Whenever you change data on a previously visited screen, you will have to proceed through the following screens in order (even if the data on them has been retained) to return to where you were before you went back and made the change; this is so that calculated values will be recalculated with the new data. For example, if you were on the Emission Rate screen, and returned to the Method, Met. Station, WMU screen to change meteorological stations, you would still have to proceed through the Wastes Managed and WMU Data for CHEMDAT8 screens, clicking on Done, to return to the Emission Rate screen.

Table 2-1 describes each of these menu tabs and how each screen associated with a tab assists you in providing the program with the inputs needed to perform the calculations. The program automatically opens the next screen after the required information is entered into the data fields and the DONE command button is clicked. To return to a previously completed input screen, click on the menu tab of choice.

Menu Bar

As shown in Figure 2-1, a menu bar is also provided with IWAIR that allows the user to perform tasks such as starting a new run, importing data from a previous run, and exiting the program.

Command Buttons

In addition to the menu tabs and menu bar, several command buttons are provided on each screen that initiate an action by the program. For instance, click the DONE command button after all data have been entered on a screen and you are ready to proceed to the next screen.

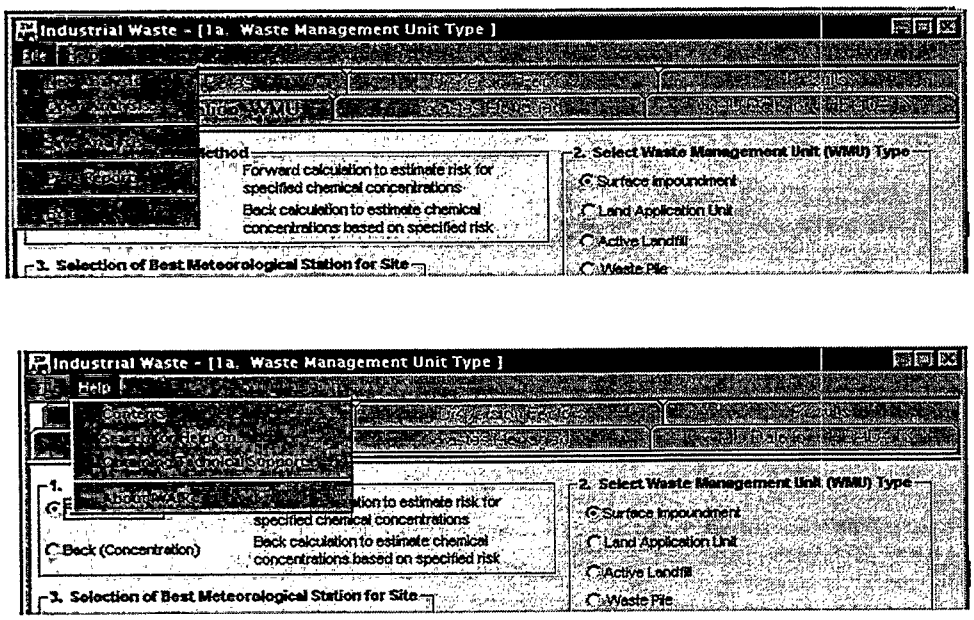


Figure 2-1. Menu bar in the IWAIR program.

Table 2-1. IWAIR Menu Tabs and Associated Screens

Menu Tab	Description of Screen Associated with Menu Tab
Method, Met Station, WMU	• Select calculation method (i.e., forward calculation to inhalation risk or backcalculation to a protective waste concentration). • Select waste management unit (WMU) Type. The WMU choices include surface impoundment, land application unit, active landfill, and wastepile. • Enter zip code or latitude and longitude of site to allow the program to select the most representative meteorological station from the program's 29 stations. • Select whether estimations will be made based on program-generated CHEMDAT8 emission rates and default ISCST3 dispersion factors, user-specified emission rates and default dispersion factors, or a combination of both IWAIR generated and user specified estimates.
Wastes Managed	• Identify up to 6 chemicals that are present in the waste managed in the WMU of concern. You can choose to view chemicals by CAS number or by chemical name (95 chemicals are included in the database in the IWAIR program). • If you selected to perform a forward calculation to risk, then the concentration of each chemical will need to be provided under this screen.
WMU Data for CHEMDAT8	This tab is enabled and its associated screens are opened if you elected to have IWAIR develop chemical-specific emission rates using EPA's CHEMDAT8 model. A variety of site-specific data (e.g., unit dimensions and waste loading information) will need to be provided. Default values are provided adjacent to the data box for several of the input parameters.
Emission Rates	CHEMDAT8 emission rates are viewed and confirmed or user-specified emission rates are entered. Source and justification for user-specified emission rates should also be entered on this screen.
Dispersion Factors	Calculate dispersion factors or provide user-specified dispersion factors. When this tab is clicked, the dispersion factors screen allows you to identify up to 5 receptors (i.e., potentially exposed individuals). For each receptor, the user specifies the distance to the receptor and the receptor type (i.e., resident or worker). Dispersion factors are calculated by the program based on these data. Alternatively, you may enter you own dispersion factors. Source and justification for the user-supplied dispersion factors should also be entered on this screen.
Results	Two different result screens are associated with this tab, one for forward calculation to risk and one for backward calculation to protective waste concentrations. You will be able to: • Select the receptor(s) (up to 5 receptors) for which the calculation is to be performed. • View the chemicals of concern that were selected under the wastes managed screen. • View to confirm input data determined in previous screens. These data include the distance from the unit to the receptor, receptor type, and dispersion factors. These data are to be used by IWAIR in the risk/waste concentration calculations. • View and override program-supplied health benchmarks. If you choose to override these data, the source and justification for the user-supplied benchmarks must be provided. • Calculate results by clicking the CALCULATE button on the forward calculation screen results in the generation and displaying of risk estimates for carcinogens and hazard quotients for noncarcinogens. Clicking the CALCULATE button on the backward calculation screen results in the generation and displaying of protective waste concentrations for each of the chemicals of concern. • Select target risk level (e.g., $1x10^{-5}$, $1x10^{-6}$) and/or a hazard quotient (e.g., 0.5, 1) that will serve as the starting point for the backward calculation for each chemical.

Every screen in the IWAIR has a HELP button so you can easily access the system's online help associated with the screen in use. The format of the help system is the same as that of a standard Windows application.

Message Prompts

The program uses message boxes to communicate important information and to confirm actions before executing a command. For instance, an error message is shown when incorrect, invalid, or incomplete information is entered.

2.6 Online Help

The program provides online help that can be accessed from any screen by clicking on the HELP command button. The HELP command button has a standard Windows format with a contents and searchable index. The online help contains information presented in this document.

2.7 Troubleshooting

Problem Category	Description of problem	Solutions
Display	The gray screens in the program appear "blotched" and are not uniformly gray in color.	Changing your monitor's display settings will fix this problem. For Windows 95 users, under the Control Panel, Display, Settings tab, make sure that the Color Pallette is set for High Color (16 bit) or True Color (32 bit). Note that these options may not be available on all machines, depending on the type of monitor and the drivers used.
	Large fonts on screen, text that drops off the screen, incomplete display tables, etc.	This problem occurs when the computer's memory resources are very low. There are two ways to fix it: • Exit IWAIR and restart the program, or if this does not work, • Restart the computer. If this behavior persists, try closing all other programs except for IWAIR when using it. (See Miscellaneous)
	Screens are not displayed correctly, display not optimized.	The IWAIR program display is optimized for screen resolutions of 800 x 600 pixels or higher. To vastly improve the display of IWAIR screens, increase your screen resolution to 800 x 600 pixels or higher.
Printing	Margins on the printed reports are not adjusted, or text is "cut off" at the edges.	Due to the large quantity of data to be displayed on the reports, the margins selected for the reports are only 0.25 inches. Printing functions were tested on an HP Laser Jet 4/4M and higher grade printers. Using older or dissimilar printers may cause problems during printing.
Uninstalling	No uninstall.exe file in folder	If you cannot find an Uninstall.exe file in the IWAIR folder, search your drive for Unwise.exe. This file will uninstall the IWAIR program.
Miscellaneous	Low system resources message is displayed, or program is crashing frequently	IWAIR may be unstable when other applications are also open due to the memory required for running IWAIR. Close out of all other applications when running IWAIR to free up the maximum resources for the program.

3.0 Selecting Calculation Method, WMU Type, and Modeling Pathway

3.1 Selecting Calculation Method

Each time you begin the program, select the mode of calculation. You can choose from two calculation methods: forward and backward. Click on the option button associated with either the forward (Risk) or the backward (Concentration) calculation option. Each of these options is discussed below.

Forward Calculation Method

The first calculation method is a forward calculation that allows you to develop inhalation risk estimates based on user-specified waste concentrations. Results from the forward calculation method include: (1) chemical-specific cancer risk estimates, (2) total cancer risk estimates (i.e., the summation of the chemical-specific risk estimates), and (3) noncancer risk estimates (i.e., hazard quotients for noncarcinogens in the waste). Use the forward calculation option to develop risk estimates if the concentrations of the constituents in the waste are known. If the program results indicate that the waste poses an unacceptable risk to exposed individuals, then you should consider conducting a more site-specific analysis or implementing corrective measures to reduce the fraction of constituents released to the atmosphere. Such measures could include pretreatment of waste to reduce volatile organic compound (VOC) concentrations before the waste enters the unit or applying unit control technologies or practices to reduce volatile air emissions. The "Protecting Air Quality" chapter of the *Guide for Industrial Waste Management* identifies and discusses some emission control options.

Backward Calculation Method

The second calculation method is a backward calculation that results in the development of waste concentrations (C_w) that are protective of human health. The calculation method can be applied in calculating waste concentrations for both wastewaters (C_w in mg/L) and solid waste (C_w in mg/kg). These concentrations are estimated based on user-defined target cancer and noncancer risk levels (e.g., $1x10^{-5}$ or $1x10^{-6}$ for carcinogens, or hazard quotient [HQ] of 0.5 or 1 for noncarcinogens). You will set these risk levels on a later screen, the Results Screen. The program uses information gathered on the IWAIR screens to calculate a waste concentration for each chemical that would not pose an inhalation risk to the receptor greater than the selected target level. The backward calculation option can be used for estimating protective waste concentrations for those users with units that have not yet received a waste to determine what concentration(s) would pose an unacceptable risk to potentially exposed individuals.

3.2 Selecting WMU Type

Identify the WMUs that are used to manage wastes of concern at your facility and run the model separately for each unit. Each of the four IWAIR unit types (described below) reflect waste management practices that are likely to occur at Industrial Subtitle D facilities.

Surface Impoundment (SI) - In the IWAIR tool, SIs are considered to be ground-based, flowthrough units. The major source of volatile emissions associated with SIs is the uncovered liquid surface exposed to the air (U.S. EPA, 1991). Impoundments can be quiescent or aerated. Aeration and/or agitation are applied to aid in treatment of the waste. Emissions tend to increase with an increase in surface turbulence because of enhanced mass transfer between the liquid and air (U.S. EPA, 1991). IWAIR can conduct emission modeling for both aerated and non-aerated SIs. Parameters to which emissions are most sensitive include surface area, unit depth, waste concentration, retention time, windspeed for quiescent systems, and biodegradation.

Tilled Land Application Units (LAUs) - The waste can be tilled or sprayed directly onto the soil and subsequently mixed with the soil by discing or tilling. Waste in an LAU is a mixture of sludge and soil. IWAIR allows the modeling of tilled LAUs. Spray application was not included because the degree of volatilization associated with this type of application practice is very site-specific and is influenced by a number of variables including meteorological conditions and application equipment. Important characteristics for the tilled LAU include surface area (the exposed area from which volatile emissions can be released) and the application rate (affects the depth of the contamination, which, along with area, defines the extent of the source for volatile emissions).

Landfills (LFs) - IWAIR allows modeling of emissions released from the surface of an active (i.e., receiving wastes) landfill. Volatilization can occur from the surface of the landfill. Important unit characteristics for the landfill include surface area and unit depth. IWAIR assumes that the landfill being modeled is a ground-based emission source.

Wastepiles (WPs) - Wastepiles are typically elevated sources used as temporary storage units for solid wastes. Important characteristics for the wastepile include surface area and height. These parameters define the exposed area from which volatile emissions can be released. Two representative pile heights (2m and 5m) were used in developing the IWAIR default dispersion factors. These values are based on the height a frontloader might be able to reach.

3.3 Determining Appropriate Modeling Pathway

Regardless of the calculation method selected (forward or backward), determine which modeling pathway to follow in using the tool. After deciding upon the appropriate calculation method and modeling pathway, proceed to either Section 4 for detailed guidance for completing forward calculations or Section 5 for backward calculations.

You can choose from four pathways that provide you the flexibility of conducting modeling using IWAIR-generated emissions rates and dispersion factors, user-specified emission and dispersion estimates, or a combination of both IWAIR-generated and user-specified estimates:

- Pathway 1: Using CHEMDAT8 emission rates and ISCST3 default dispersion factors
- Pathway 2: Using CHEMDAT8 emission rates and user-specified dispersion factors
- Pathway 3: Using user-specified emission rates and ISCST3 default dispersion factors
- Pathway 4: Using user-specified emission rates and dispersion factors.

In selecting a pathway, consider the availability of site-specific information. For example, if you have access to a limited amount of site-specific data and do not have access to emissions measurement data, then you will likely want to follow either Pathway 1 or 2 to allow IWAIR to develop CHEMDAT8 emissions rates. Similarly, if you do not have the ability (i.e., resources or access to technical capabilities) to conduct site-specific air dispersion modeling, then you will want to follow either Pathway 1 or 3 to allow IWAIR to develop dispersion factors. If site-specific emission and dispersion rates are accessible or if resources are available to develop these data, Pathway 4 will provide the most refined site-specific results.

Additionally, consider model assumptions and capabilities. Because a number of assumptions are made by IWAIR in modeling emissions and dispersion, use of these features may not be appropriate in all cases. Review the following overviews of CHEMDAT8 emission modeling and ISCST3 default dispersion factors as well as Section 1.4, *Capabilities and Limitations*, prior to choosing a pathway.

Using CHEMDAT8 Emission Rates

EPA's CHEMDAT8 model has been incorporated into the IWAIR program to assist you in the development of chemical-specific emission rates. This model has undergone extensive review by both EPA and industry representatives and is publicly available from EPA's web page (http://www.epa.gov/ttn/chief/software.html).

CHEMDAT8 considers most of the competing removal pathways that might limit air emissions, including adsorption and hydrolysis in surface impoundments, and biodegradation in all

IWAIR Assumptions Made for Modeling Volatile Emissions with CHEMDAT8

- Annual average temperature is determined by assigned meteorological station.
- Waste is homogeneous.

Quiescent and Aerated Surface Impoundment Assumptions:
- Flow-through unit operating at steady state.
- SI is well mixed.
- Biodegradation rate is first order with respect to biomass concentrations.
- Biodegradation rate follows Monod kinetics with respect to contaminant concentrations.
- Hydrolysis rate is first order with respect to contaminant concentrations.

Tilled LAU Assumptions:
- Biodegradation occurs

Landfill Assumptions:
- The active cell is modeled as instantaneously filled at time t=0 and open for 1 year.
- Cells are either depleted of the constituent or capped after 1 year.
- No biodegradation.

Wastepile Assumptions:
- Wastepile operates with fixed volume.
- Biodegradation occurs.

types of units. Adsorption is the tendency of a chemical to attach or bind to the surface of particles in the soil or waste and therefore not volatilize into the air. This tendency to adsorb to particles is an important process for estimating the concentration of the chemical on particles emitted to the air due to wind erosion. Biodegradation is the tendency of a chemical to be broken down or decomposed into less-complex chemicals by organisms in the waste or soil; for IWAIR, biodegradation is not modeled for landfills, but is modeled for all other WMU types. Similarly, hydrolysis is the tendency of a chemical to be broken down or decomposed into less-complex chemicals by reaction with water. Chemicals that decompose due to either biodegradation or hydrolysis have lower potential for emission to the air as gases or particles. Loss of contaminant by leaching or runoff is not included in the CHEMDAT8 model. Both leaching and runoff are a function of a chemical's tendency to become soluble in water and follow the flow of water (e.g., due to rainfall) down through the soil to groundwater (leaching) or downhill to surface water (runoff). These two mechanisms would also result in less chemical being available for emission to the air as gases or particles. CHEMDAT8 is considered to provide reasonable to slightly high (environmentally conservative) estimates of air emissions from the various emission sources. A more detailed discussion of the emissions modeling is provided in the *IWAIR Technical Background Document.*

Using ISCST3 Default Dispersion Factors

The IWAIR default dispersion factors were developed by conducting air dispersion modeling with EPA ISCST3 (U.S. EPA, 1995). This model is capable of modeling ground-level and elevated area sources. As part of this effort, landfills, LAUs, and SIs were modeled as ground-level area sources and wastepiles were treated as elevated area sources.

Because the ISCST3 model has considerable run times for area sources, modeling was conducted for a limited number of WMUs of representative sizes (i.e., surface area) using meteorological data obtained from 29 meteorological stations. The representative WMUs were selected from the 1985 Screening Survey of Industrial Subtitle D Establishments (Shroeder et al., 1987). This database is the most comprehensive database that EPA has to date on waste unit characteristics. This database contains data on 6,254 SIs, 1,281 WPs, 702 LAUs, and 790 LFs. The IWAIR program is designed to cover the range of unit characteristics contained in the database. To facilitate dispersion modeling, the range was divided into strata using a modified version of a statistical method called the Dalenius Hodges procedure. This procedure divided into strata the skewed distribution of areas found in the Industrial D Survey database so that all WMUs in the database would be adequately represented. The median area in each stratum was then used in the dispersion modeling. As a result, 14 surface areas were selected

Assumptions Made for Dispersion Modeling

- An area source was modeled for all WMUs.
- To minimize error due to site orientation, a square area source with sides parallel to X- and Y- axes was modeled.
- Modeling was conducted using a unit emission rate of 1 $\mu g/m^2$-s.
- Receptor points were placed on 25, 50, 75, 150, 500, and 1,000 m receptor squares starting from the edge of the source with 16 receptor points on each square.
- Dry and wet depletion options were not activated in the dispersion modeling.
- The rural option was used in the dispersion modeling since the types of WMUs being assessed are typically in nonurban areas.
- Flat terrain was assumed.

for modeling for the landfills, land application units, and surface impoundments. Seven surface areas were selected for wastepiles.

The ISCST3 modeling was conducted with data obtained from 29 representative meteorological stations. These stations were selected in an assessment for EPA's Superfund Soil Screening Level (SSL) program (EQM, 1993) as being representative of the nine general climate regions of the continental United States. The dispersion modeling was conducted using 5 years of data from each of the 29 meteorological stations. The meteorological data required as input to the ISCST3 model included hourly readings for the following parameters: wind direction, windspeed (m/s), ambient temperature (K), mixing height, and stability class.

Key Meteorological Data for the ISCST3 Model without Depletion

Wind Direction: determines the direction of the greatest impacts.

Windspeed: ground-level air concentration is inversely proportional to windspeed, so the lower the windspeed the higher the concentration.

Stability Class: impacts rate of lateral and vertical diffusion. The more unstable the air, the greater the diffusion.

Mixing Height: determines the height to which can be diffused vertically.

Unitized air concentrations (UACs) were obtained as output by running the model with a unit emission rate (i.e., 1 $\mu g/m^2$-s). The selected areas for each type of WMU were modeled using meteorological inputs obtained from the 29 representative meteorological locations in the continental United States. Receptors were placed in 16 directions at distances of 25, 50, 150, 500, and 1,000 meters from the edge of the WMU. Figure 3-1 illustrates the pattern of receptor placement around the unit. Receptor placement was made based on a sensitivity analysis that was conducted to determine the locations and spacings that would provide adequate resolution without modeling an excessive number of receptors. The resulting maximum annual average UACs at each distance serve as the IWAIR default dispersion factors.

Based on the WMU surface area provided by the user, the IWAIR tool selects an appropriate dispersion factor. If the entered WMU surface area lies between two area strata, dispersion factors for the WMU are estimated by a linear interpolation between dispersion factors for WMUs in the database with areas above and below that of the user's entered WMU area. For example, if a user specifies a landfill with a surface area of 8,000 m^2, the program will determine that this surface area falls between two modeled units with surface areas of 4,047 m^2 and 12,546 m^2. A linear interpolation method is then applied to estimates a dispersion factor for the 8,000-m^2 landfill based on the default dispersion factors stored in the IWAIR database for two similarly sized units.

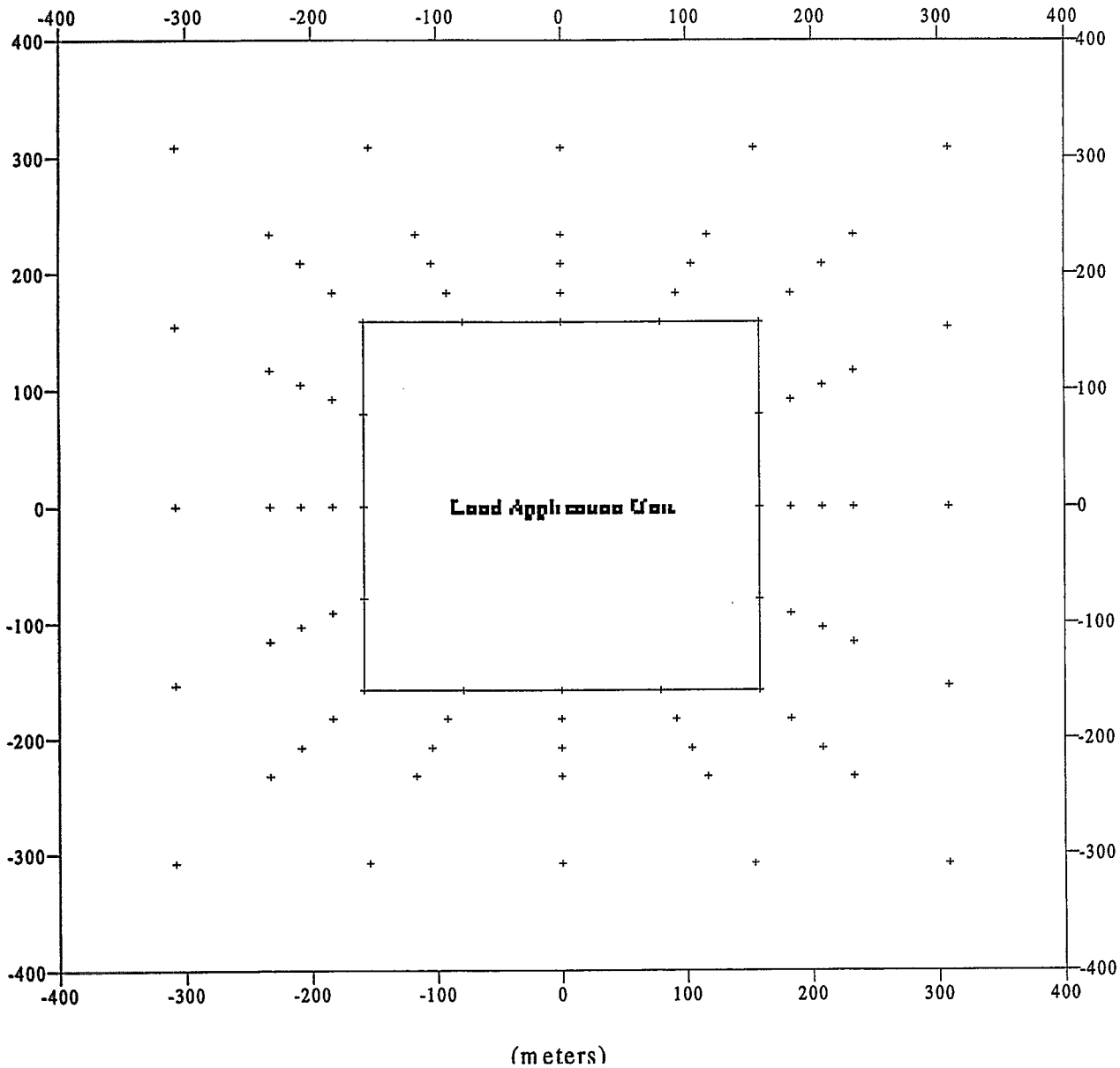


Figure 3-1. Receptor Locations.

4.0 Completing Forward Calculation to Risk

IWAIR allows you to complete a forward calculation to develop inhalation risk estimates for wastes of known chemical concentrations. Results from the forward calculation method include chemical-specific cancer risk estimates, total cancer risk estimates (i.e., the summation of the chemical-specific risk estimates), and noncancer risk estimates (i.e., hazard quotients for noncarcinogens in the waste).

IWAIR is structured in a stepwise framework. Through the use of a series of screens, IWAIR assists in selecting calculation options, identifying and entering required inputs, and generating desired outputs. There are four different pathways you can follow in performing a calculation:

- Pathway 1: Using CHEMDAT8 emission rates and ISCST3 default dispersion factors;
- Pathway 2: Using CHEMDAT8 emission rates and user-specified dispersion factors;
- Pathway 3: Using user-specified emission rates and ISCST3 default dispersion factors; and
- Pathway 4: Using user-specified emission rates and dispersion factors.

Guidance for determining which modeling pathway to follow is provided in Section 3.3. The stepwise approach employed by IWAIR to assist in calculating risk, whether you are following Pathway 1, 2, 3, or 4, is shown in Figures 4-1, 4-2, 4-3, and 4-4, respectively. The seven steps of the estimation process are shown down the right side of each figure, and the user input requirements are specified to the left of each step. The types of input data required will vary depending on the modeling pathway chosen. Screen-by-screen, IWAIR walks you through the steps of a forward calculation to arrive at inhalation risk estimates.

This section provides screen -by screen guidance that describes the data that are required as input to each screen and the assumptions that are interwoven in the calculation being performed. The guidance provided in this section will assist you in completing a forward calculation. You will not need to reference all of the information provided in this section since the guidance addresses all four of the modeling pathways. Follow only those subsections that are applicable to your chosen pathway.

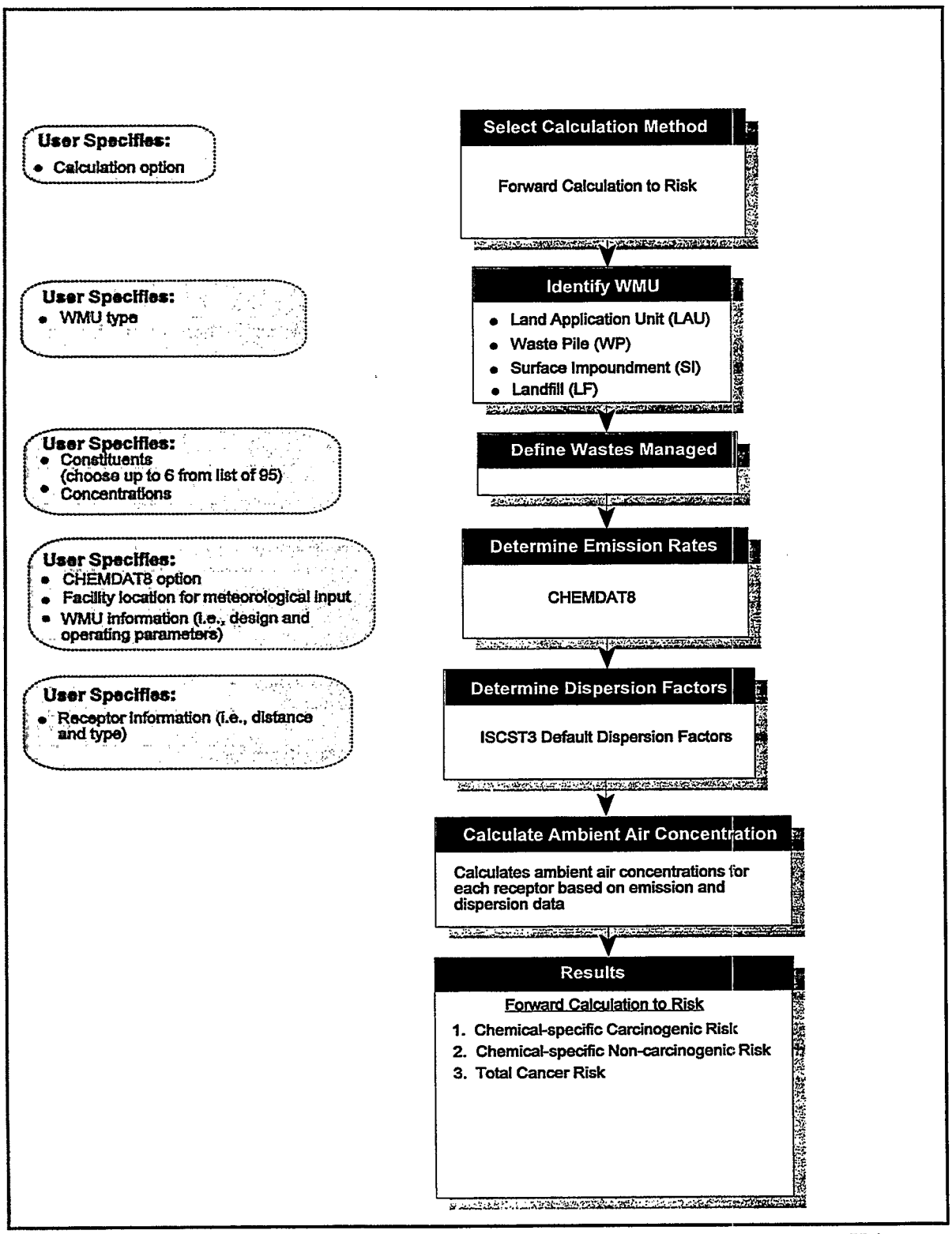


Figure 4-1. IWAIR Approach for Completing Forward Calculation to Risk: Pathway 1 - Using CHEMDAT8 Emission Rates and ISCST3 Default Dispersion Factors.

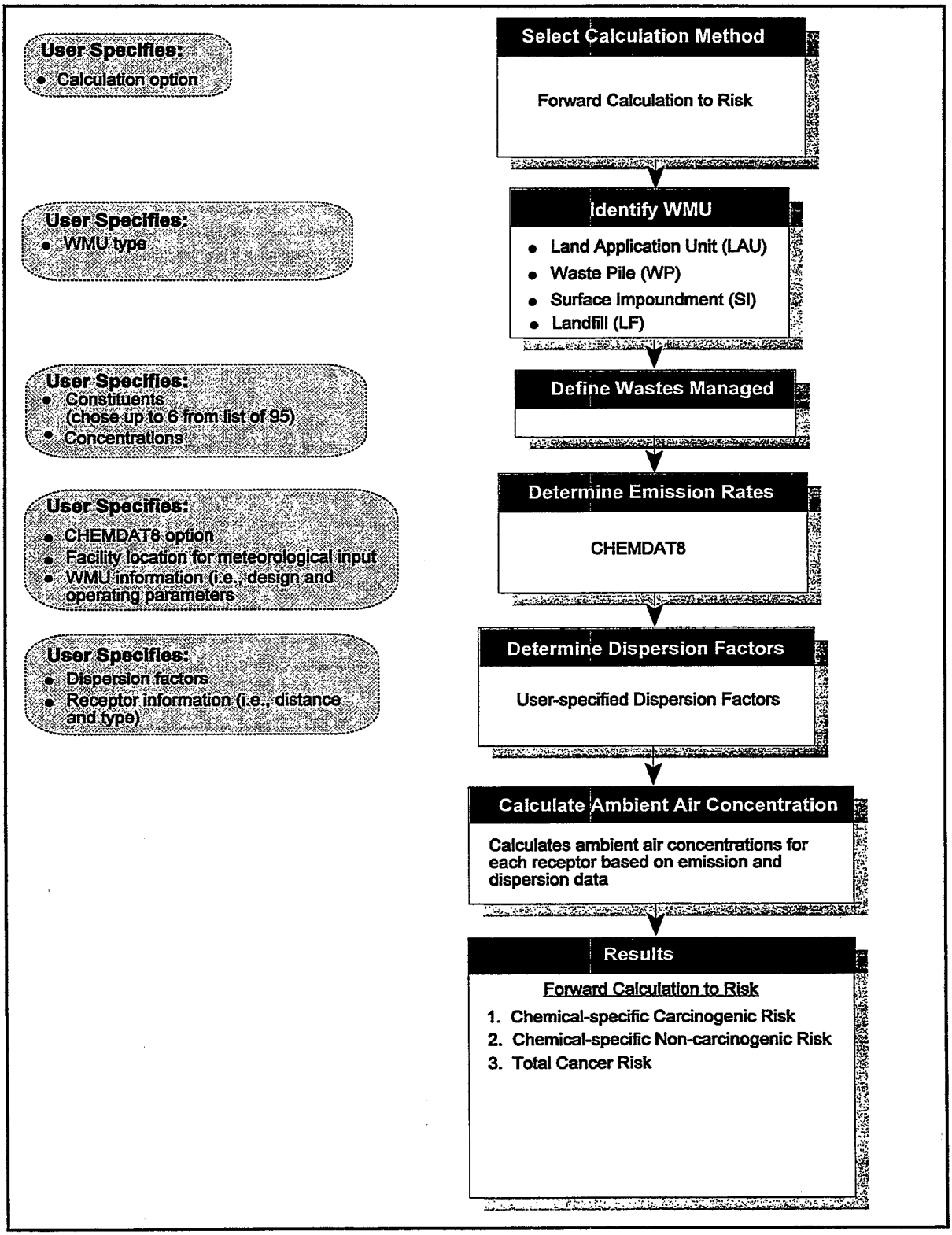


Figure 4-2. IWAIR Approach for Completing Forward Calculation to Risk: Pathway 2 - Using CHEMDAT8 Emission Rates and User-specified Dispersion Factors.

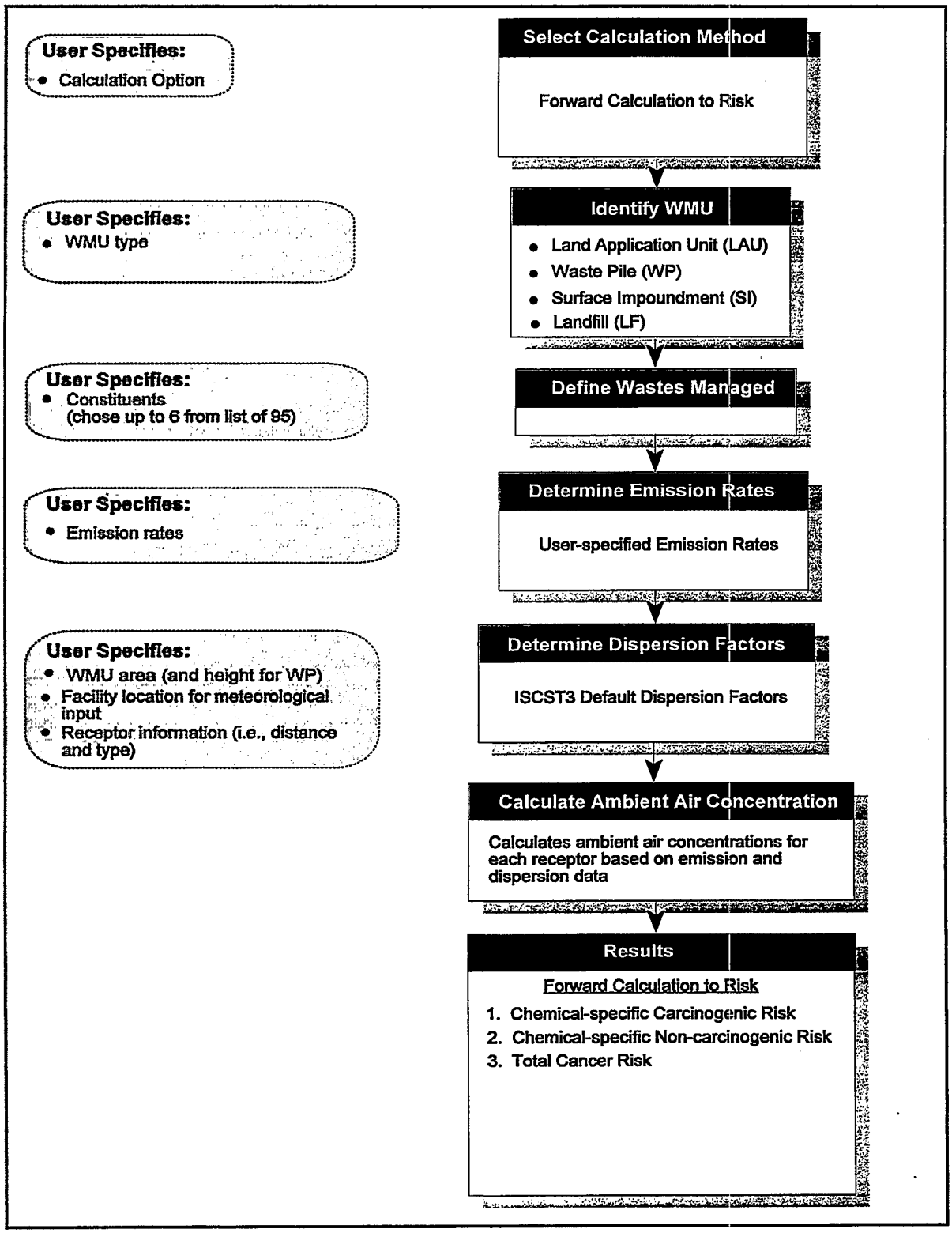


Figure 4-3. IWAIR Approach for Completing Forward Calculation to Risk: Pathway 3 - Using User-specified Emission Rates and ISCST3 Default Dispersion Factors.

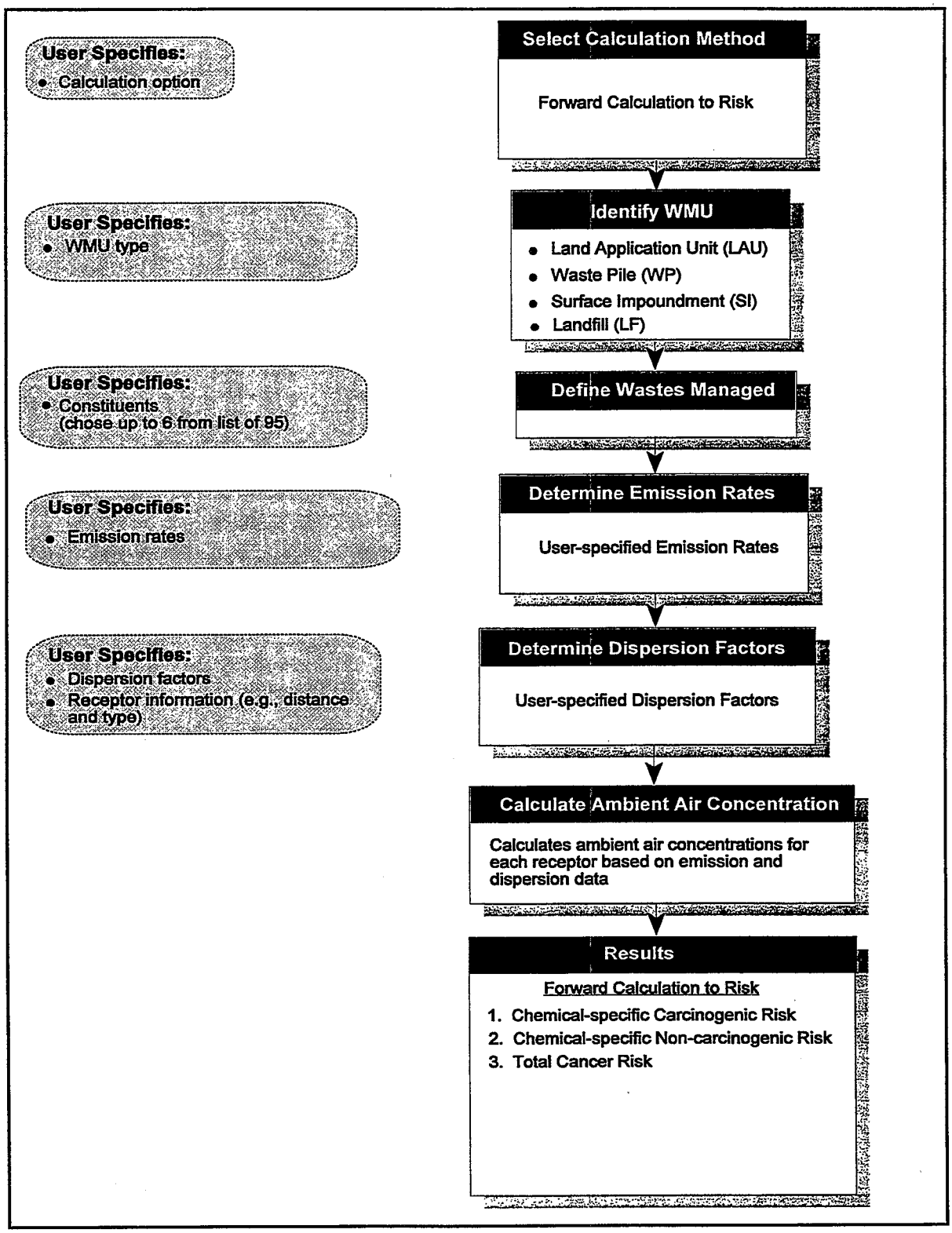
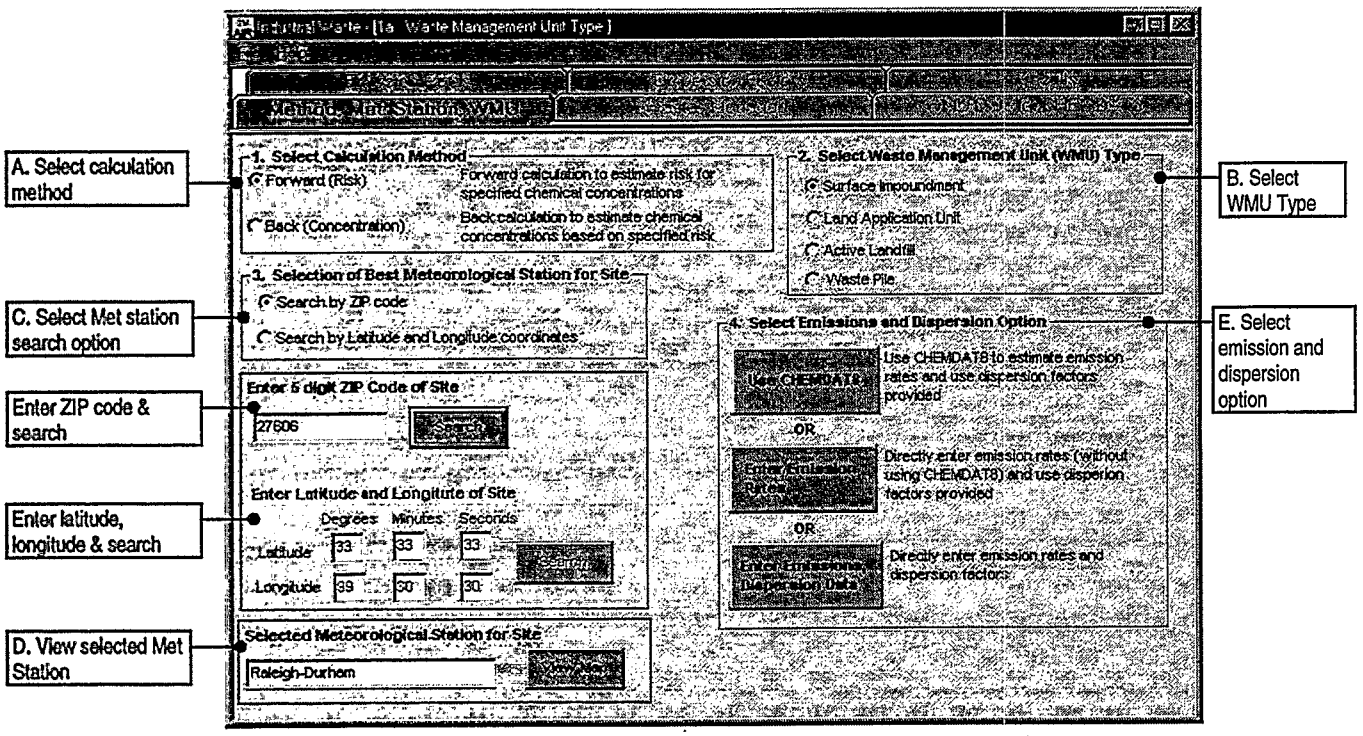


Figure 4-4. IWAIR Approach for Completing Forward Calculation to Risk: Pathway 4 - Using User-specified Emission Rates and Dispersion Factors.



Screen 1A. Method, Meteorological Station, WMU

4.1 Method, Meteorological Station, WMU (Screen 1A)

A. Select Calculation Method (Screen 1A)

Select the calculation method by clicking on the forward (Risk) calculation option button. Detailed guidance for selecting the appropriate mode of calculation is provided in Section 3.1.

B. Select Waste Management Unit (WMU) Type (Screen 1A)

Identify the WMUs that are used to manage wastes of concern at your facility and run the model separately for each unit type. The four unit types that are addressed as part of this guidance include surface impoundments (SIs) (aerated and quiescent), active landfills (LFs), wastepiles (WPs), and tilled land application units (LAUs). A detailed description of these unit types is provided in Section 3.2. Select from one of the four WMU types shown in Screen 1A by clicking on the appropriate option button.

C. Select Meteorological Station Search Option (Screen 1A)

The two search options available include the site's 5-digit zip code or its latitude and longitude. Select the appropriate search option and enter the appropriate information. This information is used to link the facility's location to one of the 29 IWAIR meteorological stations. Data from the 29 stations (shown on a map of the continental United States in Screen 1B, viewed by clicking on the VIEW MAP button shown on Screen 1A) are used as input to CHEMDAT8 emission modeling (e.g., temperature and

windspeed), and as inputs to the air dispersion modeling effort conducted to develop the default dispersion factors maintained in the IWAIR tool. Additional information on this dispersion air modeling effort and the 29 representative meteorologic stations is provided in Section 3.3.

Enter Zip Code and Search for Meteorological Station
Enter a 5-digit zip code and click on the SEARCH button to identify the default meteorological station. If the zip code was entered incorrectly or if no data were provided at all, message boxes will appear to indicate the specific problem that the tool encountered so that you can supply the needed data.

Enter Latitude and Longitude Information and Search for Meteorological Station
As shown in Screen 1A, enter the latitude and longitude of the site in degrees, minutes, and seconds. At a minimum, the program requires degrees for latitude and longitude to be entered. If available, the minutes and seconds should be supplied to ensure that the most appropriate station is selected for a site. After these data are entered, click on the SEARCH FOR MET. STATION button to identify the default meteorological station. If the latitude and longitude information was entered incorrectly or if no data were provided at all, message boxes will appear to indicate the specific problem that the tool encountered so that you can supply the needed data.

D. View Selected Meteorological Station (Screen 1A)

The meteorological station selected by the tool will be displayed in the text box. Once the meteorological station is selected, you are encouraged to view the map of the United States (VIEW MAP button, Screen 1A) showing the 29 meteorological stations to ensure that the selection was made correctly. For example, if the latitude of a site was entered incorrectly, then the selected meteorological station would likely not be the most representative station. In this case, the map will assist you in identifying this error prior to proceeding with the calculations.

E. Select Emission and Dispersion Option (IWAIR-Generated or User-Specified) (Screen 1A)

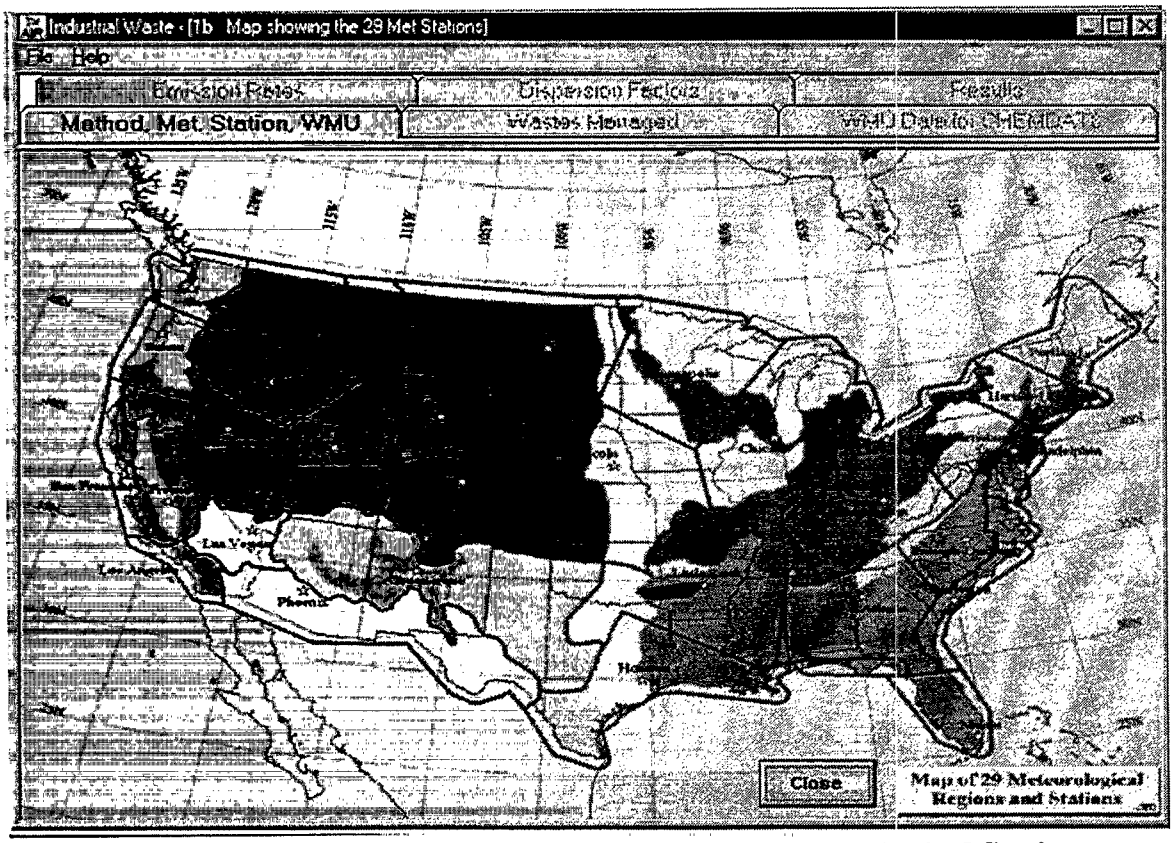
You must select from the IWAIR emission and dispersion data options. Under these options, you have the flexibility of conducting modeling using IWAIR-generated emission rates and dispersion factors, user-specified emission and dispersion estimates, or a combination of both IWAIR-generated and user-specified estimates.

The tool uses emission rate and dispersion factor estimates in both the forward and backward calculations. As seen in Screen 1A, you must select one of the three options provided for obtaining emission and dispersion data:

- Option 1 - *Use CHEMDAT8*
  Select Option 1 to use CHEMDAT8 for calculating the emissions from your unit regardless of whether you want to calculate or enter dispersion factors. This allows you to enter a variety of unit-specific information that IWAIR will use to develop chemical-specific emission rate estimates through the use of EPA's CHEMDAT8 model. These inputs also provide the information needed to use the ISCST3 dispersion factors provided with IWAIR; however, you may also enter your own dispersion factors. You will be

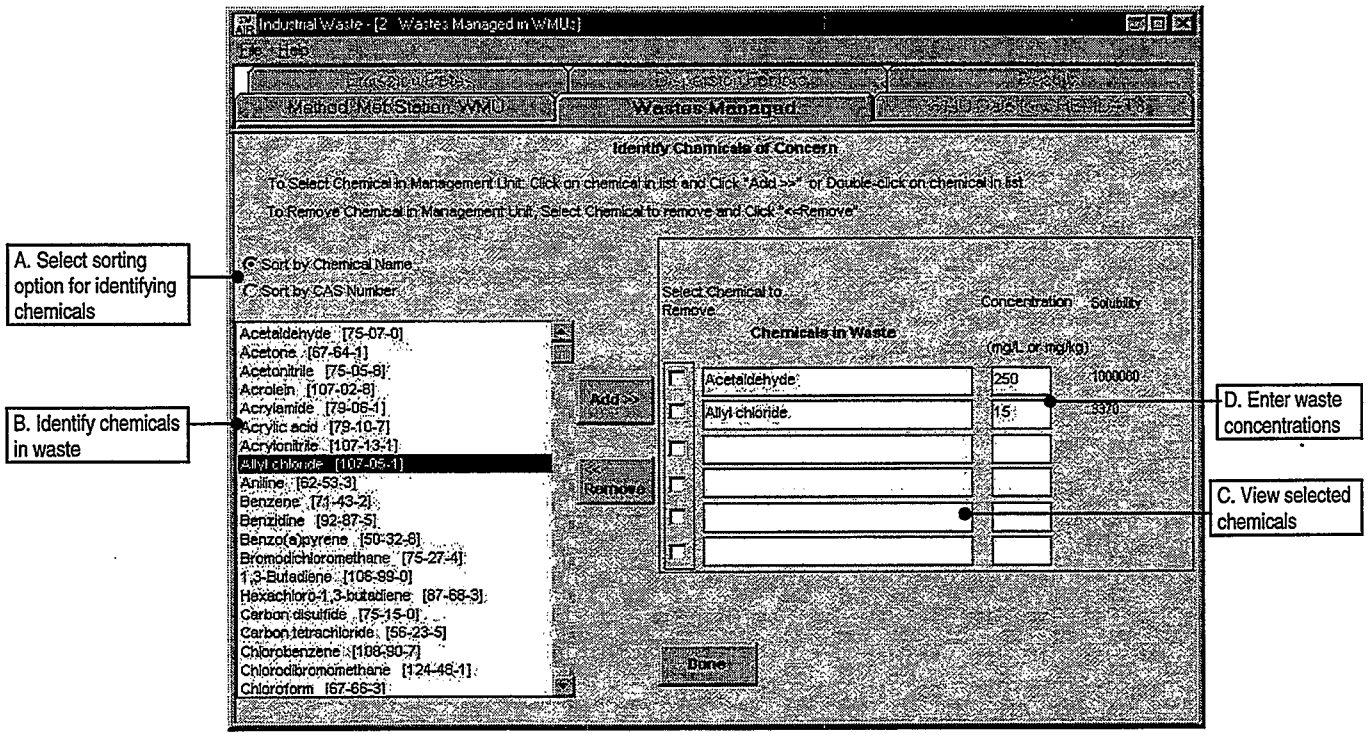
allowed to override the IWAIR emission estimates on subsequent screens. Option 1 is most appropriate for use if Pathway 1 or 2 was selected in Section 3.3. Select this option by clicking the Use CHEMDAT8 command button.

- Option 2 - *Enter Emission Rates*
  Select Option 2 to enter your own site-specific emission rates (g/m^2-s) on a subsequent screen. Rates may be developed based on monitoring data or measurements or by conducting modeling with a different emission model. Under this option, IWAIR can be used to estimate dispersion based on ISCST3 default dispersion factors. If this option is selected, you will still be allowed to override the IWAIR dispersion factors on subsequent screens with site-specific unitized dispersion factors ($\mu g/ m^3$ per $\mu g/m^2$-s). Option 2 is most appropriate for use if Pathway 3 was selected in Section 3.3. Select this option by clicking the ENTER EMISSION RATES command button. Once selected, a message box will appear that directs you to enter WMU area (m^2). If a waste pile is being modeled, a subsequent box will appear for the height of the unit to be entered. These WMU data are used by the model to calculate dispersion estimates.



Screen 1B. Map of Continental USA Showing 29 Meteorological Stations

- Option 3 - *Enter Emission, Dispersion Data.*
  Select Option 3 to enter your own emission estimates (g/m^2-s) and unitized dispersion factors ($\mu g/ m^3$ per $\mu g/m^2$-s). Option 3 is most appropriate for use if Pathway 4 was selected in Section 3.3. This option is selected by clicking the ENTER EMISSIONS, DISPERSION DATA command button.



Screen 2. Wastes Managed

4.2 Wastes Managed (Screen 2)

To perform a forward calculation risk, identify the chemical(s) in the waste being managed and, if you are using CHEMDAT8, enter the concentration (mg/L or mg/kg) of each chemical.

A. Select Sorting Option for Identifying Chemicals (Screen 2)

IWAIR includes a predetermined list of 95 chemicals from which you can identify waste constituents. These constituents are shown with their Chemical Abstracts (CAS) number in Section 1, Table 1-1. To facilitate the chemical identification process, IWAIR allows you to sort this list of chemicals alphabetically by chemical name or by CAS number. As shown in Screen 2, select a sort order by clicking on the button to the left of the sorting option of choice.

B. Identify Chemicals in Waste (Screen 2)

Identify up to six chemicals in a waste for modeling with IWAIR. Identify a chemical by clicking on the chemical name or CAS number and clicking on the **Add>>** command button. To remove a waste constituent from consideration, select the check box located to the left of the chemical name and click the **<<Remove** command button.

C. View Selected Chemicals (Screen 2)

The chemicals you identified for consideration are displayed in text boxes shown on Screen 2. You can remove waste constituents from consideration by selecting the check box to the left of the chemical and clicking the **<<Remove** command button.

D. Enter Waste Concentrations (Screen 2)

If you are using CHEMDAT8, enter a chemical-specific waste concentration for each chemical identified. This is not necessary if you will enter your own emission rates. The concentration should be expressed as mg/L for wastewaters and mg/kg for solid wastes. The concentration entered for a single compound can not exceed its solubility limit (identified to the right of the concentration textbox) nor should the total organic concentration exceed 1,000,000 mg/kg or mg/L (equivalent to ppm). If these conditions are not met, an error message will be displayed.

4.3 Enter WMU data for Using CHEMDAT8 Emission Rates

If you elected to use CHEMDAT8 emission rates in the risk calculations (i.e., selected the Use CHEMDAT8 command button shown previously on Screen 1A), you will need to enter WMU data as specified in this section. If you did not elect to use CHEMDAT8 emission rates, then you should proceed to Section 4.4, *Emission Rates*.

The section provides guidance in providing input data needed to develop CHEMDAT8 emission estimates for the four unit types addressed by IWAIR.

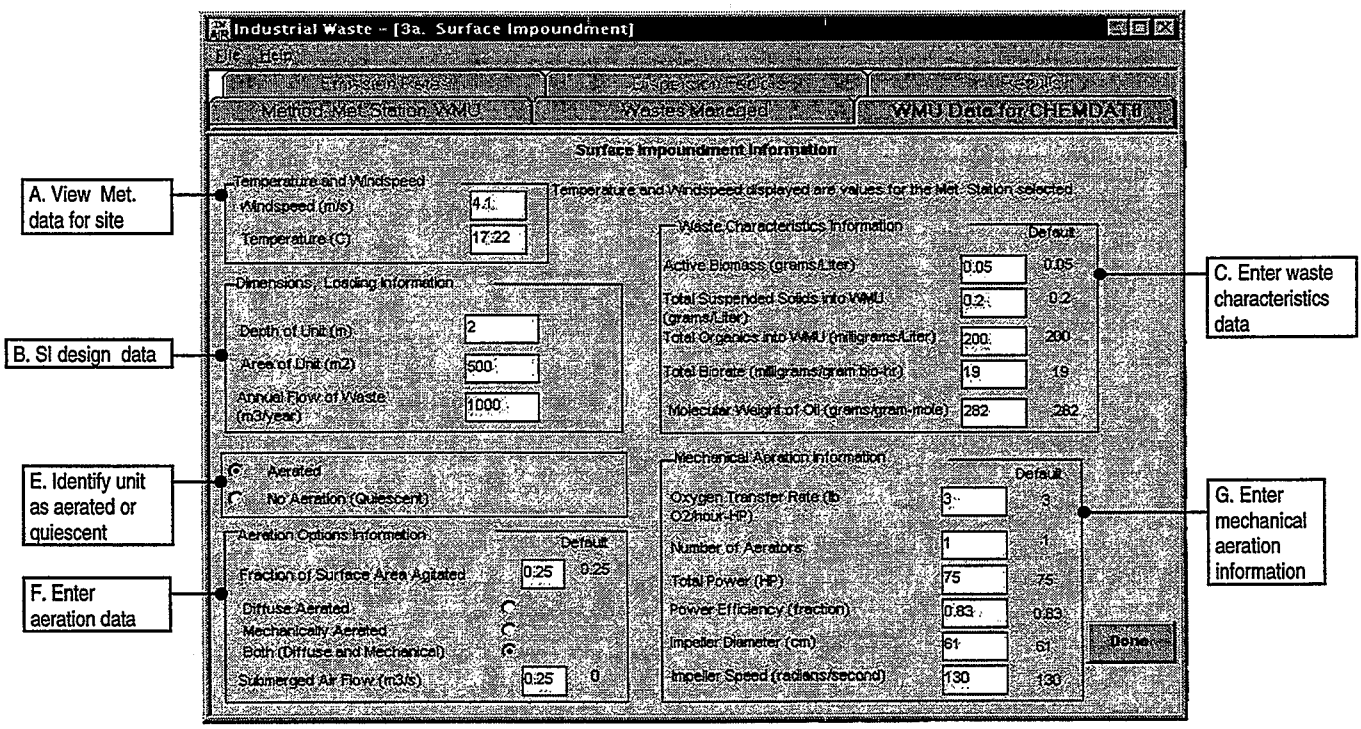
Surface impoundments. The major source of volatile emissions associated with surface impoundments is the uncovered liquid surface exposed to the air (U.S. EPA, 1991). Aeration and/or agitation are applied to aid in treatment of the waste, and emissions tend to increase with an increase in surface turbulence because of enhanced transfer of liquid phase contaminants to the air (U.S. EPA, 1991). Parameters to which emissions are most sensitive include surface area, unit depth, waste concentration, retention time, windspeed for quiescent systems, and biodegradation.

Land Application Units. The waste can be tilled or sprayed directly onto the soil and subsequently mixed with the soil by discing or tilling. Waste in a LAU is a mixture of sludge and soil. IWAIR allows the modeling of tilled LAUs. Another model may be more appropriate if your LAU uses spray application. Air emissions from land treatment units are dependent on the chemical/physical properties of the organic constituents, such as vapor pressure, diffusivity, and biodegradation rate. Operating and field parameters affect the emission rate, although their impact is not as great as that of the constituent properties.

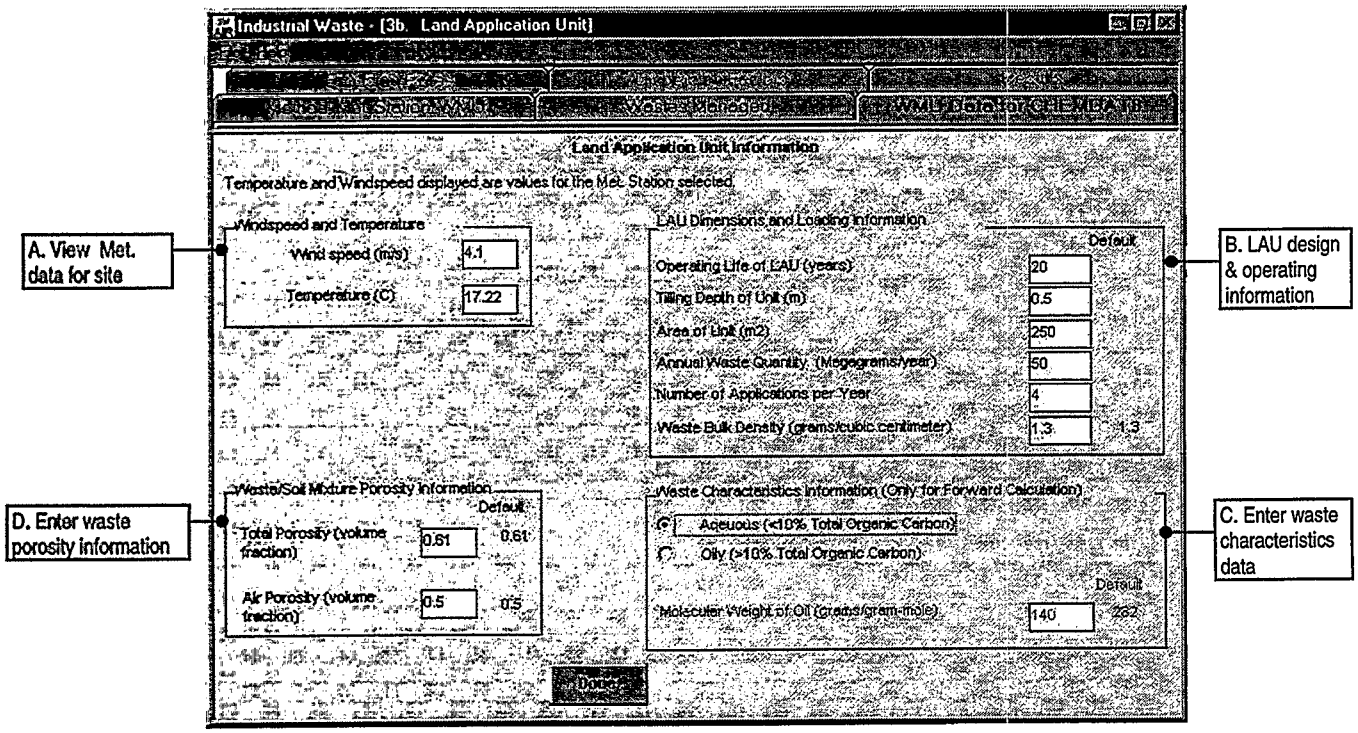
Active Landfill. IWAIR allows the modeling of emissions released from the surface of an active (i.e., receiving wastes) landfill. The landfill model is sensitive to the air porosity of the solid waste, the liquid loading in the solid waste, the waste depth (assumed to be the same as the unit depth), constituent concentration in the waste, and the volatility of the constituent (U.S. EPA, 1991).

Wastepiles. The waste pile emission model is sensitive to the air porosity of the solid waste, the liquid loading in the solid waste, the wastepile height, constituent concentration in the waste, and the volatility of the constituent (U.S. EPA, 1991).

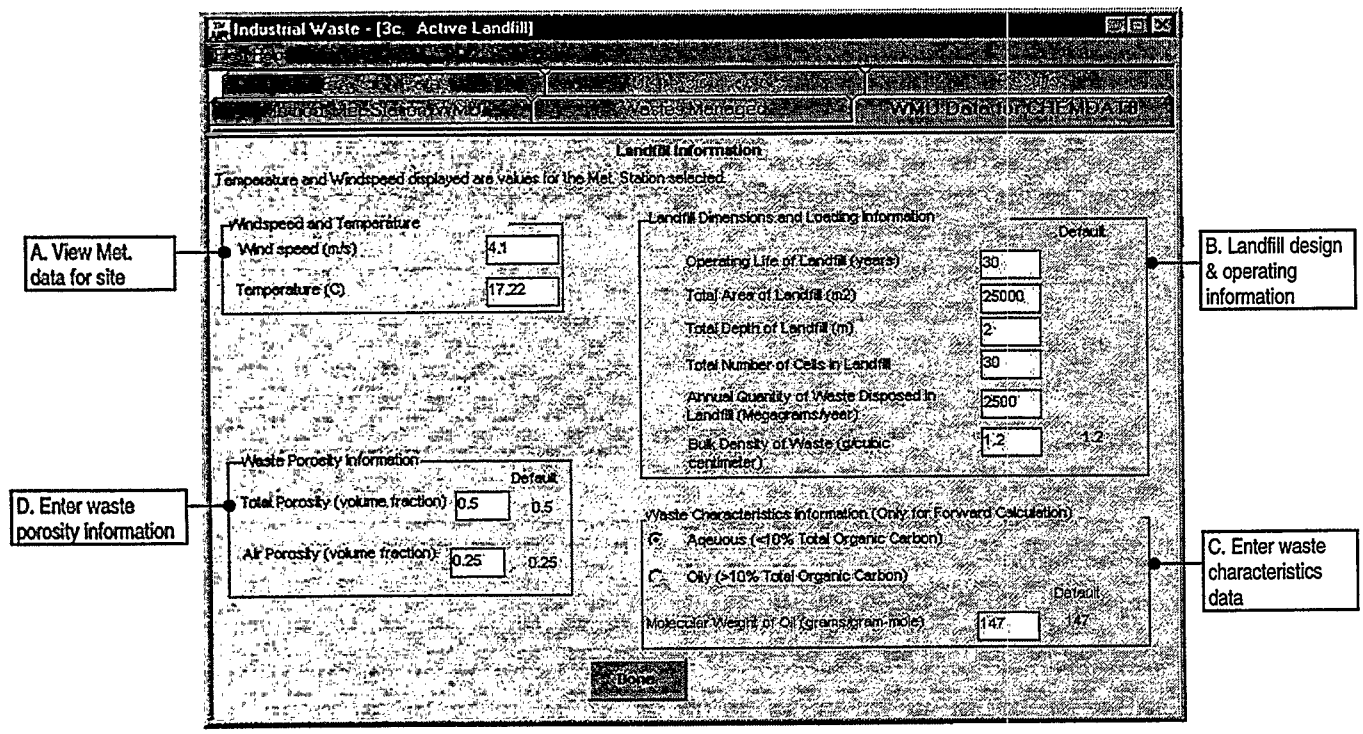
Screens 3A, 3B, 3C, and 3D, respectively, identify the CHEMDAT8 input requirements for surface impoundments, land application units, landfills, and wastepiles. Guidance for completing each screen is provided below. For several of the required inputs, default values are provided to the right of the screen textboxes. These default values were selected to represent average or typical operating conditions. If appropriate, the defaults can be applied in the absence of site-specific data. The basis for these default values is provided in the IWAIR Technical Background Document.



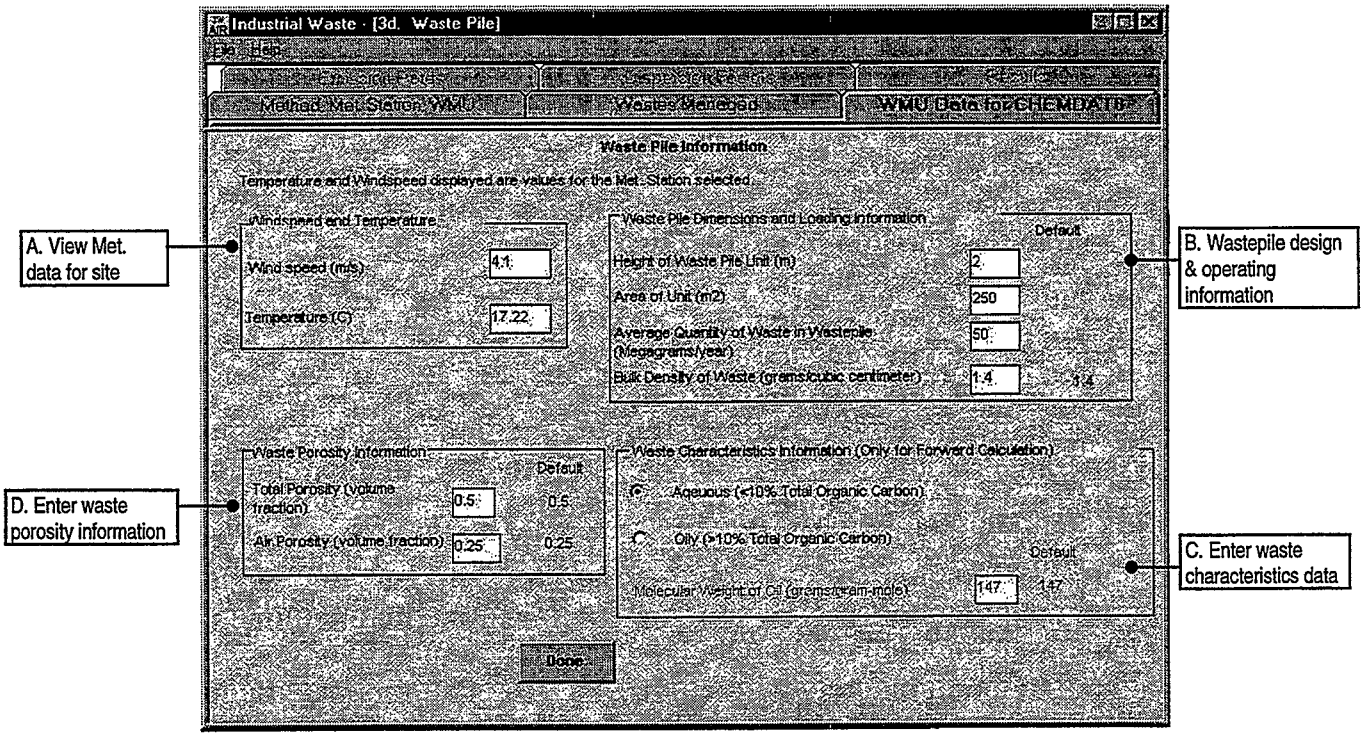
Screen 3A. WMU Data for CHEMDAT8: Surface Impoundment



Screen 3B. WMU Data for CHEMDAT8: Land Application Unit



Screen 3C. WMU Data for CHEMDAT8: Landfill



Screen 3D. WMU Data for CHEMDAT8: Wastepile

A. ***View Meteorological Data for Site (Screens 3A, 3B, 3C, and 3D)***

Both windspeed and temperature can affect the volatilization rate of a chemical. Average temperature and windspeed are used as input to the CHEMDAT8 model. Drawing from the meteorological data stored in IWAIR, the program will display the average annual temperature and windspeed available for the representative meteorological station that was determined for the site in Screen 1A. Alternatively, you can enter average windspeed and temperature for your site if the default values are significantly different.

B. ***Enter Unit Design and Operating Data***

Enter Surface Impoundment Design Data (Screen 3A):

Enter the unit dimensions and loading information in the textboxes shown in each Screen 3A. The data include the depth of the surface impoundment in meters, the area of the surface impoundment in square meters, and the annual flow of the waste in cubic meters per year.

Enter LAU Design and Operating Information (Screen 3B)

Enter the unit dimensions and loading information, including the operating life of the unit in years, tilling depth of the unit (m), area of the unit in square meters (m^2), annual waste quantity in megagrams per year, number of application per year, and waste bulk density in grams per cubic centimeter (g/cm^3).

Enter Landfill Design and Operating Information (Screen 3C):
Enter the unit dimensions and loading information in the textboxes in Screen 3B. The model assumes that the landfill is divided into cells, with only one cell active at a time. Emissions are modeled from the active cell. The data to be entered include the operating life of the unit in years, total area of the unit in square meters (m^2), depth of the unit (m), number of cells in your unit, annual quantity of wastes disposed in landfill (Mg/year), and bulk density of waste (g/cubic centimeter).

Enter Wastepile Design and Operating Information (Screen 3D):
The unit dimensions and loading information to be entered include the height of the pile in meters (m), area of the unit in square meters (m^2), annual quantity of waste in pile (Mg/year), and bulk density of the waste in g/cm^3.

C. ***Enter Waste Characteristics Data (Screens 3A, 3B, 3C, and 3D)***
For Surface Impoundments Only - Enter Waste Characteristics Data (Screens 3A)
The waste characteristic information to be entered for surface impoundments include active biomass (grams/liter), total suspended solids into WMU (milligrams/liter), total organics into WMU (milligrams/liter), total biorate (milligrams/ gram bio-hr), and molecular weight of oil (grams/gram-mole).

LAUs , LFs, and WPs Only - Enter Waste Characteristics Data (Screens 3B, 3C, and 3D)
Specify if the waste being modeled is an aqueous- or oily-phase waste. If a waste is identified as oily, then you will also need to enter a waste density.

In making the determination of whether a waste is oily or aqueous, you should examine the fraction of the waste that is organic. Consider the following guidance in making this determination.

Oily: If the total concentration of all organics in the waste is greater than 10%, then the waste should be identified as oily. IWAIR does this automatically if the combined concentration of all chemicals entered is greater than 100,000 mg/kg or mg/L, or 10%.

Aqueous: If the total concentration of all organics in the waste is less than 10%, then the waste should be identified as aqueous.

Based on this distinction, the model will apply either the aqueous or the oily waste equilibrium partitioning algorithm. For oily (organic) wastes, the model uses Raoult's law and the liquid-to-air partition coefficient becomes proportional to the contaminant's partial vapor pressure. For aqueous wastes assumed to partition predominantly to water (e.g., rain and water in the soil), the model uses Henry's law and the liquid-to-air partition coefficient becomes proportional to the contaminant's Henry's law coefficient.

D. For LAUs, Landfills, and WPs Only - Enter Waste Porosity Information (Screens 3B, 3C, and 3D)

Waste (or soil/waste mixture for LAUs) porosity information required as input includes total porosity (unitless) and air porosity (unitless). Total porosity includes air porosity and the space occupied by oil and water within waste. Total porosity (η), also sometimes call saturated water content, can be calculated from the bulk density (BD) of the waste and particle density (ρ_s) as follows:

$$\eta = 1 - \frac{BD}{\rho_s}$$

In the absence of site-specific data, IWAIR identifies default values of 0.5 and 0.25, respectively, for total porosity and air porosity. Air porosity cannot exceed total porosity.

E. For Surface Impoundments Only - Identify Unit as Aerated or Quiescent (Screen 3A)

IWAIR models both quiescent (not aerated) or aerated impoundments. Aeration or agitation of a liquid waste in an impoundment enhances transfer air (oxygen) to the liquid to improve mixing or to increase biodegradation (U.S. EPA, 1991). Identify your unit as aerated or quiescent (i.e., not aerated) by clicking the appropriate option button.

F. For Aerated Surface Impoundments Only - Enter Aeration Data (Screen 3A)

Aeration is achieved through the use of mechanical mixers such as impellers (i.e., mechanically aerated) or by sparging air which bubbles up from the bottom of the unit (i.e., air diffuse aerated). If your surface impoundment is aerated, provide information to characterize the operation. This information includes fraction of surface area agitated (unitless) and an indication of whether the unit is aerated through the use of air diffusion or mechanically aerated, or both. If the unit has diffused aeration, you will also need to enter a submerged air flowrate (m^3/s) in this screen.

G. For Mechanically Aerated Surface Impoundments Only - Enter Mechanical Aeration Information (Screen 3A)

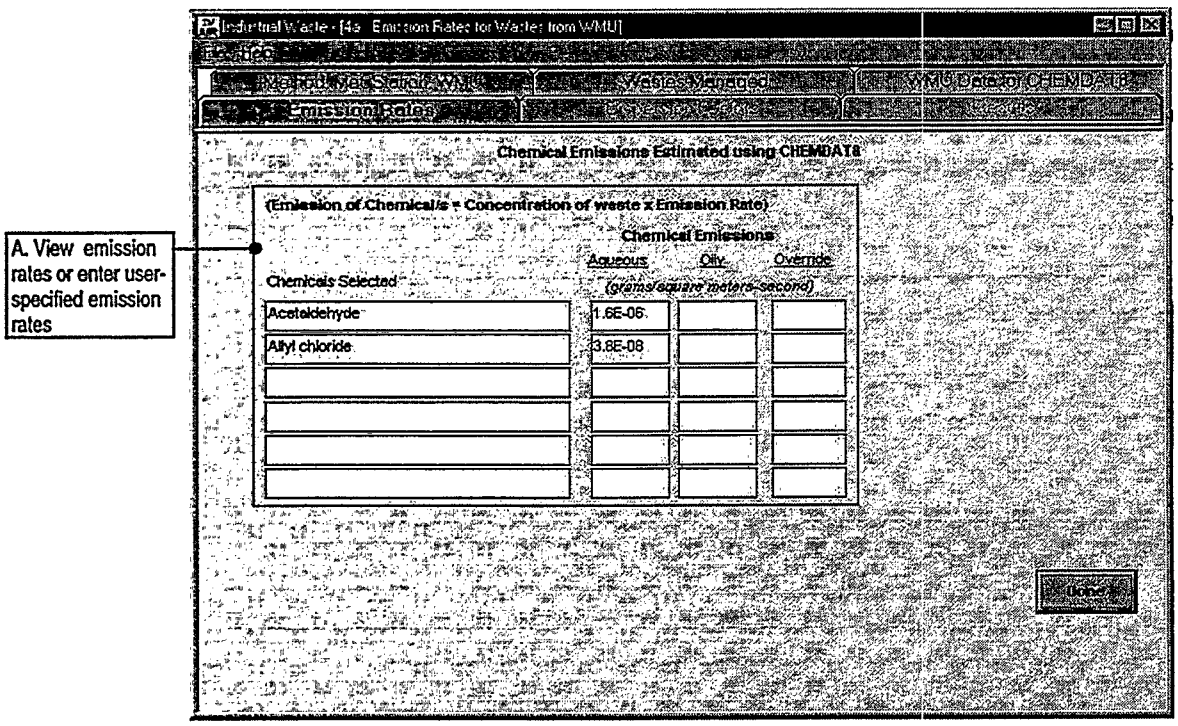
If a surface impoundment is mechanically aerated, you will need to provide additional operating parameter information. These data include oxygen transfer rate (lb O_2/hour-HP), number of aerators, total power (HP), powers efficiency (fraction), impeller diameter (cm), and impeller speed (radian/second).

Done. Once you provide the required WMU inputs, click the DONE button to enable the Emission Rates menu tab and open the Emission Rates screen. Proceed to Section 4.4, *Emission Rates*.

4.4 Emission Rates

Guidance for using CHEMDAT8 emission rates or entering your own emission rates is provided in this section. View and confirm the CHEMDAT8 emission rates as directed in Section 4.4.1. If you did not elect to use CHEMDAT8 (i.e., selected the ENTER EMISSION RATES or ENTER EMISSIONS, DISPERSION DATA command buttons shown previously on Screen 1A), proceed to Section 4.4.2, *User-Specified Emission Rates.*

Please note that all calculated and entered values on the Emission Rate screen will be lost if you return to a previous screen and make changes. This includes both calculated and entered override emission rate values.



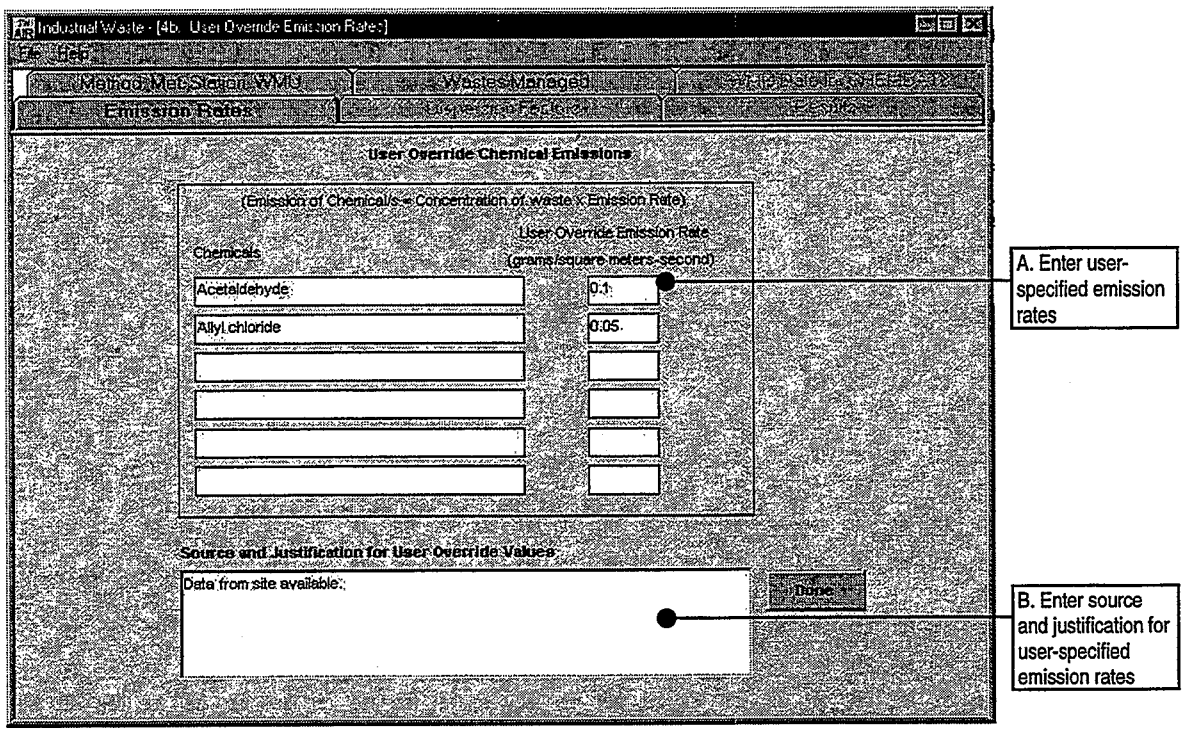
Screen 4A. CHEMDAT8: Emission Rates

4.4.1 Using CHEMDAT8 Emission Rates (Screen 4A)

A. View CHEMDAT8 Emission Rates or Enter User-Specified Emissions (Screen 4A)

Screen 4A shows the calculated CHEMDAT8 emission rates. With the exception of waste managed in surface impoundments (assumed to be aqueous), emission rates will be displayed under the Aqueous or Oily column headings depending on how you characterized your waste on the WMU Data for CHEMDAT8 screens (Screens 3B, 3C, or 3D). If you wish to override the displayed rates, enter alternate rates (g/m^2-s) in the textboxes located under Override. If alternate rates are entered, IWAIR

will prompt you to identify the source and justification for these data. This documentation should be entered in the text box displayed on the screen. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later data. Confirm the emission rates to be used in the calculations by clicking the DONE button. The program will then automatically enable the Dispersion Factors menu tab and open the Dispersion Factors screen. Proceed to Section 4.5, *Dispersion Factors*.



Screen 4B. User Specified Emission Rates

4.4.2 User-Specified Emission Rates (Screen 4B)

A. Enter User-Specified Emissions (Screen 4B)

Enter site-specific emission rates (g/m^2-s) in the text box under User Override. The source and the justification for these data and the estimation method employed should also be documented using the textbox on the screen.

B. Enter Source and Justification for User-specified Emission Rates (Screen 4B)

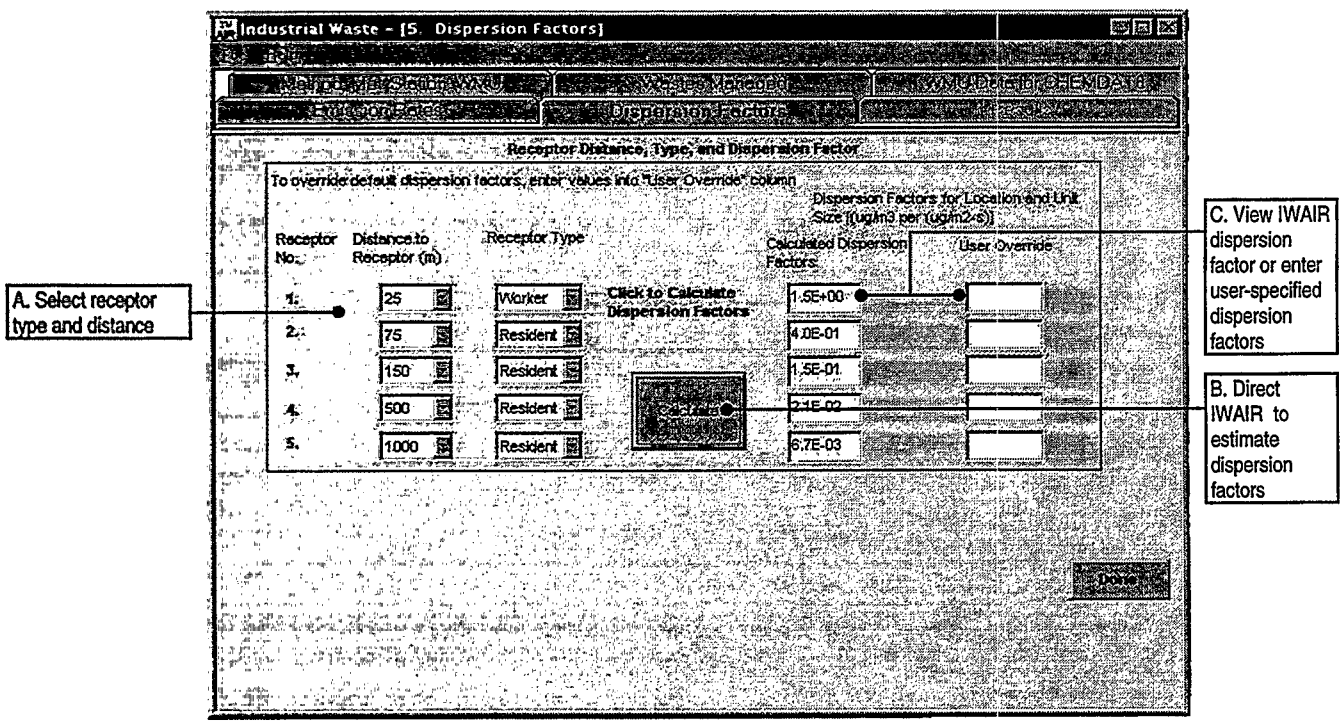
The program will prompt you to provide justification for user-specified emission rates and documentation of the estimation method applied. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later date.

Done. Once you have entered the emission data and source/justification, click the DONE button to enable the Dispersion Factors menu tab and open the Dispersion Factors screen. Proceed to Section 4.5, *Dispersion Factors.*

4.5 Dispersion Factors

Dispersion modeling outputs are used to estimate air concentrations to which the various human receptors are exposed. Guidance for using the ISCST3 default dispersion factors or entering your own site-specific dispersion factors is provided in Section 4.5.1 and 4.5.2, respectively. If you elected to use ISCST3 dispersion factors provided in IWAIR (i.e., selected the USE CHEMDAT8 or ENTER EMISSION RATES command buttons shown previously on Screen 1A), you will need to follow the guidance provided in Section 4.5.1. If you did not elect to use the default dispersion factors, you should proceed to Section 4.5.2, *User-Specified Dispersion Factors.*

Please note that all calculated and entered values on the Dispersion Factor screen will be lost if you return to a previous screen and make changes. This includes receptor locations and types, and calculated and entered override dispersion factor values.



Screen 5A. Using ISCST3 Default Dispersion Factors

4.5.1 Using ISCST3 Default Dispersion Factors (Screen 5A)

In Screen 5A, you will provide receptor information (i.e., receptor type and distance to the receptor) and click the CALCULATE button; IWAIR will develop site-specific dispersion factors based on default dispersion data. If you wish to override the IWAIR-developed dispersion factors, enter alternate site-specific unitized dispersion factors. If you enter alternative dispersion factors, you should document the source and the justification for these data in the text box on the screen.

A. Select Receptor Type and Distance (Screen 5A)

Enter information concerning the receptors of concern (i.e., potentially exposed individuals). You can specify up to five receptors, including Distance to Receptor and Receptor Type. You can specify two receptor types, resident or worker, at six distances (25, 50, 75, 150, 500, and 1,000 meters) from the edge of the WMU.

Distance to Receptor - For each receptor of concern, determine the distance from the edge of the unit to the receptor. Based on this distance, select from the six default distances (25, 50, 75, 150, 500, and 1,000 meters) the one that best approximates the location of your receptor, using the drop-down box positioned under the Distance to Receptor column heading. Note that selecting a smaller distance will overestimate risk, and selecting a larger distance will underestimate risk. These distances correspond to the distances for which air dispersion modeling was conducted to develop the IWAIR default dispersion factors. The *IWAIR Technical Background Document* discusses the analysis that was conducted in determining the appropriateness of these default distances.

Receptor Type - Two different types of exposed individuals, a worker and a resident, can be modeled with IWAIR. The difference between these two receptors is in the exposure factors, such as body weight and inhalation rate, used to calculate risk for carcinogens. There is no difference between them for noncarcinogens. The IWAIR Technical Background Document describes the exposure factors used for residents and workers. The assumptions for workers reflect a full-time, outdoor worker. The assumptions for residents reflect males and females from birth through age 30. Use the drop-down box positioned under the Receptor Type column heading to select either a worker or resident.

B. Direct IWAIR to Estimate Dispersion Factors (Screen 5A)

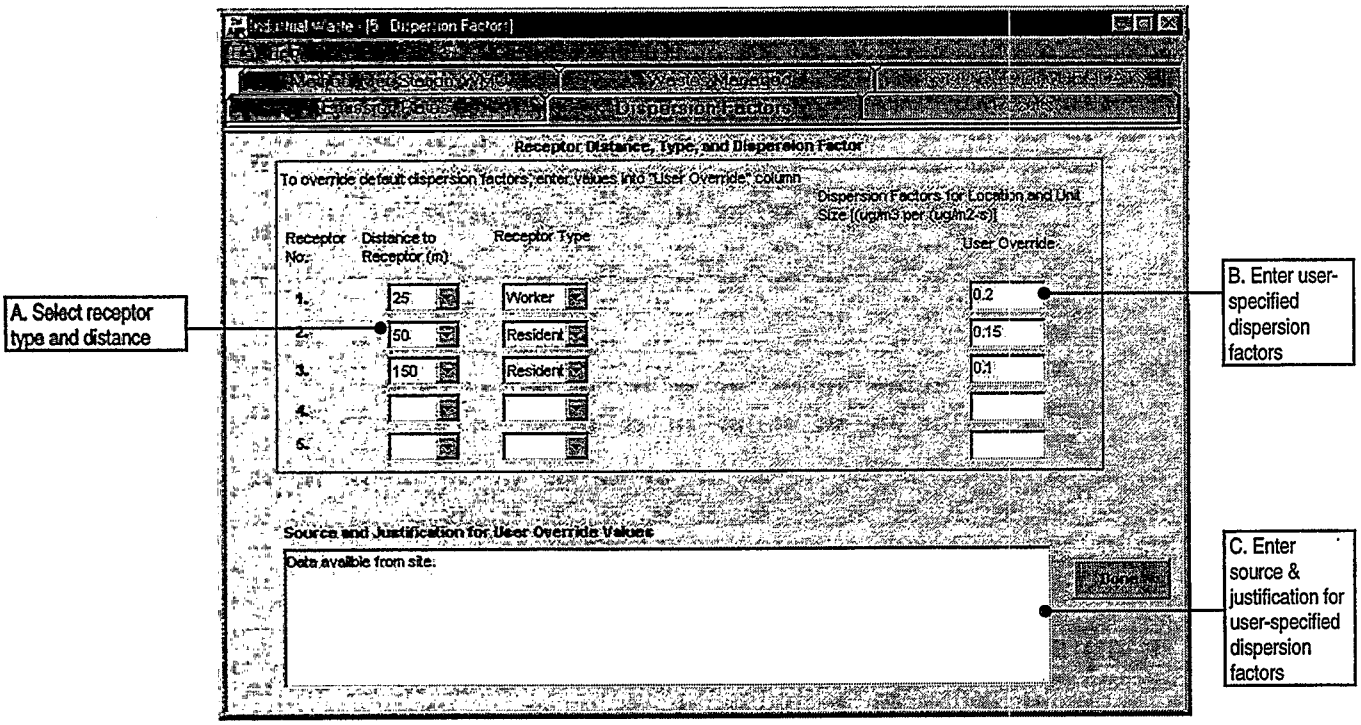
After the requested receptor information is provided, click on the CALCULATE button to direct the program to determine an appropriate dispersion factor based on the IWAIR default dispersion data. The resulting dispersion factor will be displayed for each receptor of concern. A discussion of the development of IWAIR default dispersion data and the methodology used by the program in selecting an appropriate dispersion factor for each WMU/receptor combination is provided in Section 3.3. A more detailed discussion of the air dispersion modeling effort is provided in the *IWAIR Technical Background Document.*

C. View IWAIR Dispersion Factors or Enter User-Specified Dispersion Factors (Screen 5A)

You may override the program-calculated dispersion factors by entering alternative dispersion data in the text box located under the User Override column (see Screen 5A). If you choose to provide alternative dispersion factors, document the source and the justification for these data in the text box that

will appear. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later date.

Done. Once the program has developed dispersion factors, click the DONE button to open the Results menu tab. Proceed to Section 4.6, *Results*.



Screen 5B. User Specified Dispersion Factors

4.5.2 User-Specified Dispersion Factors (Screen 5B)

A. Select Receptor Type and Distance (Screen 5B)

Enter information concerning the receptors of concern (i.e., potentially exposed individuals). You can specify up to five receptors. The receptor information includes Distance to Receptor and Receptor Type. You can specify two receptor types (residents or workers) at six distances (25, 50, 75, 150, 500, and 1,000 meters) from the edge of the WMU.

Distance to Receptor - For each receptor of concern, determine the distance from the edge of the unit to the receptor. Based on this distance, select from the six default distances (25, 50, 75, 150, 500, and 1,000 meters) the one that best approximates the location of your receptor, using the drop-down box positioned under the Distance to Receptor column heading. These values are only for your reference and are not used in calculations, since you are entering your own dispersion factors.

Receptor Type - Two different types of exposed individuals, a worker and a resident, can be modeled with IWAIR. The difference between these two receptors is in the exposure factors, such as body weight and inhalation rate, used to calculate risk for carcinogens. There is no difference between them for noncarcinogens. The IWAIR Technical Background Document describes the exposure factors used for residents and workers. The assumptions for workers reflect a full-time, outdoor worker. The assumptions for residents reflect a males and females from birth through age 30. Use the drop-down box positioned under the Receptor Type column heading to select either a worker or resident.

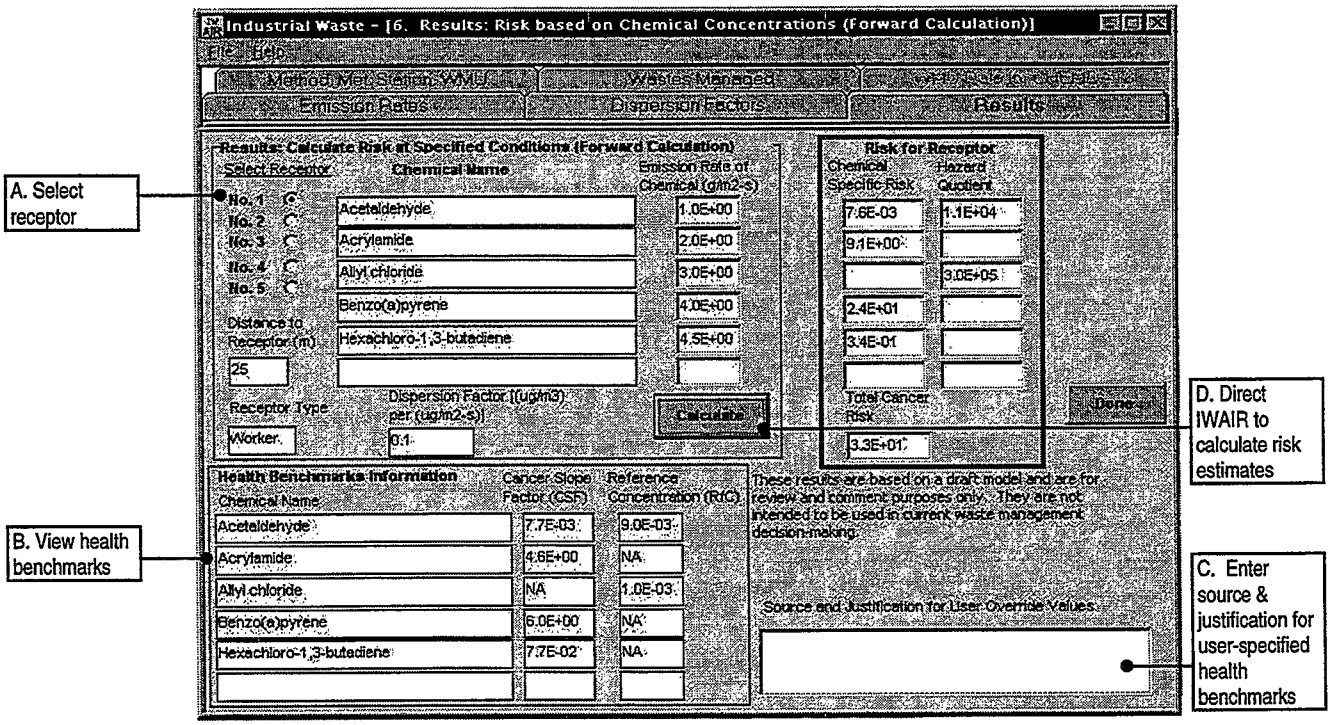
B. Enter User-Specified Dispersion Factors (Screen 5B)

For each receptor specified, enter site-specific unitized dispersion factors ($\mu g/m^3$ per $\mu g/m^2$-s) in the text box located under User Override.

C. Enter Source and Justification for User Specified Dispersion Factors (Screen 5B)

The program will prompt you to provide justification for user-specified dispersion data and documentation of the estimation method applied. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later data.

Done. Once you have entered dispersion data, click on the DONE button to open the Results menu tab. Proceed to Section 4.6, Results.



Screen 6. Results

4.6 Results (Screen 6)

The cancer and non-cancer risk estimates attributable to emissions from a WMU can be calculated using IWAIR for residents and workers. The program combines the constituent's air concentration with receptor exposure factors and toxicity benchmarks to calculate the risk from concentrations managed in the unit. For each receptor, IWAIR calculates air concentrations using emission and dispersion data specified or calculated in previous screens. To reflect exposure that would occur in a lifetime (i.e., from childhood through adult), the model applies a time-weighted-average approach. This approach considers exposure that would occur during five different phases of life (i.e., Child < 1 year, Child 1-5 yrs, Child 6-11 yrs, Child 12-18 yrs, and Adult). The exposure factors addressed as part of this approach include inhalation rate, body weight, exposure duration, and exposure frequency. Default values applied by IWAIR were identified based on data presented in EPA's *Exposure Factors Handbook* (U.S. EPA, 1997a) and represent average exposure conditions. IWAIR incorporates standard toxicity benchmarks (cancer slope factors for carcinogens and reference concentrations for noncarcinogens) for 95 constituents. These health benchmarks were obtained primarily from the EPA's Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1998a, 1997b). IWAIR uses these data to perform a forward calculation to obtain risk estimates.

Please note that all calculated and entered values on the Results screen will be lost if you return to a previous screen and make changes. This includes entered override health benchmarks as well as all calculated results.

A. Select Receptor (Screen 6)

Select a single receptor to serve as the focal exposure point for the calculations by clicking on the option button associated with the receptor of choice. As discussed above under Section 4.5, you can specify up to 5 receptors for consideration. However, results can only be seen on the screen for one receptor at a time. Once results are calculated and displayed for the receptor of choice, you can select a different receptor by clicking on one of the other receptor option buttons.

B. View or Enter Health Benchmarks (Screen 6)

Screen 6 allows you to view the health benchmarks that IWAIR will use in calculating risk estimates. If you choose not to use these data, you can enter alternate health benchmarks. Enter cancer slope factors (per mg/kg-d) in textboxes located under Cancer Slope Factors (CSF) and reference concentrations (mg/m^3) under Reference Concentration (RfC). Do not use a reference dose in the place of a reference concentration.

C. Enter Source and Justification for User Specified Values (Screen 6)

If you choose to override the IWAIR-provided benchmarks, you should specify the source and the justification of the alternative data in the textbox. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later date.

D. Direct IWAIR to Calculate Risk (Screen 6)

Click on the CALCULATE button to calculate the risk. Hazard quotients (unitless) and cancer risk estimates (unitless), respectively, are displayed for each noncarcinogen and carcinogen identified as

being managed. In addition, a total cancer risk estimate, which is the sum of the chemical-specific risk estimates, is displayed.

Done. Click the DONE button to initiate a new run or save the run that you have just completed. A dialog box will appear to guide you through restarting the model or saving the current run.

5.0 Completing Backward Calculation to Protective Waste Concentration

IWAIR allows you to complete a backward calculation to develop protective waste concentrations (C_w). The calculation method can be applied in calculating waste concentrations for both wastewaters (C_w in mg/L) and solid waste (C_w in mg/kg). These concentrations are estimated based on user-defined target cancer and noncancer risk levels (e.g., $1x10^{-5}$ or $1x10^{-6}$ for carcinogens, or hazard quotient of 0.5 or 1 for noncarcinogens). The user defines these risk levels on the results screen.

The release of a chemical to the atmosphere is impacted by whether a waste is an aqueous- or oily-phase waste. This determination depends on the fraction of the waste that is organic. Oily wastes are defined in this model as having a total concentration of all organics in the waste greater than 10% while aqueous wastes have a total organic concentrations less than 10%. Based on this distinction, the model will apply either an aqueous or the oily waste equilibrium partitioning algorithm. For oily (organic) wastes, the model uses Raoult's law and the liquid-to-air partition coefficient becomes proportional to the contaminant's partial vapor pressure. For aqueous wastes assumed to partition predominantly to water (e.g., rain and water in the soil), the model uses Henry's law and the liquid-to-air partition coefficient becomes proportional to the contaminant's Henry's law coefficient.

The backcalculation is initially based on an aqueous-phase waste, as this is more conservative for most chemicals. For some chemicals in some units, it may not be possible to reach the target risk without the concentration exceeding the solubility (in waste waters) or the soil saturation limit (in solid wastes) of the chemical. Once these limits are exceeded, the waste would be considered oily. In this case, IWAIR will switch to oily-phase emission rates and continue. If the target risk is still not reached when the concentration reaches the maximum 1,000,000 mg/kg or mg/L, then the program will output a concentration of 1,000,000 and will note the maximum risk (or HQ) achievable.

For a very few chemicals, the oily phase emissions are more conservative, and the backcalculation is then always based on an oily-phase waste.

IWAIR is structured in a stepwise framework. Through the use of a series of screens, IWAIR assists in selecting calculation options, identifying and entering required inputs, and generating desired outputs. There are four different pathways you can follow in performing a calculation:

- Pathway 1: Using CHEMDAT8 emission rates and ISCST3 default dispersion factors;
- Pathway 2: Using CHEMDAT8 emission rates and user-specified dispersion factors;

- Pathway 3: Using user-specified emission rates and ISCST3 default dispersion factors; and

- Pathway 4: Using user-specified emission rates and dispersion factors.

Guidance for determining which modeling pathway to follow is provided in Section 3.3. The stepwise approach employed by IWAIR to assist in calculating waste concentration, whether you are following Pathway 1, 2, 3, or 4, is shown in Figures 5-1, 5-2, 5-3, and 5-4, respectively. The seven steps of the estimation process are shown down the right side of each figure, and the user input requirements are specified to the left of each step. The types of input data required will vary depending on the modeling pathway chosen. Screen-by-screen, IWAIR walks you through the steps of a backward calculation to arrive at protective waste concentration estimates.

This section provides screen-by-screen guidance that describes the data that are required as input to each screen and the assumptions that are interwoven in the calculation being performed. The guidance provided in this section will assist you in completing a backward calculation. You will not need to reference all of the information provided in this section since the guidance addresses all four of the modeling pathways. Follow only those subsections that are applicable to your chosen pathway.

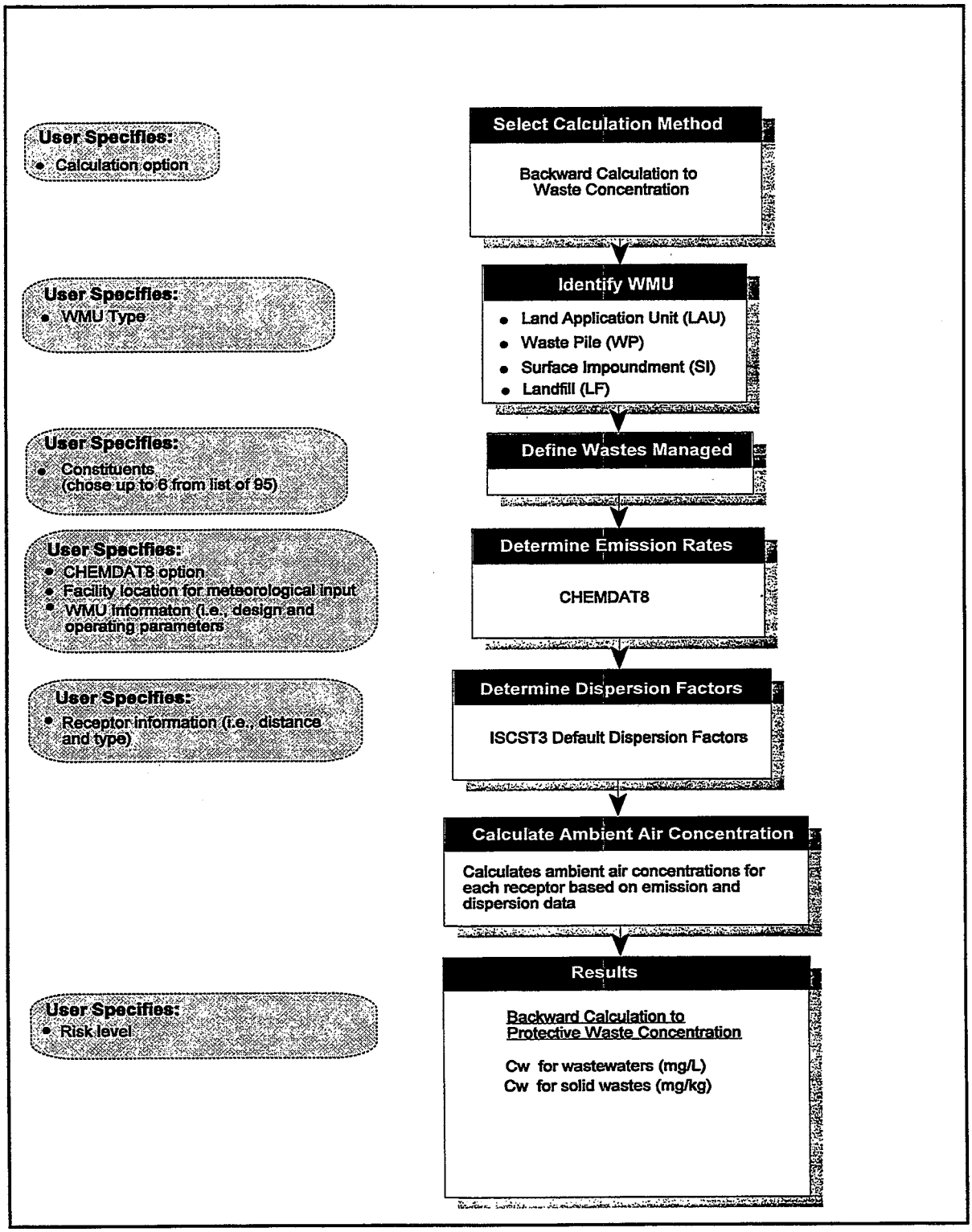


Figure 5-1. IWAIR Approach for Completing Backward Calculation to Protective Waste Concentration: Pathway 1 - Using CHEMDAT8 Emission Rates and ISCST3 Default Dispersion Factors.

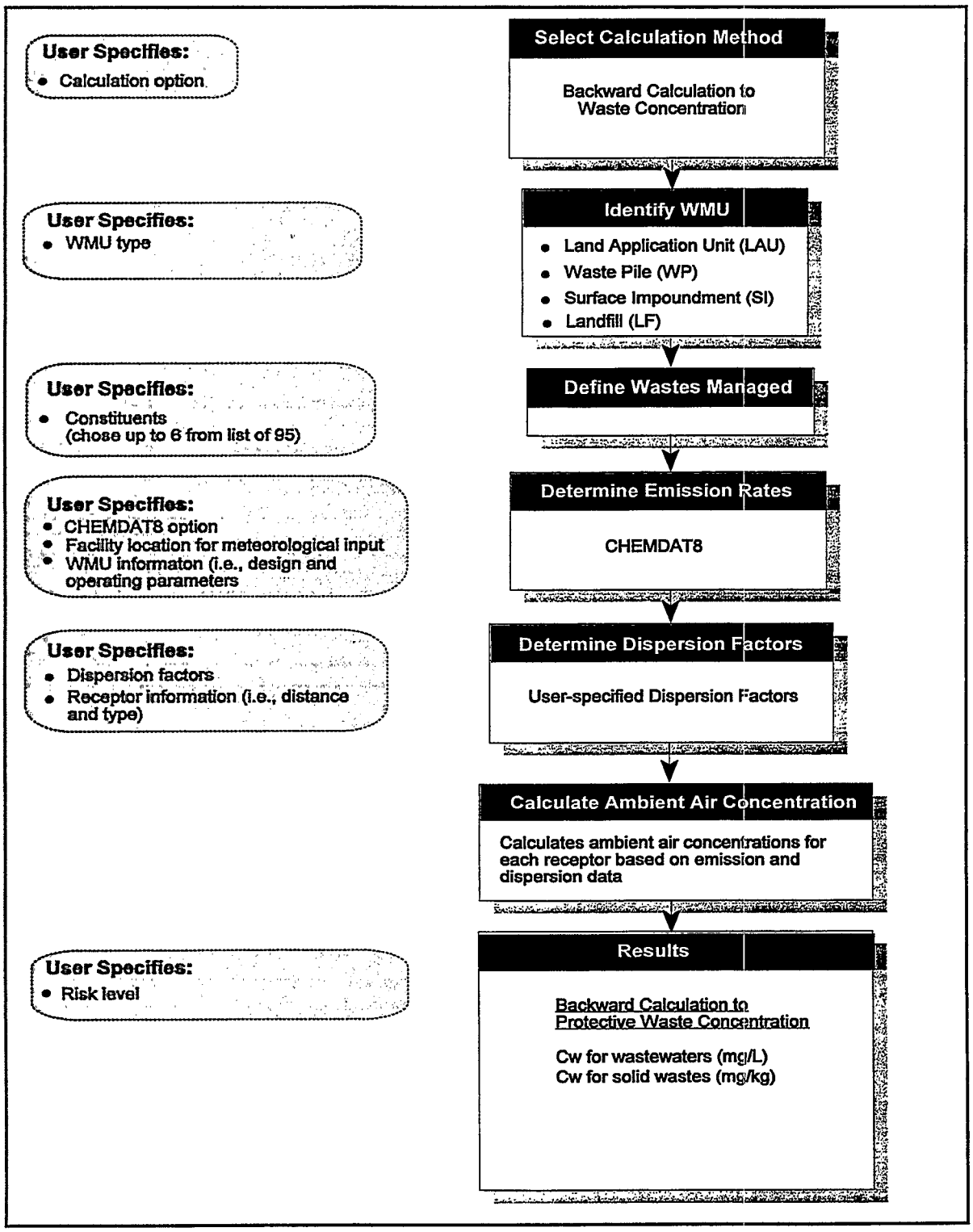


Figure 5-2. IWAIR Approach for Completing Backward Calculation to Protective Waste Concentration: Pathway 2 - Using CHEMDAT8 Emission Rates and User-specified Dispersion Factors.

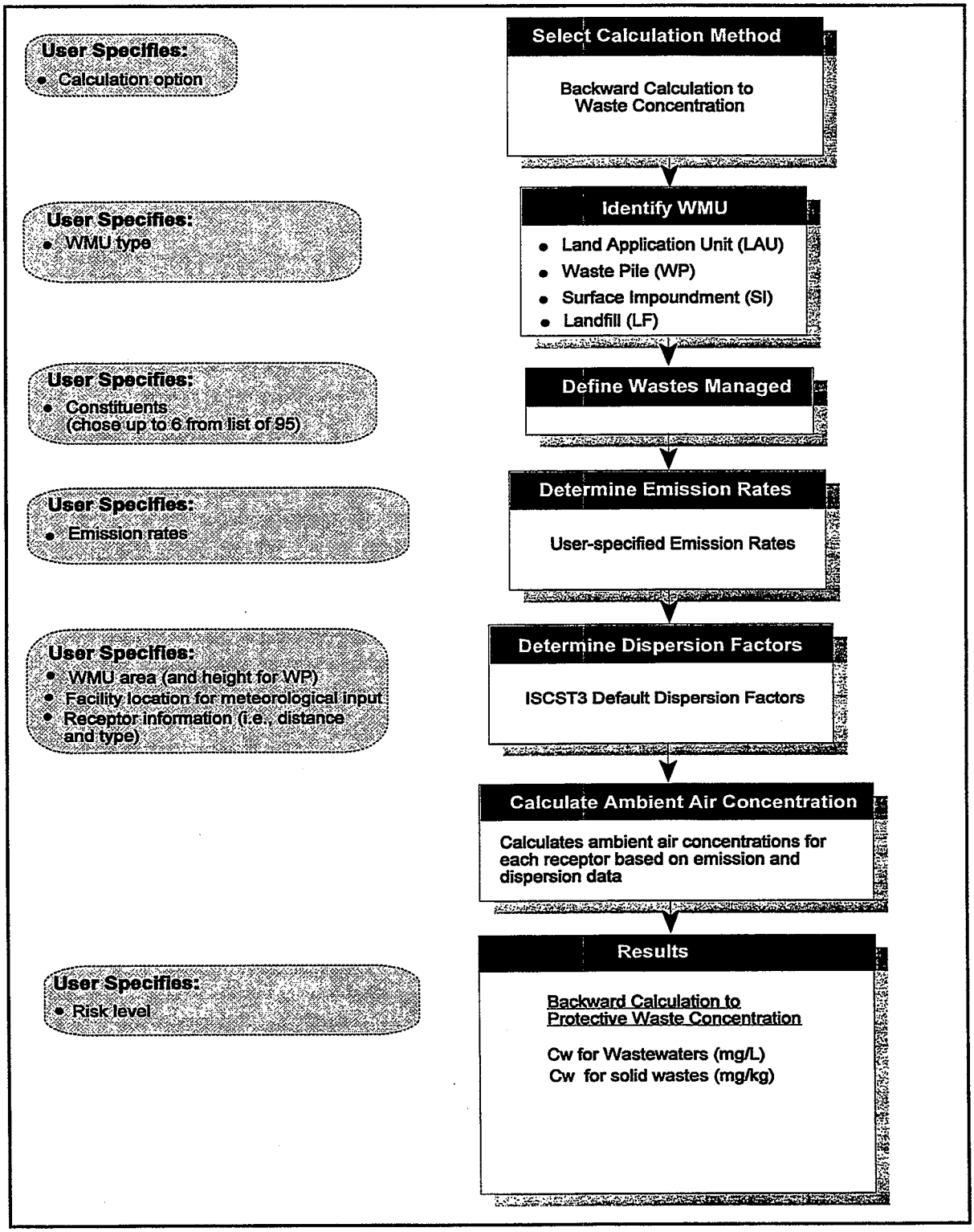


Figure 5-3. IWAIR Approach for Completing Backward Calculation to Protective Waste Concentration: Pathway 3 - Using User-specified Emission Rates and ISCST3 Default Dispersion Factors.

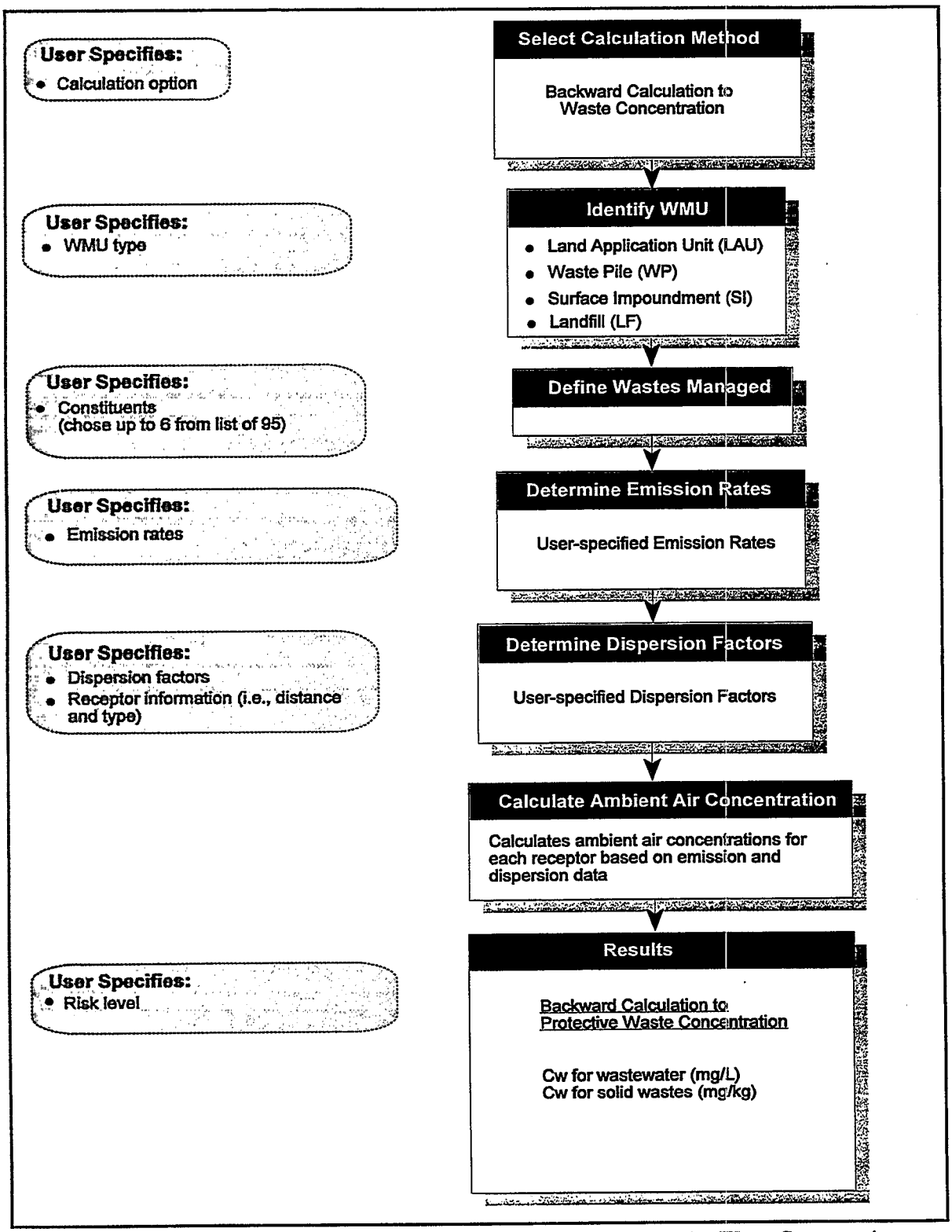
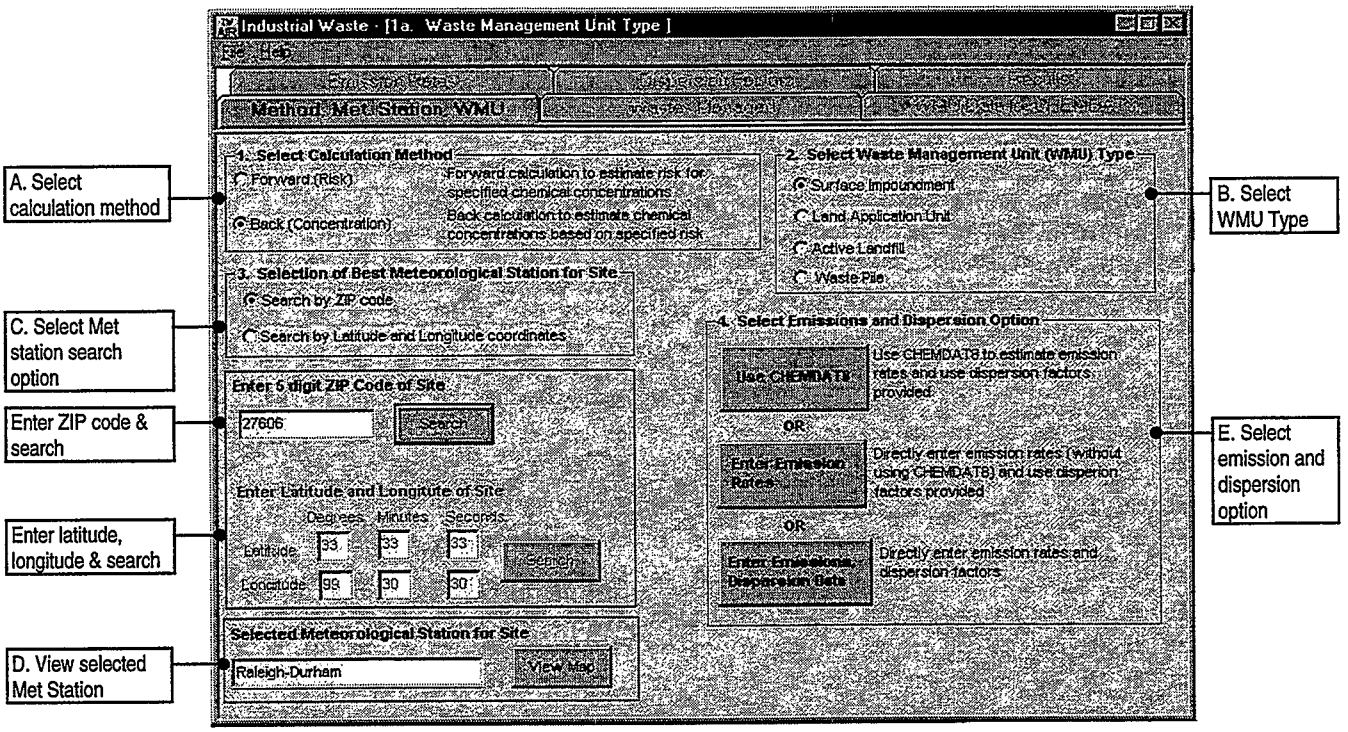


Figure 5-4. IWAIR Approach for Completing Backward Calculation to Protective Waste Concentration: Pathway 4 - Using User-specified Emission Rates and Dispersion Factors.



Screen 1A. Method, Meteorological Station, WMU

5.1 Method, Meteorological Station, WMU (Screen 1A)

A. Select Calculation Method (Screen 1A)

Select the calculation method by clicking on the option button associated with the backward (Concentration) calculation option. Detailed guidance for selecting the appropriate mode of calculation is provided in Section 3.1.

B. Select Waste Management Unit (WMU) Type (Screen 1A)

Identify the WMUs that are used to manage wastes of concern and run the model separately for each unit type. The four unit types that are addressed as part of this guidance include surface impoundments (SIs) (aerated and quiescent), active landfills (LFs), wastepiles (WPs), and tilled land application units (LAUs). A detailed description of these unit types is provided in Section 3.2. Select from one of the four WMU types shown in Screen 1A by clicking on the appropriate option button.

C. Select Meteorological Station Search Option (Screen 1A)

The two search options available include the site's 5-digit zip code or its latitude and longitude. Select the appropriate search option and enter the appropriate information. This information is used to link the facility's location to one of the 29 IWAIR meteorological stations. Data from the 29 stations (shown on a map of the continental United States in Screen 1B, viewed by clicking on the VIEW MAP button shown on Screen 1A) are used as input to CHEMDAT8 emission modeling (e.g., temperature and windspeed), and as inputs to the air dispersion modeling effort conducted to develop the default

dispersion factors maintained in the IWAIR tool. Additional information on this dispersion air modeling effort and the 29 representative meteorologic stations is provided in Section 3.3.

Enter 5 Digit Zip Code of Site
Enter a 5-digit zip code and click on the SEARCH button to identify the default meteorological station. If the zip code was entered incorrectly or if no data were provided at all, message boxes will appear to indicate the specific problem that the tool encountered so that the user can supply the needed data.

Enter Latitude and Longitude of Site
As shown in Screen 1A, enter the latitude and longitude of the site in degrees, minutes, and seconds. At a minimum, the program requires degrees for latitude and longitude to be entered. If available, the minutes and seconds should be supplied to ensure that the most appropriate station is selected for a site. After these data are entered, click on the SEARCH button. If the latitude and longitude information was entered incorrectly or if no data were provided at all, message boxes will appear to indicate the specific problem that the tool encountered so the user can supply the needed data.

D. View Selected Meteorological Station (Screen 1A)

The meteorological station selected by the tool will be displayed in the text box. Once the meteorological station is selected, you are encouraged to view the map of the United States showing the 29 meteorological stations to ensure that the selection was made correctly. For example, if the latitude of a site was entered incorrectly, then the selected meteorological station would likely not be the most representative station. In this case, the map will assist you in identifying this error prior to proceeding with the calculations.

E. Select Emission and Dispersion Option (Screen 1A)

Select from IWAIR emission and dispersion data options. These options provide the flexibility of conducting modeling using IWAIR-generated emission rates and dispersion factors, user-specified emission and dispersion estimates, or a combination of both IWAIR-generated and user-specified estimates.

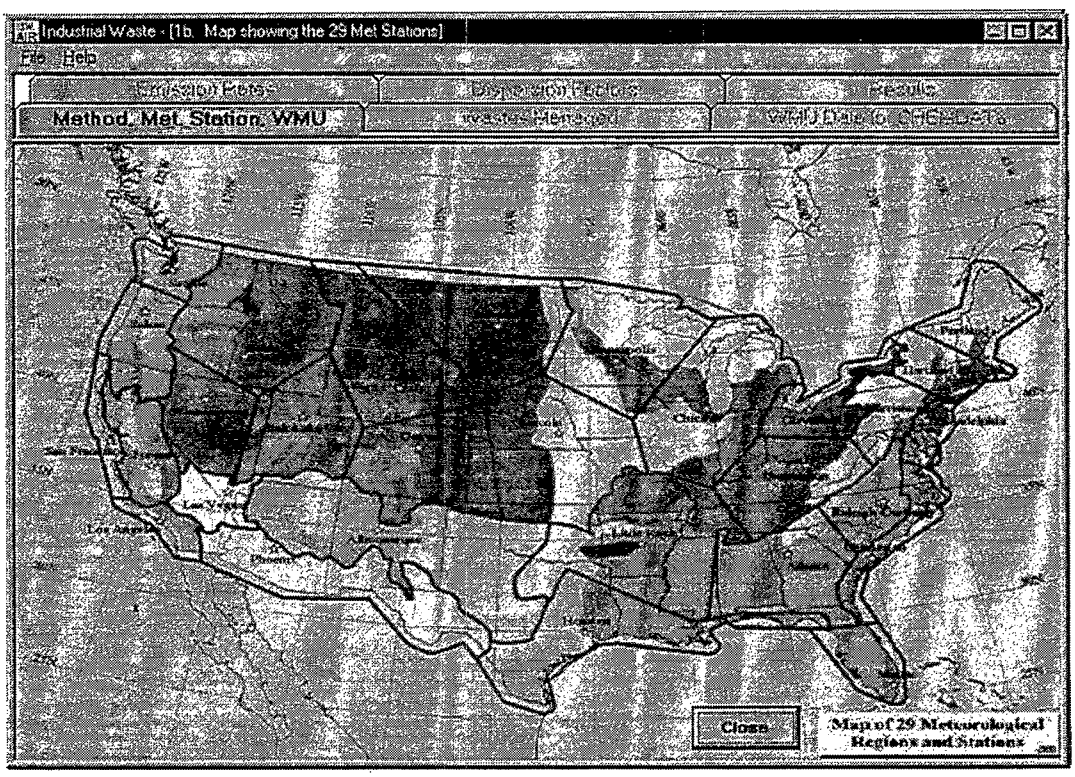
The tool uses emission rate and dispersion factor estimates in both the forward and backward calculations. As seen in Screen 1A, you must select one of the three options provided for obtaining emission and dispersion data:

- Option 1 - *Use CHEMDAT8*
  Select Option 1 to use CHEMDAT8 for calculating the emissions from your unit regardless of whether you want to calculate or enter dispersion factors. This allows you to enter a variety of unit-specific information that IWAIR will use to develop chemical-specific emission rate estimates through the use of EPA's CHEMDAT8 model. These inputs also provide the information needed to use the ISCST3 dispersion factors provided with IWAIR; however, you may also enter your own dispersion factors. You will be allowed to override the IWAIR emission estimates on subsequent screens. Option 1 is

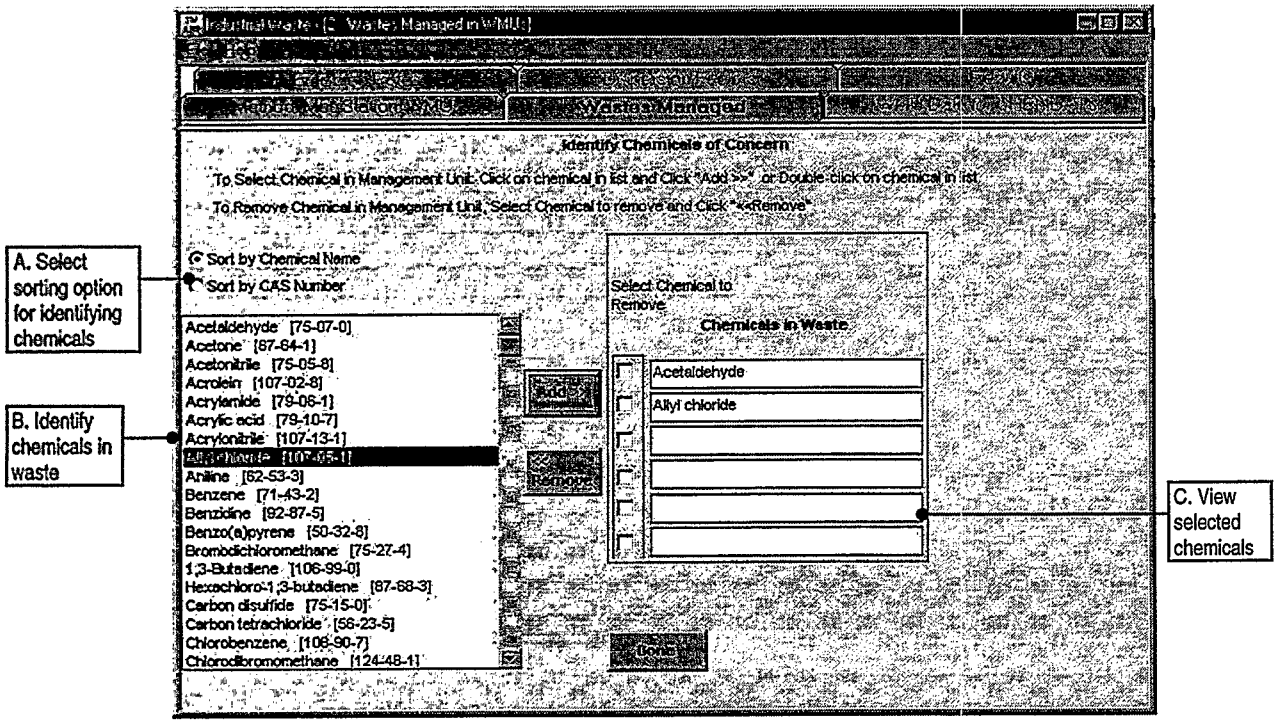
most appropriate for use if Pathway 1 or 2 was selected in Section 3.3. Select this option by clicking the Use CHEMDAT8 command button.

- Option 2 - *Enter Emission Rates*
  Select Option 2 to enter your own site-specific emission rates (g/m^2-s) on a subsequent screen. Rates may be developed based on monitoring data or measurements or by conducting modeling with a different emission model. Under this option, IWAIR can be used to estimate dispersion based on ISCST3 default dispersion factors. If this option is selected, you will still be allowed to override the IWAIR dispersion factors on subsequent screens with site-specific unitized dispersion factors ($\mu g/ m^3$ per $\mu g/m^2$-s). Option 2 is most appropriate for use if Pathway 3 was selected in Section 3.3. Select this option by clicking the ENTER EMISSION RATES command button. Once selected, a message box will appear that directs you to enter WMU area (m^2). If a waste pile is being modeled, a subsequent box will appear for the height of the unit to be entered. These WMU data are used by the model to calculate dispersion estimates.

- Option 3 - *Enter Emission, Dispersion Data.*
  Select Option 3 to enter your own emission estimates (g/m^2-s) and unitized dispersion factors ($\mu g/ m^3$ per $\mu g/m^2$-s). Option 3 is most appropriate for use if Pathway 4 was selected in Section 3.3. This option is selected by clicking the ENTER EMISSIONS, DISPERSION DATA command button.



Screen 1B. Map of Continental USA Showing 29 Meteorological Stations



Screen 2. Wastes Managed

5.2 Wastes Managed (Screen 2)

To perform a backward calculation to arrive at protective waste concentration estimates, identify the chemical(s) of concern in the waste.

A. Select Sorting Option for Identifying Chemicals (Screen 2)

IWAIR includes a predetermined list of 95 chemicals from which you can identify waste constituents. These constituents are shown with their Chemical Abstracts (CAS) numbers in Section 1, Table 1-1. To facilitate the chemical identification process, IWAIR allows you to sort this list of chemicals alphabetically by chemical name or by CAS number. As shown in Screen 2, select a sort order by clicking on the button to the left of the sorting option of choice.

B. Identify Chemicals in Waste (Screen 2)

Identify up to six chemicals in a waste for modeling with IWAIR. Identify a chemical by clicking on the chemical name or CAS number and clicking on the **Add>>** command button. To remove a waste constituent from consideration, select the check box located to the left of the displayed chemical name and click the **<<Remove** command button.

C. View Selected Chemicals (Screen 2)

The chemicals you identified for consideration are displayed in text boxes shown on Screen 2. You can remove waste constituents from consideration by selecting the check box to the left of the chemical and clicking the **<<Remove** command button.

5.3 Enter WMU Data for Using CHEMDAT8 Emission Rates

If you elected to use CHEMDAT8 emission rates in the calculations (i.e., selected the Use CHEMDAT8 command button shown previously on Screen 1A), you will need to enter WMU data as specified in this section. If you did not elect to use CHEMDAT8 emission rates, then you should skip this section and proceed to Section 5.4, *Emission Rates*.

The section provides guidance in providing input data needed to develop CHEMDAT8 emission estimates for the four unit types addressed by IWAIR.

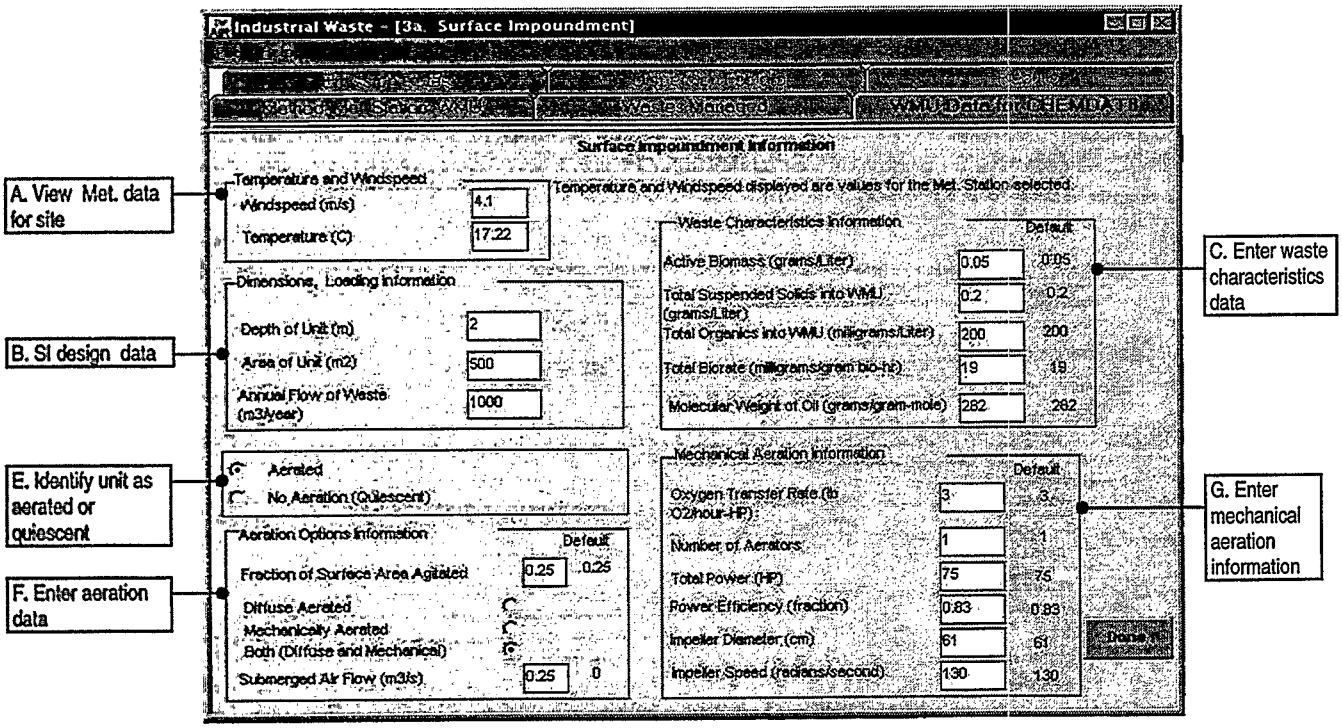
Surface Impoundments. The major source of volatile emissions associated with surface impoundments is the uncovered liquid surface exposed to the air (U.S. EPA, 1991). Aeration and/or agitation are applied to aid in treatment of the waste, and emissions tend to increase with an increase in surface turbulence because of enhanced transfer of liquid phase contaminants to the air (U.S. EPA, 1991). Parameters to which emissions are most sensitive include surface area, unit depth, waste concentration, retention time, windspeed for quiescent systems, and biodegradation.

Land Application Units. The waste can be tilled or sprayed directly onto the soil and subsequently mixed with the soil by discing or tilling. Waste in a LAU is a mixture of sludge and soil. IWAIR allows the modeling of tilled LAUs. Another model may be more appropriate if your LAU uses spray application. Air emissions from land treatment units are dependent on the chemical/physical properties of the organic constituents, such as vapor pressure, diffusivity, and biodegradation rate. Operating and field parameters affect the emission rate, although their impact is not as great as that of the constituent properties.

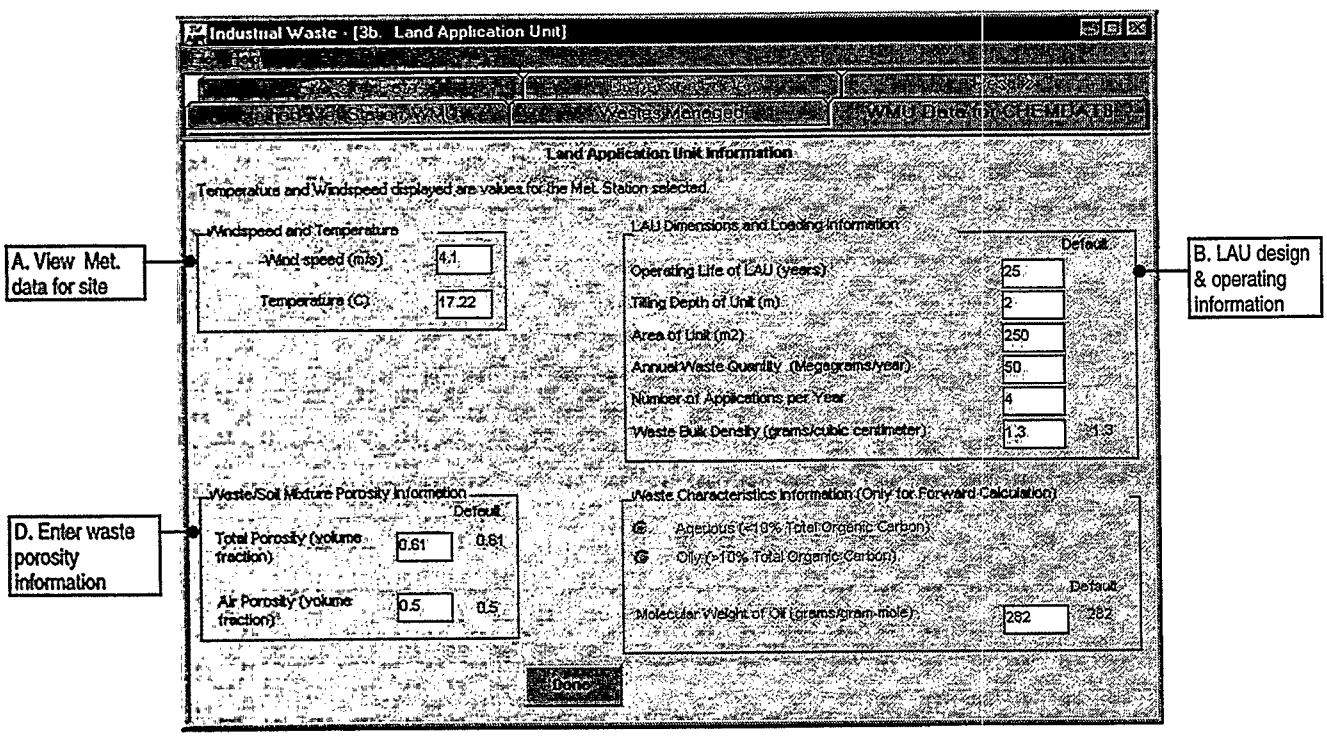
Active Landfills. IWAIR allows the modeling of emissions released from the surface of an active (i.e., receiving wastes) landfill. The landfill model is sensitive to the air porosity of the solid waste, the liquid loading in the solid waste, the waste depth (assumed to be the same as the unit depth), constituent concentration in the waste, and the volatility of the constituent (U.S. EPA, 1991).

Wastepiles. The waste pile emission model is sensitive to the air porosity of the solid waste, the liquid loading in the solid waste, the wastepile height, constituent concentration in the waste, and the volatility of the constituent (U.S. EPA, 1991).

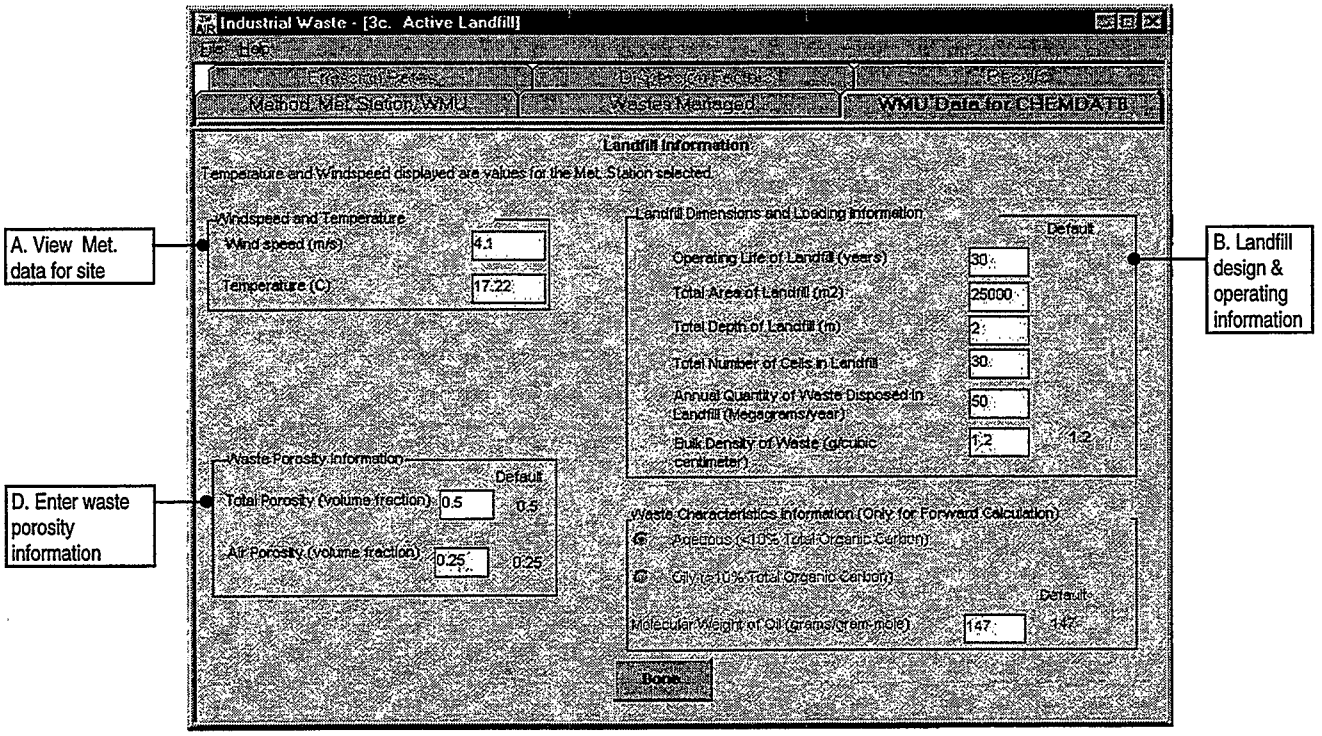
Screens 3A, 3B, 3C, and 3D, respectively, identify the CHEMDAT8 input requirements for surface impoundments, land application units, landfills, and wastepiles. Guidance for completing each



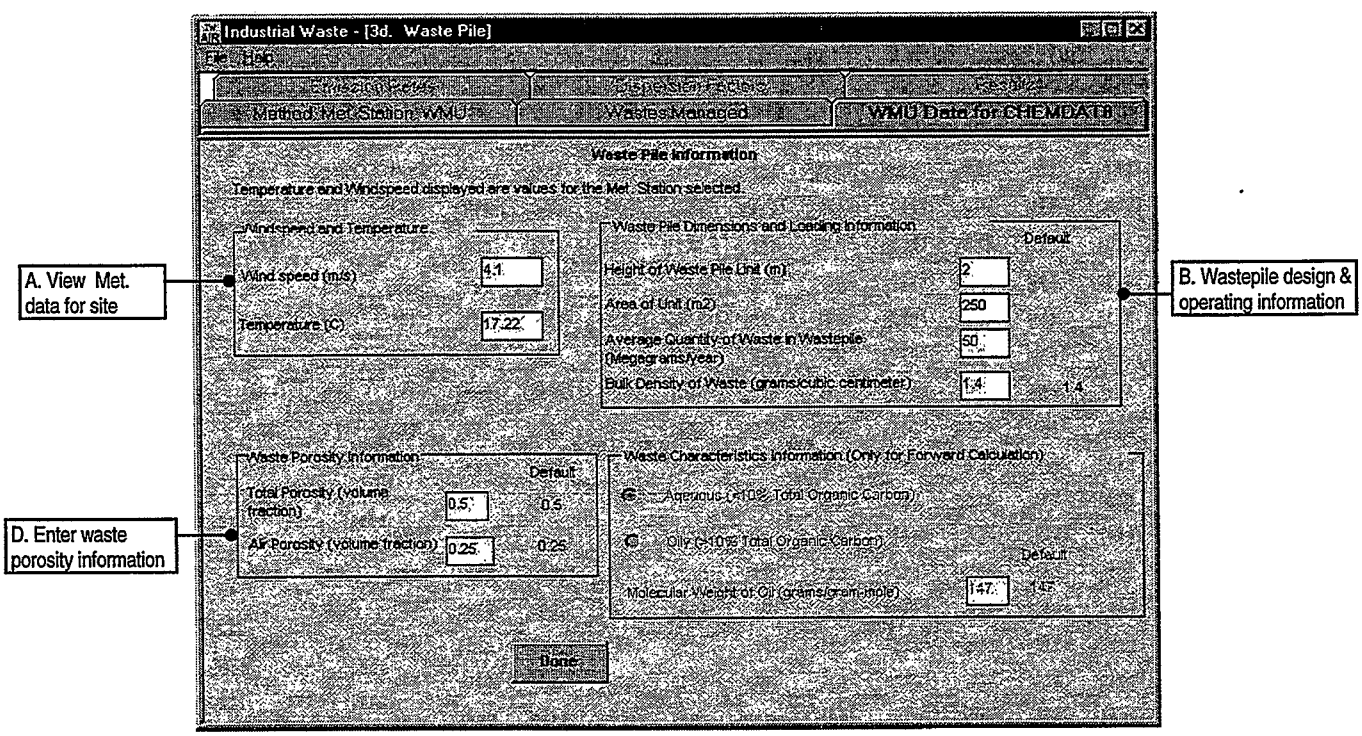
Screen 3A. WMU Data for CHEMDAT8: Surface Impoundment



Screen 3B. WMU Data for CHEMDAT8: Land Application Unit



Screen 3C. WMU Data for CHEMDAT8: Landfill



Screen 3D. WMU Data for CHEMDAT8: Wastepile

screen is provided below. For several of the required inputs, default values are provided to the right of the screen textboxes. These default values were selected to represent average or typical operating conditions. If appropriate, the defaults can be applied in the absence of site-specific data. The basis for these default values is provided in the IWAIR Technical Background Document.

A. View Meteorological Data for Site (Screens 3A, 3B, 3C, and 3D)

Both windspeed and temperature can affect the volatilization rate of a chemical. Average temperature and windspeed are used as input to the CHEMDAT8 model. Drawing from the meteorological data stored in IWAIR, the program will display the average annual temperature and windspeed available for the representative meteorological station that was determined for the site in Screen 1A. Alternatively, you can enter average windspeed and temperature for your site if the default values are significantly different.

B. Enter Unit Design and Operating Data

Enter Surface Impoundment Design Data (Screen 3A):

Enter the unit dimensions and loading information in the textboxes shown in each Screen 3A. The data include the depth of the surface impoundment in meters, the area of the surface impoundment in square meters, and the annual flow of the waste in cubic meters per year.

Enter LAU Design and Operating Information (Screen 3B)

Enter the unit dimensions and loading information, including the operating life of the unit in years, tilling depth of the unit (m), area of the unit in square meters (m^2), annual waste quantity in megagrams per year, number of application per year, and waste bulk density in grams per cubic centimeter (g/cm^3).

Enter Landfill Design and Operating Information (Screen 3C):

Enter the unit dimensions and loading information in the textboxes in Screen 3B. The model assumes that the landfill is divided into cells, with only one cell active at a time. Emissions are modeled from the active cell. The data to be entered include the operating life of the unit in years, total area of the unit in square meters (m^2), depth of the unit (m), number of cells in your unit, annual quantity of wastes disposed in landfill (Mg/year), and bulk density of waste (g/cubic centimeter).

Enter Wastepile Design and Operating Information (Screen 3D):

The unit dimensions and loading information to be entered include the height of the pile in meters (m), area of the unit in square meters (m^2), annual quantity of waste in pile (Mg/year), and bulk density of the waste in g/cm^3.

C. For Surface Impoundments Only - Enter Waste Characterization Data (Screens 3A)

The waste characteristic information to be entered for surface impoundments include active biomass (grams/liter), total suspended solids into WMU (milligrams/liter), total organics into WMU (milligrams/liter), total biorate (milligrams/ gram bio-hr), and molecular weight of oil (grams/gram-mole).

D. For LAUs, LFs, and WPs Only - Enter Waste Porosity Information (Screens 3B, 3C, and 3D)

Waste (or soil/waste mixture for LAUs) porosity information required as input includes total porosity (unit less) and air porosity (unitless). Total porosity includes air porosity and the space occupied by oil and water within waste. Total porosity (η), also sometimes call saturated water content, can be calculated from the bulk density (BD) of the soil and particle density (ρ_s) as follows:

$$\eta = 1 - \frac{BD}{\rho_s}$$

In the absence of site-specific data, IWAIR identifies default values of 0.5 and 0.25, respectively, for total porosity and air porosity. Air porosity cannot exceed total porosity.

E. For Surface Impoundments Only - Identify Unit as Aerated or Quiescent (Screen 3A)

IWAIR models both quiescent (not aerated) and aerated impoundments. Aeration or agitation of a liquid waste in an impoundment enhances transfer air (oxygen) to the liquid to improve mixing or to increase biodegradation (U.S. EPA, 1991). Identify your unit as aerated or quiescent (i.e., not aerated) by clicking the appropriate option button.

F. For Aerated Surface Impoundments Only - Enter Aeration Data (Screen 3A)

Aeration is achieved through the use of mechanical mixers such as impellers (i.e., mechanically aerated) and/or by sparging air which bubbles up from the bottom of the unit (i.e., air diffuse aerated). If your surface impoundment is aerated, provide information to characterize the operation. This information includes fraction of surface area agitated (unitless) and an indication of whether the unit is aerated through the use of air diffusion or mechanically aerated, or both. If the unit has diffused aeration, you will also need to enter a submerged air flowrate (m^3/s) in this screen.

G. For Mechanically Aerated Surface Impoundments Only - Enter Mechanical Aeration Information (Screen 3A)

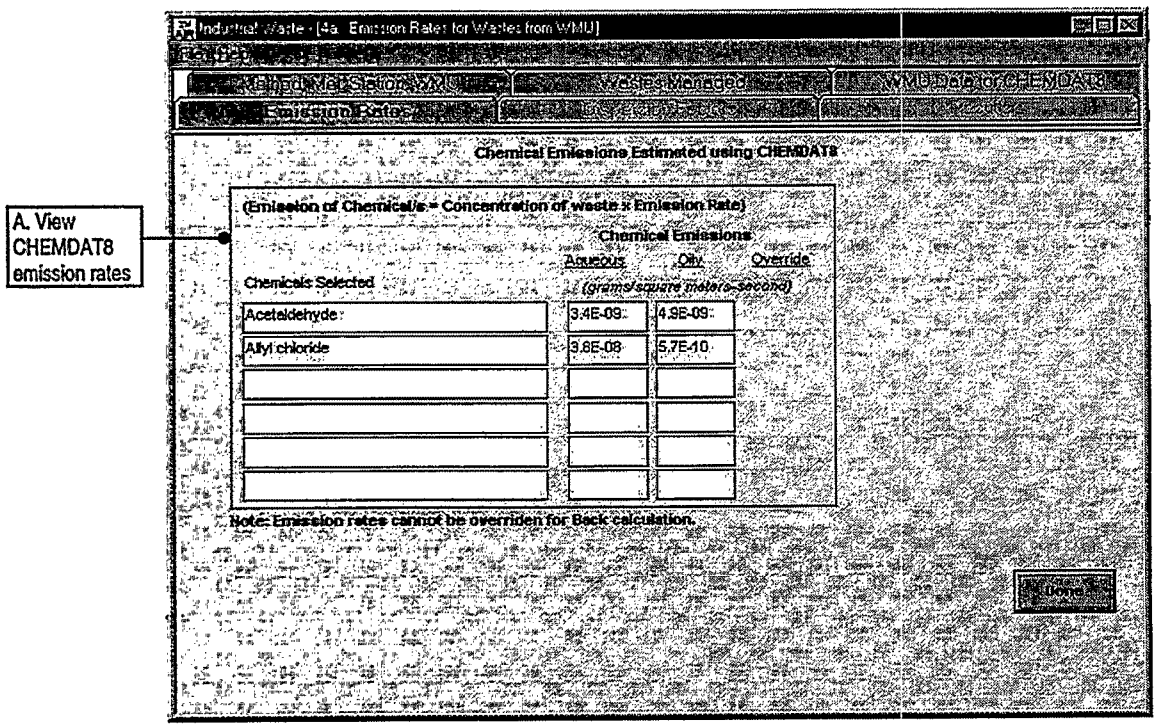
If a surface impoundment is mechanically aerated, you will need to provide additional operating parameter information. These data include oxygen transfer rate (lb O_2/hour-HP), number of aerators, total power (HP), powers efficiency (fraction), impeller diameter (cm), and impeller speed (radian/second).

Done. Once you provide the required WMU inputs, click the DONE button to enable the Emission Rates menu tab and open the Emission Rates screen. Proceed to Section 5.4, *Emission Rates*.

5.4 Emission Rates

Guidance for using CHEMDAT8 emission rates or entering your own emission rates is provided in this section. View and confirm the CHEMDAT8 emission rates as directed in Section 5.4.1. If you did not elected to use CHEMDAT8 (i.e., selected the ENTER EMISSION RATES or ENTER EMISSIONS, DISPERSION DATA command buttons shown previously on Screen 1A), proceed to Section 5.4.2, *User Specified Emission Rates*.

Please note that all calculated and entered values on the Emission Rate screen will be lost if you return to a previous screen and make changes. This includes both calculated and entered override emission rate values.

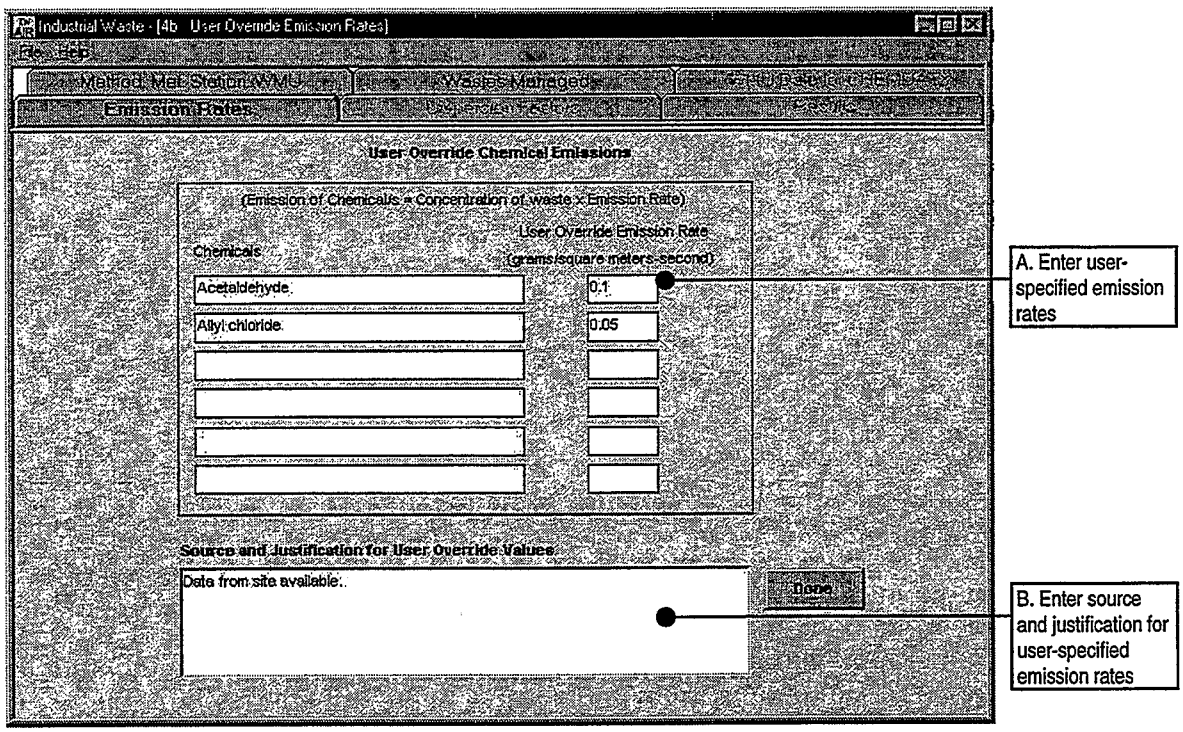


Screen 4A. CHEMDAT8 Emission Rates

5.4.1 Using CHEMDAT 8 Emission Rates (Screen 4A)

A. View CHEMDAT8 Emission Rates (Screen 4A)

Screen 4A shows the both the oily- and aqueous-phase waste CHEMDAT8 emission rates. Confirm the emission rates to be used in the calculations by clicking the DONE button. The program will automatically enable the Dispersion Factors menu tab and open the Dispersion Factors screen. Proceed to Section 5.5, *Dispersion Factors*.



Screen 4B. User Specified Emission Rates

5.4.2 User-Specified Emission Rates (Screen 4B)

A. Enter User-Specified Emissions (Screen 4B)

Enter site-specific normalized emission rates (g/m^2-s per mg/kg or g/m^2-s per mg/L) in the text box located under User Override. Your emission rates *must be* normalized to a unit concentration. If you provide alternate rates, the source and the justification for these data and estimation method employed should also be documented using the textbox on the screen.

B. Enter Source and Justification for User-specified Emission Rates (Screen 4B)

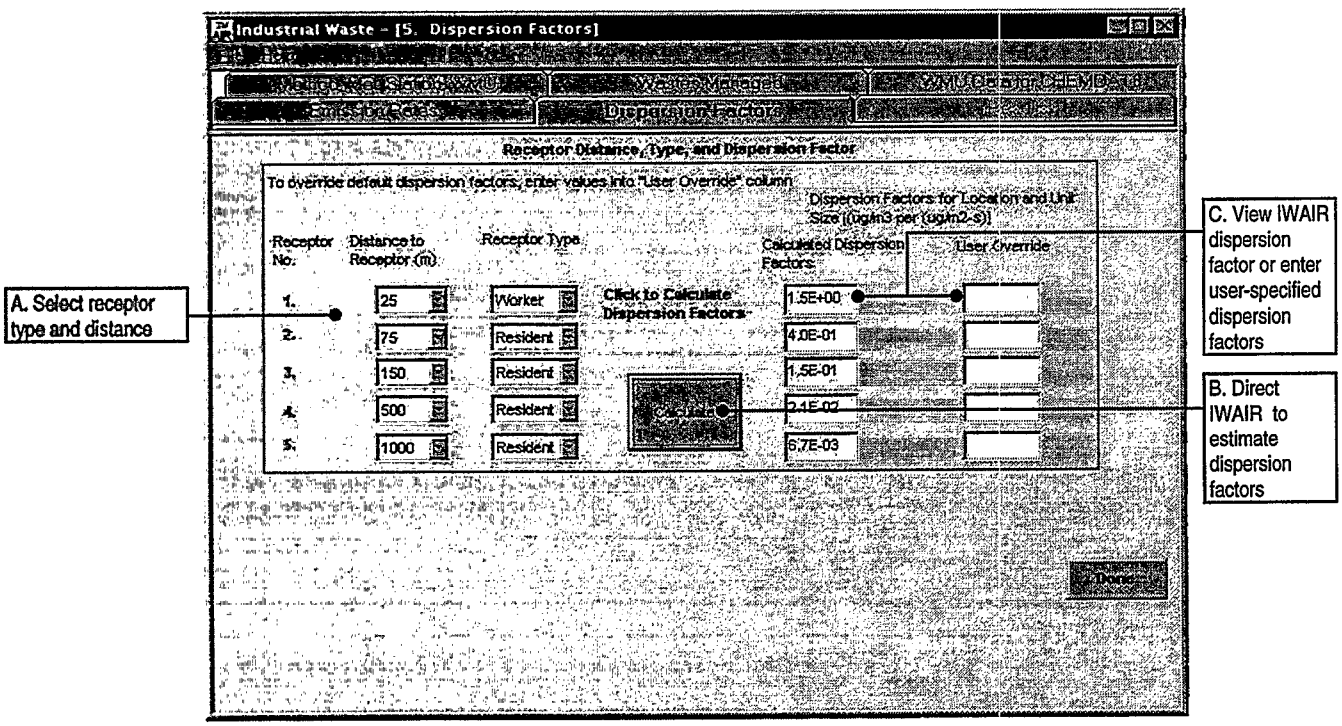
The program will prompt the user to provide justification for using user-specified emission rates and documentation of the estimation method applied. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later date.

Done. Once you have entered emission data and source/justification, click the DONE button to enable the Dispersion Factors menu tab and open the Dispersion Factors screen. Proceed to Section 5.5, *Dispersion Factors*.

5.5 Dispersion Factors

Dispersion modeling outputs are used to estimate air concentrations to which the various human receptors are exposed. Guidance for using the ISCST3 default dispersion factors or entering your own site-specific dispersion factors is provided in Section 5.5.1 and 5.5.2, respectively. If you elected to use ISCST3 dispersion factors provided in IWAIR (i.e., selected the Use CHEMDAT8 or ENTER EMISSION RATES command buttons shown previously on Screen 1A), you will need to follow the guidance provided in Section 5.5.1. If you did not elect to use the default dispersion factors, you should proceed to Section 5.5.2, *User-Specified Dispersion Factors*.

Please note that all calculated and entered values on the Dispersion Factor screen will be lost if you return to a previous screen and make changes. This includes receptor locations and types, and calculated and entered override dispersion factor values.



Screen 5A. Using ISCST3 Default Dispersion Factors

5.5.1 Using ISCST3 Default Dispersion Factors (Screen 5A)

In Screen 5A, you will provide receptor information (i.e., receptor type and distance to the receptor) and click on the CALCULATE button; IWAIR will develop site-specific dispersion factors based on default dispersion data. If you wish to override the IWAIR-developed dispersion factors, enter alternate site-specific unitized dispersion factors. If you enter alternative dispersion factors, you should document the source and the justification for these data in the text box on the screen.

A. Select Receptor Type and Distance (Screen 5A)

Enter information concerning the receptors of concern (i.e., potentially exposed individuals). You can specify up to five receptors, including Distance to Receptor and Receptor Type. You can specify two receptor types at six distances (25, 50, 75, 150, 500, and 1000 meters) from the edge of the WMU.

Distance to Receptor - For each receptor of concern, determine the distance from the edge of the unit to the receptor. Based on this distance, select from the six default distances (25, 50, 75, 150, 500, and 1,000 meters) the one that best approximates the location of your receptor, using the dropdown box under the Distance to Receptor heading. Note that selecting a smaller distance will overestimate risk, and selecting a larger distance will underestimate risk. These distances correspond to the distances for which air dispersion modeling was conducted to develop the IWAIR default dispersion factors. The *IWAIR Technical Background Document* discusses the analysis that was conducted in determining the appropriateness of these default distances.

Receptor Type - Two different types of exposed individuals, a worker and a resident, can be modeled with IWAIR. The difference between these two receptors is in the exposure factors, such as body weight and inhalation rate, used to calculate risk for carcinogens. There is no difference between them for noncarcinogens. The IWAIR Technical Background Document describes the exposure factors used for residents and workers. The assumptions for workers reflect a full-time, outdoor worker. The assumptions for residents reflect a males and females from birth through age 30. Use the drop-down box positioned under the Receptor Type column heading to select either a worker or resident.

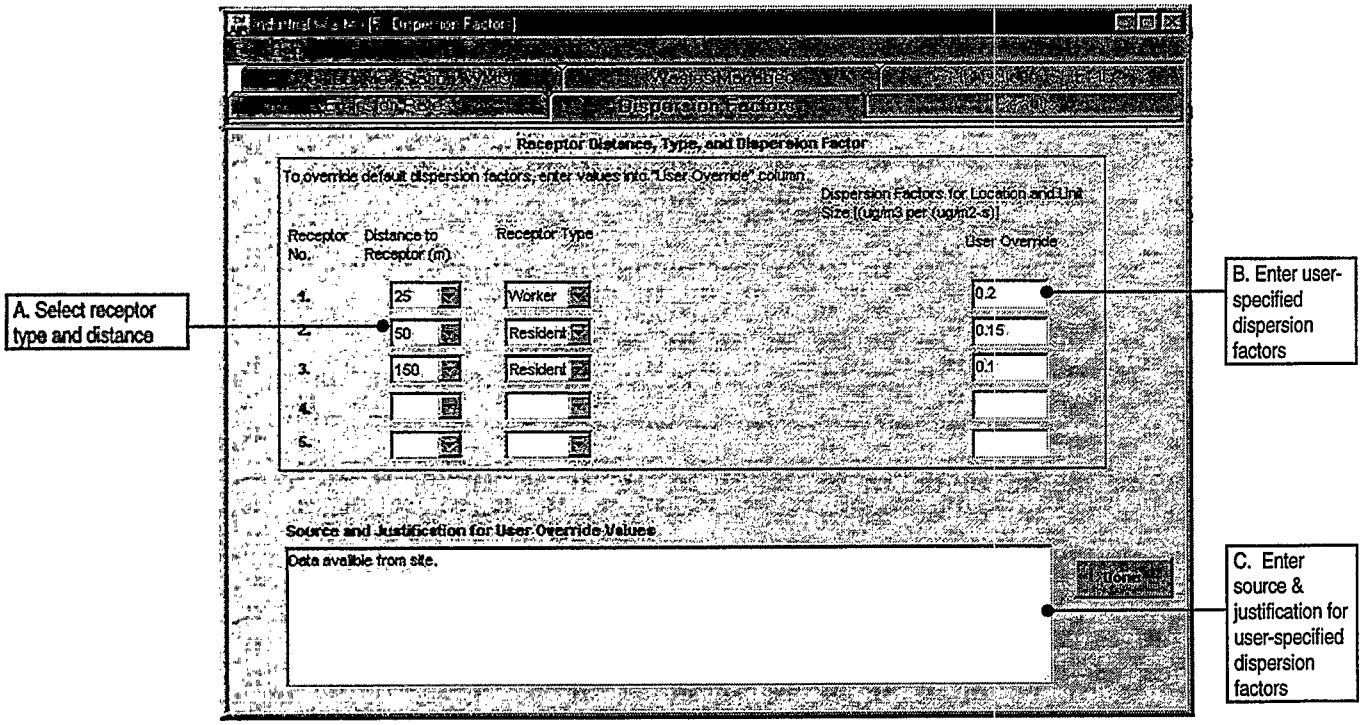
B. Direct IWAIR to Estimate Dispersion Factors (Screen 5A)

After the requested receptor information is provided, click on the CALCULATE button to direct the program to determine an appropriate dispersion factor based on the IWAIR default dispersion data. The resulting dispersion factor will be displayed for each receptor of concern. A discussion of the development of IWAIR default dispersion data and the methodology used by the program in selecting an appropriate dispersion factor for each WMU/receptor combination is provided in Section 3.3. A more detailed discussion of the air dispersion modeling effort is provided in the *IWAIR Technical Background Document.*

C. View IWAIR Dispersion Factors or Enter User-Specified Dispersion Factors (Screen 5A)

You may override the program-calculated dispersion factors by entering alternative dispersion data in the text box located under the User Override column (see Screen 5A). If you choose to provide alternative dispersion factors, document the source and the justification for these data in the text box that will appear. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later date.

Done. Once the program has developed dispersion factors, click the DONE button to open the Results menu tab. Proceed to Section 5.6, *Results.*



Screen 5B. User Specified Dispersion Factors

5.5.2 User-Specified Dispersion Factors (Screen 5B)

A. Select Receptor Type and Distance (Screen 5B)

Enter information concerning the receptors of concern (i.e., potentially exposed individuals) you can specify up to 5 receptors. The receptor information includes Distance to Receptor and Receptor Type. You can specify 2 receptor types in 16 directions at 6 distances (25, 50, 75, 150, 500, and 1,000 meters) from the edge of the waste management unit.

Distance to Receptor - For each receptor of concern, determine the distance from the edge of the unit to the receptor. Based on this distance, select from the six default distances (25, 50, 75, 150, 500, and 1,000 meters) the one that best approximates the location of your receptor, using the drop-down box positioned under the Distance to Receptor column heading. These values are only for your reference, and are not used in calculations, since you are entering your own dispersion factors.

Receptor Type - Two different types of exposed individuals, a worker and a resident, can be modeled with IWAIR. The difference between these two receptors is in the exposure factors, such as body weight and inhalation rate, used to calculate risk for carcinogens. There is no difference between them for noncarcinogens. The IWAIR Technical Background Document describes the exposure factors used for residents and workers. The assumptions for workers reflect a full-time, outdoor worker. The assumptions for residents reflect a males and females from birth through age 30. Use the drop-down box positioned under the Receptor Type column heading to select either a worker or resident.

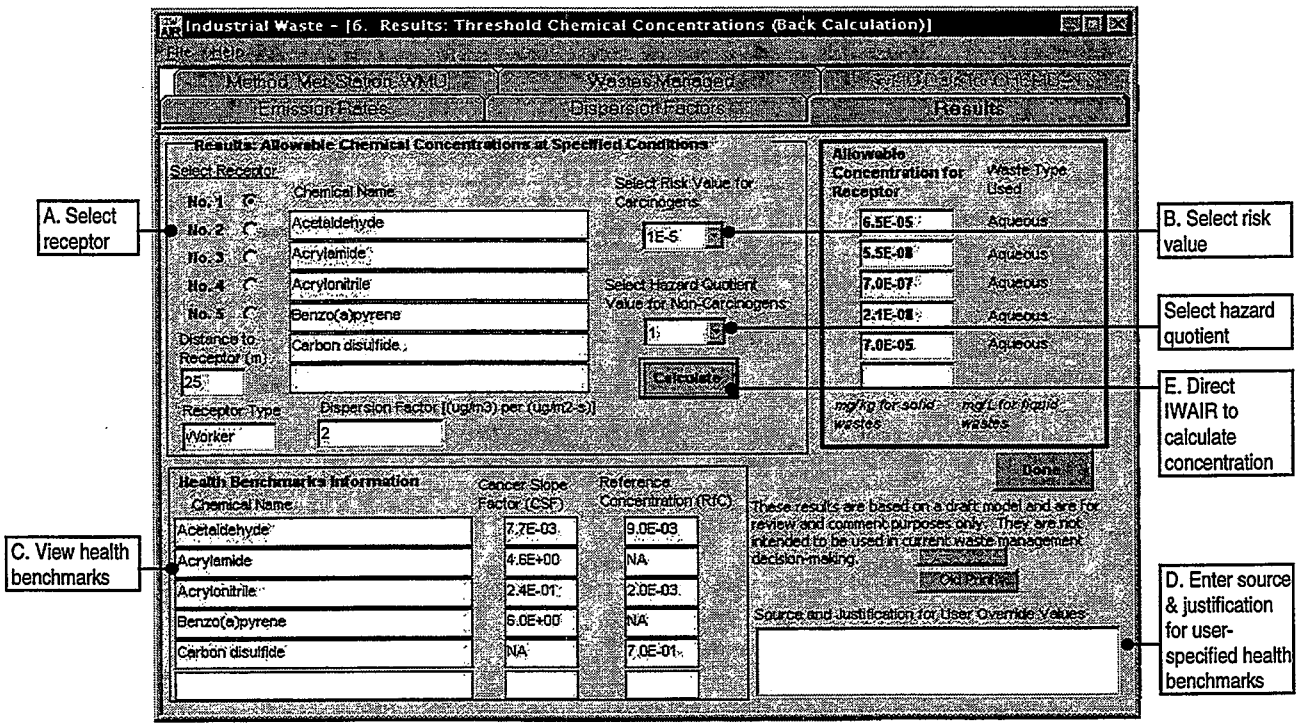
B. Enter User-Specified Dispersion Factors (Screen 5B)

For each receptor specified, enter site-specific unitized dispersion factors ($\mu g/m^3$ per g/m^2-s) in the text box located under User Override.

C. Enter Source and Justification for User-Specified Dispersion Factors (Screen 5B)

The program will prompt you to provide justification for using user-specified dispersion data and documentation of the estimation method applied. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later date.

Done. Once you have entered dispersion data, click the DONE button to open the Results menu tab. Proceed to Section 5.6, *Results*.



Screen 6. Results

5.6 Results (Screen 6)

Protective waste concentrations can be calculated from user-specified risk levels. The program combines the constituent's air concentration with receptor exposure factors and toxicity benchmarks to calculate the waste concentrations that are protective of human health. For each receptor, IWAIR calculates air concentrations using emission and dispersion data specified or calculated in previous screens. To reflect exposure that would occur in a lifetime (i.e., from childhood through adult), the model applies a time-weighted-average approach. This approach considers exposure that would occur during five different phases of life (i.e., Child < 1 yr, Child 1-5 yrs, Child 6-11 yrs, Child 12-18 yrs, and

Adult). The exposure factors addressed as part of this approach include inhalation rate, body weight, exposure duration, and exposure frequency. The default values that are applied in developing these time-weighted-average exposures were identified based on data presented in EPA's *Exposure Factors Handbook* (U.S. EPA, 1997a) and represent average exposure conditions. IWAIR incorporates standard toxicity benchmarks (cancer slope factors for carcinogens and reference concentrations for noncarcinogens) for 95 constituents. These health benchmarks were obtained primarily from the EPA's Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1998a, 1997b). IWAIR uses these data to perform a backward calculation to obtain protective waste concentrations estimates.

The approach applied by IWAIR includes an iterative forward calculation algorithm. The program sets an initial waste concentration, calculates risk, compares that to the target risk, then adjusts the waste concentration and recalculates until the target risk is achieved.

If you are modeling a land-based unit and have elected to use CHEMDAT8 to calculate emissions, IWAIR will perform backcalculations for both an aqueous-phase waste and an oily-phase waste, and will output the lower of the two resulting concentrations. For most chemicals, that will be the aqueous-phase concentration, but for a few chemicals (most notably formaldehyde), it will be the organic-phase concentration. If you elected to enter your own emission rates, or if you are modeling a surface impoundment, IWAIR will only backcalculate and output concentrations for an aqueous-phase waste.

In performing backcalculations, IWAIR ensures that backcalculated aqueous-phase concentrations do not exceed the soil saturation limit (for land-based units) or the solubility (for surface impoundments) for that chemical. This prevents impossible results from occurring. Similarly, the program also ensures that backcalculated oily-phase concentrations do not exceed 1,000,000 mg/kg. If the target risk or hazard quotient cannot be achieved by any possible concentration (i.e., in an aqueous-phase waste up to the soil saturation or solubility, or in an oily-phase waste up to 1,000,000 mg/kg), then the program will note the maximum risk or hazard quotient that can be reached, and the backcalculated concentration will be set to the concentration that results in the maximum possible risk or hazard quotient. This will be either the soil saturation limit or 1,000,000 if you are modeling a land-based unit using CHEMDAT8, or the soil saturation limit if you are modeling a land-based unit with your own emission factors, or the solubility if you are modeling a surface impoundment.

Please note that all calculated and entered values on the Results screen will be lost if you return to a previous screen and make changes. This includes entered override health benchmarks and entered target risk and hazard quotients, as well as all calculated results.

A. Select Receptor (Screen 6)

Select a single receptor to serve as the focal exposure point for the calculations by clicking on the option button associated with the receptor of choice. As discussed above in Section 5.5, you can specify up to 5 receptors of concern. However, results can only be seen on the screen for one receptor at a time. Once results are calculated and displayed for one receptor, you can select another receptor of concern by clicking on one of the other receptor option buttons.

B. Specify Risk Level (Screen 6)

Specify a target cancer and noncaner risk levels. As shown in Screen 6, a drop down box is used to allow to select an appropriate risk levels (e.g., a hazard quotient of 1 for noncarcinogens or 1 x 10^{-6} for carcinogens).

C. View or Enter Health Benchmarks (Screen 6)

Screen 6 allows the you to view the health benchmarks IWAIR uses in the calculations. If a you chooses not to use these data, alternate health benchmarks can be entered. Cancer slope factors (per mg/kg-d) will be entered in textboxes located under Cancer Slope Factors (CSF) and reference concentrations (mg/m^3) under Reference Concentration (RfC). Do not use a reference dose in the place of a reference concentration.

D. Enter Source and Justification for User-Specified Values (Screen 6)

If you choose to override the IWAIR provided benchmarks, you should specify the source and the justification of the alternative data in the textbox. It is important to provide this documentation as a reference that will allow you or another user to view and understand saved files at a later date.

E. Direct IWAIR to Calculate Protective Waste Concentration (Screen 6)

Click on the CALCULATE button to calculate waste concentration estimates. Waste concentration estimates will be displayed for each chemical of concern. If CHEMDAT8 emission rates were used in the calculations, the waste phase (aqueous or oily) that served as the basis for these rates will be displayed to the right of the waste concentration textboxes.

When using the IWAIR tool in backward calculation mode, you need to remember that the specified target levels are chemical-specific and do not represent total or cumulative cancer risk levels (i.e., the summation of the chemical-specific risk estimates). If multiple chemicals of concern are present in the waste, the cumulative cancer risk will likely be greater than the specific target risk level. To estimate the cumulative risk posed to the receptor of concern, you can multiply the number of carcinogens in the waste by the specified target risk level. For example, if a waste being managed contains 5 carcinogens and the single target risk level specified is $1x10^{-6}$, then the cumulative risk posed to the receptor of concern would be equal to the product of the number of carcinogens in the waste (5) times the target risk level ($1x10^{-6}$) or $5x10^{-6}$.

Done. Click the DONE button to initiate a new run or save the run that you have just completed. •A dialog box will appear to guide you through restarting the model or saving the current run.

6.0 Example Calculations

IWAIR allows the user to conduct forward calculations to estimate cancer and noncancer inhalation risk estimates or back calculations to estimate protective waste concentrations from a specified target risk level. The following example calculations were prepared to demonstrate the calculation approaches applied by IWAIR.

The example calculations are performed for a tilled land application unit with a surface area of 1000 square meters. It was assumed that the waste managed in the unit contains the carcinogen formaldehyde and noncarcinogen acrolein. The default emission rates and dispersion rates used in the calculations were developed using EPA's models CHEMDAT8 and the Industrial Source Complex Short Term model, version 3 (ISCST3 model), respectively. The meteorological inputs used in conducting emission and dispersion modeling were developed based on data obtained for Huntington, West Virginia, which is one of the 29 IWAIR meteorological stations. The exposed individual is assumed to be located 25 meters from the edge of the unit.

Carcinogens

As discussed above, it was assumed that the waste managed in the land application unit contained the carcinogen formaldehyde. The cancer slope factor (CSF) from formaldehyde is 4.6E-02 (per mg/kg-d).

Forward Calculation:

Using constituent-specific information for formaldehyde, Equations 1 through 3 illustrate the process of completing a forward calculation to arrive at risk. For this example, it is assumed that formaldehyde is present in the waste at a concentration of 6.5 mg/kg. The model combines emission rates and dispersion data to predict an ambient air concentration at the point of exposure (i.e., 25 meters from the unit).

Calculation of C_{air}:

$$C_{air} = C_{waste} \times ER \times DF \times 10^3 \text{ mg/g} = 2E{-}4 \qquad (6\text{-}1)$$

where

C_{air} = air concentration (mg/m^3)

C_{waste} = waste concentration (mg/kg) = 6.5 mg/kg

ER = unitized emission rate ([g/m^2-s]per[mg/kg]) associated with a waste concentration of 1 mg/kg. ER for Formaldehyde is 3E-8 [(g/m^2-s)per(mg/kg)].

DF = dispersion factor [(mg/m^3) per (mg/m^2-s)] associated with an emission rate of 1 g/m^2-s. DF for an assumed receptor located 25 meters from the unit is 1 [(mg/m^3)per(mg/m^2-s)].

The resulting air concentration can be combined with receptor exposure factors and toxicity benchmarks to calculate the risk from concentrations managed in the unit.

Risk for carcinogens can be calculated as follows:

$$\text{Risk} = \frac{C_{air} \times \text{CSF} \times \text{IR} \times \text{ED} \times \text{EF}}{\text{BW} \times \text{AT} \times 365 \text{ d/yr}} \quad (6\text{-}2)$$

where

Risk = Individual risk (unitless)
C_{air} = air concentration (mg/m^3)
CSF = cancer slope factor (per mg/kg-d)
IR = inhalation rate (m^3/d)
ED = exposure duration (yr)
EF = exposure frequency (d/yr)
BW = body weight (kg)
AT = averaging time (yr).

To reflect exposure that would occur in a lifetime (i.e., from childhood through adult), the model applies a modified version of Equation 6-2 that employs a time-weighted-average approach. This approach considers exposure that would occur during five different phases of life (i.e., Child < 1 yr, Child 1-5 yrs, Child 6-11 yrs, Child 12-18 yrs, and Adult).

IWAIR calculates lifetime risk as follows:

$$\text{Risk} = \frac{C_{air} \times \text{EF} \times \text{CSF}}{\text{AT} \times 365 \text{ d/yr}} \times \sum_{i=1}^{5} \frac{IR_i \times ED_i}{BW_i} \quad (6\text{-}3)$$

where

Risk = risk (unitless)
C_{air} = air concentration (mg/m^3)
EF = exposure frequency (day/yr) = 350 for all ages
CSF = cancer slope factor (mg/kg/day)$^{-1}$ = 4.6E-2 for formaldehyde
AT = averaging time (yr) = 70
IR_i = inhalation rate for age group i (m^3/day)
ED_i = exposure duration for age group i (yr)
BW_i = body weight for age group i (kg)

Table 6-1. Parameter Values Used in Estimating Time Weighted Average Exposure

Body Weight	Body Weight (kg)	Inhalation Rate (m^3/day)	Exposure Duration (years)	Exposure Frequency (days/year)
Adult	69.1	13.3	11	350
Child < 1 year	9.1	4.5	1	350
Child 1-5 years	15.4	7.55	5	350
Child 6-11 years	30.8	11.75	6	350
Child 12-18 years	57.2	14.0	7	350

The exposure factors addressed as part of this approach include inhalation rate, body weight, exposure duration, and exposure frequency. The Table 6-1 identifies the default values that were applied for each age group.

These default values were identified based on data presented in EPA's *Exposure Factors Handbook* (U.S. EPA, 1997a) and represent average exposure conditions.

Substituting these values into Equation 6-3 gives:

$$\text{Risk} = \frac{2E-4 \times 350 \times 4.6E-2}{70 \times 365} \times \left(\frac{13.3 \times 11}{69.1} + \frac{4.5 \times 1}{9.1} + \frac{7.55 \times 5}{15.4} + \frac{11.75 \times 6}{30.8} + \frac{14.0 \times 7}{57.2} \right) = 1E-6$$

Backward Calculation:

IWAIR performs backward calculations using an interative forward calculation algorithm. Using Equations 1 through 3 above, the program sets an initial waste concentration, calculates risk, compares the resulting risk estimate to the user-specified risk level, then adjusts the waste concentration and recalculates until the target risk is achieved. For example, the program would begin with a waste concentration of 1 mg/kg and solve Equation 6-1 to obtain an air concentration of 3E-5 mg/m^3. Based on this air concentration, Equation 6-3 would result in a risk estimate of 1.7E-7. This risk estimate would then be compared to the specified risk level (e.g., 1 x 10^{-6}). Based on this comparison, the waste concentration would be adjusted upward and the estimation process repeated until the program arrived at a protective waste concentration of 6.5 mg/kg. As demonstrated above, this waste concentration corresponds to inhalation risk estimate of 1 x 10^{-6}.

Noncarcinogens

To demonstrate the calculation process for noncarcinogens, it is assumed that the waste managed in the model land application unit contains the noncarcinogen acrolein. Acrolein has a reference concentration (RfC) of 2E-05 (mg/m^3).

Forward Calculation:

Using constituent-specific information for acrolein, Equations 6-4 and 6-5 illustrate the process of forward calculating to noncarcinogenic risk (i.e., hazard quotient). For this example, it is assumed that acrolein is present in the waste at a concentration of 1 mg/kg.

The hazard quotient for noncarcinogens can be calculated as follows:

$$HQ = \frac{C_{air}}{RfC} \qquad (6\text{-}4)$$

where

HQ	=	hazard quotient (unitless)
C_{air}	=	air concentration (mg/m^3)
RfC	=	reference concentration (mg/m^3) = 2E-05 (mg/m^3).

Substituting Equation 6-1 into Equation 6-4 and solving for HQ:

$$HQ = \frac{C_{waste} \times ER \times DF \times 10^3 mg/g}{RfC} \qquad (6\text{-}5)$$

where

C_{waste}	=	waste concentration (mg/kg) = 1 mg/kg
ER	=	unitized emission rate ([g/m^2-s]per[mg/kg]) associated with a waste concentration of 1 mg/kg. ER for Acrolein is 2E-08 [(g/m^2-s)per(mg/kg)].
DF	=	unitized dispersion factor [(mg/m^3) per (mg/m^2-s)] associated with an emission rate of 1 g/m^2-s. DF for a receptor assumed to be located 25 meters from the unit is 1 [(mg/m^3)per(mg/m^2-s)].
RfC	=	reference concentration (mg/m^3) = 2E-05 (mg/m^3).

Substituting in parameter values:

$$HQ = \frac{1 \times 2E{-}8 \times 1 \times 10^3 mg/g}{2E{-}5}$$

$$HQ = 1$$

Backward Calculation:

IWAIR performs backward calculations using an interative forward calculation algorithm. Using the above equations, the program sets an initial waste concentration (C_{waste}), calculates risk, compares the resulting risk estimate to the user-specified risk level, then adjusts the waste concentration and recalculates until the target risk is achieved. For example, the program would begin with a waste concentration of 1 mg/kg and solve Equation 6-1 to obtain an air concentration of 2E-5 mg/m^3. Based on this air concentration, Equation 6-5 would result in a hazard quotient of 1. This risk estimate would then be compared to the specified risk level (e.g., HQ of 0.5). Based on this comparison, the waste concentration would be adjusted downward and the estimation process would be repeated until the program arrived at a protective waste concentration of 0.5 mg/kg which corresponds to a hazard quotient of 0.5 for acrolein.

7.0 References

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