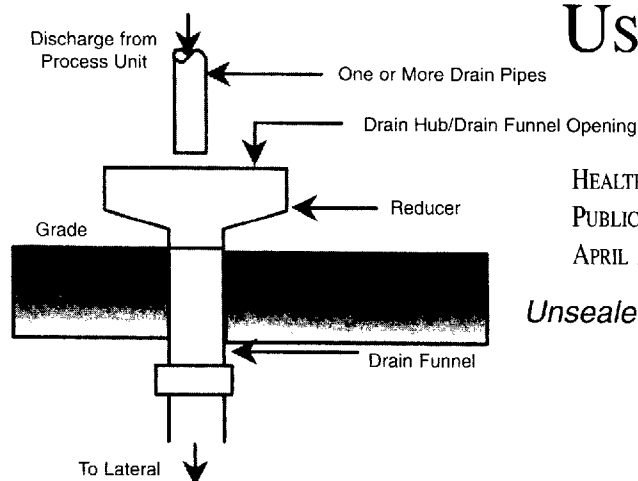


FUGITIVE EMISSIONS FROM REFINERY PROCESS DRAINS VOLUME III

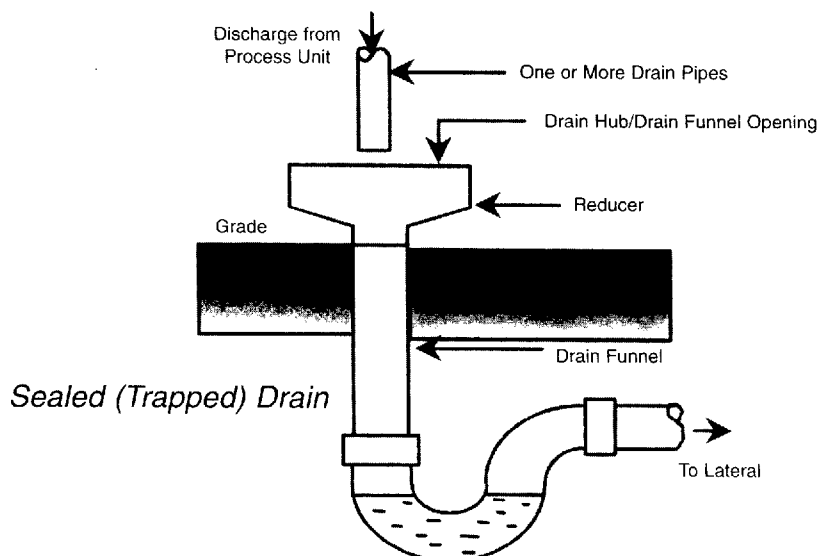
PROCESS DRAIN EMISSION CALCULATOR

APIDRAIN VERSION 1.0 USER'S GUIDE



HEALTH AND ENVIRONMENTAL SCIENCES DEPARTMENT
PUBLICATION NUMBER 4681
APRIL 1999

Unsealed Drain



Sealed (Trapped) Drain

For Technical Support:

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ENVIROMEGA, INC.
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FAX: (905) 689-7040
EMAIL: ENG@ENVIROMEGA.COM

Record the APIDRAIN Registration Number
from the enclosed registration form:
I46810 - _ _ _

Fugitive Emissions From Refinery Process Drains Volume III

Process Drain Emission Calculator

APIDRAIN Version 1.0 User's Guide

Health and Environmental Sciences Department

API PUBLICATION NUMBER 4681

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PREFACE

The results of this study are presented in three separate reports.

- Volume I entitled "*Fugitive Emission Factors for Refinery Process Drains*" (API Publication Number 4677) contains simplified emission factors that can be used to quickly estimate total volatile organic compound (VOC) emissions from refinery process drains.
- Volume II entitled "*Fundamentals of Fugitive Emissions from Refinery Process Drains*" (API Publication Number 4678) describes theoretical concepts and equations that may be used in a model (APIDRAIN) to estimate speciated VOC emissions. The model can provide insight on how to change process drain variables (flow rate, temperature, etc.) to reduce emissions.
- Volume III entitled "*APIDRAIN Version 1.0, Process Drain Emission Calculator*" (API Publication Number 4681) is the computer model with user's guide to estimate emissions from refinery process drains. The software allows users to calculate VOC emissions based on the emission factors in Volume I and equations for speciated emissions in Volume II.

All three volumes of this study can be purchased separately; however, it is suggested that the user consider purchase of the entire set to gain a complete understanding of fugitive emissions from refinery process drains.

ABSTRACT

Emissions from refinery process drains are under increasing regulatory scrutiny, particularly with respect to volatile organic compounds (VOCs) and hazardous air pollutants (HAPs). Drain emissions are currently estimated using EPA's AP-42 factor for non-methane hydrocarbons. The factor is now considered obsolete because it does not reflect design modifications that have resulted in significant reductions in emissions. As a result, the AP-42 factor over-predicts emission rates in many cases. API has recently sponsored projects that investigate emissions from process drains and that develop mechanistic models to predict VOC and HAP emission rates based on mass transfer fundamentals and conservation of mass. In this project, API has funded the development of a user-friendly model called APIDRAIN that incorporates a suite of procedures for estimating emission rates from refinery process drains. In addition to the mass transfer model, APIDRAIN also provides an option to estimate emission rates using emission factors, correlation equations, and a stripping efficiency estimation procedure. Users may create process units, and within each process unit, specify the drain estimation procedure used. The level of detail in reports generated ranges from a simple facility overview to a detailed categorization of emission rates of specific chemical compounds from individual drains within each process unit. The APIDRAIN model will enable users to easily categorize drains and report drain emission rates in various process units based on the quality of collected analytical data of contaminants in process liquid or gas phase streams.

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Documents

Document Sharing Hub

Section 1

INTRODUCTION

1.1 BACKGROUND

Emissions from refinery process drains are under increased regulatory scrutiny, particularly with respect to volatile organic compounds (VOCs) and hazardous air pollutants (HAPs), pursuant to the Clean Air Act Amendments of 1990. Emissions from refinery process drains are currently estimated in the industry using EPA's AP-42 factor of 0.070 lb/hr of total non-methane hydrocarbons. There have been significant design modifications to refinery process drains over the years since the AP-42 factor was first developed. The design changes have resulted in significant emission reductions from process drains, and the AP-42 factor is now considered obsolete because it over-predicts emission rates in many cases.

The American Petroleum Institute (API) funded a project to develop a mathematical model that predicts acceptably accurate emissions from refinery process drains. A mechanistic model was developed to predict VOC and HAP emission rates from process drains based on mass transfer fundamentals and conservation of mass. The mechanistic model accounts for emissions that may occur as the process wastewater is discharged from a pipe nozzle to the drain hub, emissions from the surface of a water seal, if present, and emissions from wastewater falling from the leg of the process drain into water conveyed in the underlying collection channel.

API initiated a project to incorporate the mechanistic model for refinery process drains into a suite of procedures for estimating emissions from refinery process drains resulting in a user-friendly software tool called APIDRAIN. In addition to the mass transfer mechanistic model, APIDRAIN also offers two other options for estimating emissions from process drains. They include (1) emission factors, and (2) correlation equations. Each calculation option requires considerably different input information. Thus, the user can choose the appropriate estimation method based on the level of detailed information available. APIDRAIN enables the user to sum up the emissions from drains within a refinery process unit, or from the entire refinery. The model user can quickly and easily predict the contribution of process drain emissions to the total emission inventory of a refinery.

The estimation procedures provided by APIDRAIN are generally applicable across the petroleum industry (exploration and production, refining and marketing terminals), as indicated in Table 1-1. The screening value correlation developed for the South Coast Air Quality Management District (SCAQMD) applies only to petroleum refineries in southern California, and only to inactive drains in those refineries. The stripping efficiency procedure and University of Texas model may be used to estimate process drain emissions in other industrial sectors. The stripping efficiency procedure applies only to sealed drains, while the UT model can be used to estimate emission rates from both sealed and unsealed drains.

Table 1-1 Applicability of Drain Emission Estimation Procedures in APIDRAIN Model

Estimation Procedure	Applicable to		
	South. California Petroleum Refineries	Petroleum Industry	Other Industries
AP-42 Zero/Pegged Factors		X	
OVA Screening (EPA)		X	
OVA Screening (SCAQMD)*	X		
Stripping Efficiency Factors†		X	X
University of Texas Model		X	X

* for inactive drains

†for sealed drains only

1.2 PRINCIPLES OF USE AND SYSTEM REQUIREMENTS

APIDRAIN operates as a workbook under the PC-based Microsoft[®] Excel[™] for Windows[™] environment, and therefore requires a PC system with the capacity to run Excel[™] and the Windows[™] operating system. (At a minimum, a 486DX2 Windows[™] 3.11 platform with 8 Mbyte RAM is needed to operate the APIDRAIN workbook.) The user must complete independent installations of Windows[™] and Excel[™] to begin using the software. The APIDRAIN workbook is enhanced with automatic functions that enable the user to summarize easily important reporting information and to generate tabular emission totals for both specific refinery process units and for the entire refinery. Therefore, it is not necessary for the user to possess a rigorous understanding of Excel[™] to use APIDRAIN; only a few common principles of the Windows[™]

operating environment are needed (such as point-and-click, and navigation of tab and arrow keys). APIDRAIN is also designed such that the user has a great deal of discretion in the selection of emission estimation procedures.

1.3 INSTALLATION

APIDRAIN comes with an installation program to assist a user in transferring the model to the user's computer hard drive. **Users must employ the SETUP.EXE program to install APIDRAIN.** To begin the installation program from MS-Windows™ '95, the user first clicks with the mouse pointer on the Windows™ Explorer icon, and then on the floppy disk drive (usually A:). From Windows™ 3.1, use the file manager to access the floppy drive (usually A:). The floppy disk contains four files:

- apid.001
- apidc.inf
- disk.id
- setup.exe

Double-click on the setup.exe file to activate the installation program. A dialog box appears with development information, with a prompt to continue; click OK to proceed. A second dialog box next appears offering the user two choices, either to proceed with the installation or to exit the installation. The user should click on the install option and OK to proceed. The installation next prompts the user to declare the drive on which to install the model; this will usually be the local hard drive root directory (C:). Click on OK to accept the selected drive. The installation program then prompts the user to define the directory name for the APIDRAIN files. By default, the installation will create a directory called "APIDRAIN" at the root directory. The user may accept this by clicking on the OK box, or if desired, modify the name of the directory, using up to eight characters, prior to accepting. At the completion of the installation, a dialog box appears with address and contact information about the developer (Enviromega Inc.) regarding technical assistance or bug reporting.

The user will now have a program group box with an icon on the computer screen. The icon is:

- APIDrain 1.0

1.4 SAVING APIDRAIN FILES

To ensure the model runs properly, it is recommended that users retain the original master Excel™ file without any modifications, and that all configured facilities be renamed as separate files. Any saved, renamed files should be kept in the same directory as the master Excel™ file so that links in the macros may be maintained.

1.5 EXITING FROM APIDRAIN

To exit from the APIDRAIN model, users should use the menu item *File/Exit Drain Model*. This will leave the program in Excel™, but will remove the APIDRAIN model toolbar from the worksheet. The user may then exit from Excel™ if so desired. If a user closes the model using the MS- Windows™ close icon (box with X in the upper right corner of Windows™ programs), the model and Excel™ will close, but the model toolbar will be left active in Excel™ the next time it is opened. To remove the drain model toolbar from Excel™ in this case, use the menu item *View/Toolbars*, and click off the Drain toolbar.

1.6 TECHNICAL SUPPORT

API has retained Enviromega Inc., the contractors who developed the APIDRAIN model, to provide technical support for registered users of the modeling software. Technical questions arising from use of the model may be addressed to

Enviromega Inc.
7 Innovation Drive, Ste 245
Flamborough, ON, Canada
L9H 7H9

Tel: (905) 689-4410
FAX: (905) 689-7040
Email: eng@enviromega.com

Please have your registration number available when requesting technical support, as only registered users will be eligible for this service.

Section 2

USING APIDRAIN

2.1 START-UP

Reminder: Excel™ does not have an automatic back-up feature. Periodic saving of the spreadsheet is recommended after data entry, either by clicking the save icon on the tool bar, or clicking on the *File/Save* menu items.

To initiate the APIDRAIN model, the user double-clicks on the APIDRAIN 1.0 icon. If operating in MS Office 97, a dialog box will appear with a button that shows "Enable Macros" (Figure 2.1). Click on this button to generate the macros used in the APIDRAIN model. If operating in Excel™ Version 5, this dialog box will not appear.

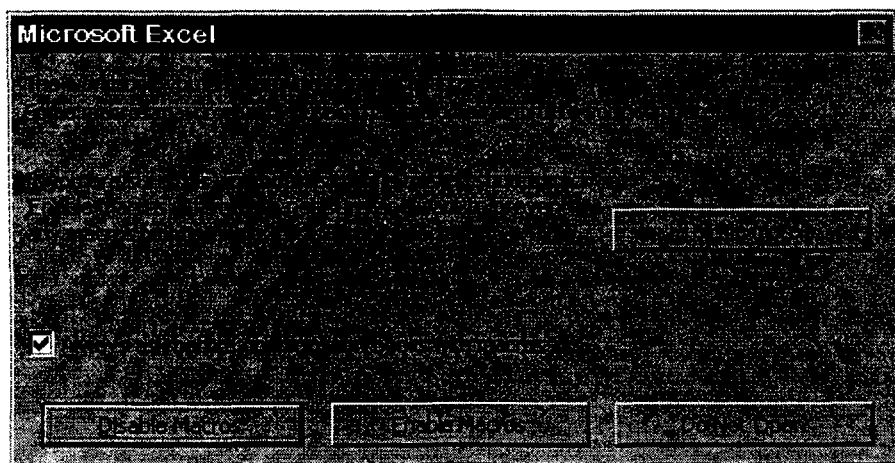


Figure 2.1 Enable Macro Dialog Box

Three initial start-up screens will appear sequentially. These describe the model ownership, copyright and development.

Following the last start-up screen, the user is presented with three options (Figure 2.2):

- create a new facility workbook;
- open an existing facility workbook;
- exit the APIDRAIN program.

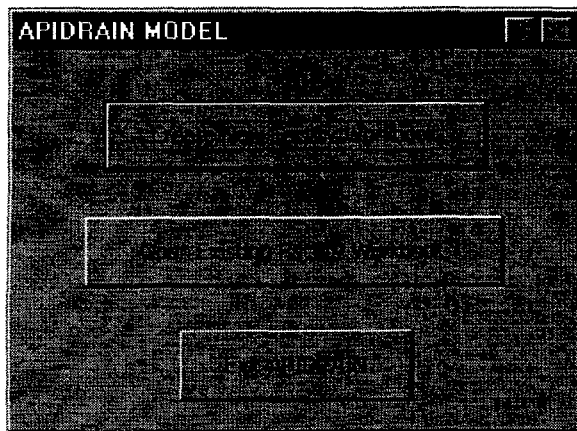


Figure 2.2 APIDRAIN Start-Up Dialog

When the user clicks on the *Create New Facility Workbook* button, the summary facility page will appear (Figure 2.3). At this point in the program, the facility summary is empty, showing no process units or facility total emissions. All estimation methods are shown on this summary, so that emissions from different units may be characterized by different estimation methods (AP-42 factors, OVA screening correlations, stripping efficiency factors or the UT drain model).

Drain Emission Calculator - Book3												
Process Unit Drain												
Total Emissions per Process Unit (Pounds per Year)												
Total # Process Units		AP-42 Emission Factor		OVA Correlation EPA		OVA Correlation SCAQMD		Stripping Factor		UT Drain Model		
Estimation	# of	Actual	Potential	Actual	Potential	Actual	Potential	Actual	Potential	Actual	Potential	
Process Unit ID	Method	Drains										
Facility Totals												

Figure 2.3 New Facility Worksheet

If the user has previously created a facility workbook, by clicking on the *Open Existing Facility Workbook* button, a dialog box appears that allows the user to select the directory and file name of the previously created facility.

2.2 FACILITY DESCRIPTION

The next step for a user starting to work with the spreadsheet will be to characterize the facility (refinery, distribution terminal, other). Point the mouse to the menu at the top of the screen to the item **Facility** and click. A drop-down box will appear with the following items:

- **Add New Process Unit**
- **Edit Selected Process Unit**
- **Delete Selected Process Unit**
- **Author Info**
- **General Info**
- **Operating Info**
- **Contact Info**

Click on the *Author Info* item to enter information regarding the facility and corporate name, and the person preparing the model (Figure 2.4).

Refinery Drain Emission Calculator	
This Workbook Has Been Prepared for:	
Field Name:	
Facility Name:	
Company:	
This Workbook Has Been Prepared By:	
Name:	
Company:	
Street Address:	
City, State, Zip	
This Workbook Was Last Modified On:	

Figure 2.4 Author Information

When entry is finished, click on the *Facility/General Info* menu item to characterize the facility site information, permit and regulatory data (Figure 2.5).

Field Name:		Facility Permit #:	
Facility Name:	Test Facility	Nearest Town:	
Facility ID:		Dist. To Nrst. Receptor (mi.):	
Company:		County/Parish:	
Street Address:		EPA Region:	EPA Region I
Mailing Address:		Facility Type:	
City:		SIC Code Description:	
State:		SIC Code:	
Street Zip:		Dun & Bradstreet No:	
Mailing Zip:		Principal Business:	
Telephone:		Latitude:	
Fax:		Longitude:	
E-mail Address:		UTM Northing:	
Other (2):		UTM Easting:	
Other (3):		UTM Zone:	

Figure 2.5 General Facility Information Sheet

When entry is finished, click on the *Facility/Operating Info* menu item (Figure 2.6). This describes the schedule of the facility that is used in estimating the monthly, quarterly and annual emission rates. Note the number of hours per year is a calculated value based on the hours/day, days/week and weeks/year. As a calculated number (protected cell), the value appears in red. Atmospheric pressure at the specified elevation is calculated according to the formula (ASCE, 1992):

$$P_{el} = 14.7 * (1 - 3.5 * 10^{-5} * h)$$

where: P_{el} = atmospheric pressure in psia at elevation h (feet) above mean sea level.

When entry is finished, click on the *Facility/Contact Info* menu item to enter the information (Figure 2.7). At the completion of this entry, all the preliminary facility site information has been entered. It is recommended that the user save the information to a working file if not already done.

Facility Operating Information	
Year:	
Site Operating Status:	Active
Hours/Day:	24
Day/Week:	7
Week/Year:	52
Hours/Year:	8760
Summer %:	
Fall %:	
Winter %:	
Spring %:	
Elevation (ft above Sea Level):	300
Atmospheric Pressure (psia):	14.54565

Figure 2.6 Facility Operation Sheet

Regulatory Contact Person		Facility Contact Person	
Name:		Name:	
Title:		Title:	
Company:		Company:	
Mailing Address:		Mailing Address:	
City:		City:	
State:		State:	
Zip:		Zip:	
Phone:		Phone:	
Fax:		Fax:	
E-mail Address:		Email Address:	

Figure 2.7 Contact Information Sheet

2.3 APIDRAIN TOOLBAR ICONS

At the top of the APIDRAIN model is a toolbar with a series of icons that can be used to speed the characterization of the process units and drains. A brief identification of the toolbar icons follows.



Open Facility. This icon is used to retrieve an existing facility file, and is equivalent to the menu selection *File/Open Facility*.



Save Facility. This icon is equivalent to the menu selection *File/Save Facility*.



Print Facility. This icon is equivalent to the menu selection *File/Print*.



Go to Facility View. This icon duplicates the menu selection items *Process Unit/Return to Facility Emissions* and *Drain /Return to Facility Emissions*.



Edit Process Unit. Either of these icons is equivalent to the menu selection *Facility/Edit Selected Process Unit*.



Edit Drain. This icon is equivalent to the menu selection *Process Unit/Edit Selected Drain*.



Insert New Unit/Drain. In the Facility Summary worksheet, this icon is equivalent to the menu selection *Facility/Add New Process Unit*, or, in the Process Unit worksheet, it is equivalent to the menu selection *Process Unit/Add New Drain*.



Delete Selected Unit/Drain. In the Facility Summary worksheet, this icon is equivalent to the menu selection *Facility/Delete Selected Process Unit*, or, in the Process Unit worksheet, it is equivalent to the menu selection *Process Unit/Delete Selected Drain*.

2.4 PROCESS DATA ENTRY

2.4.1 Creating Process Units and Drains

Once the facility information has been entered, characterization of the process units and the drains within those units may proceed. Click on the *Facility/Add Process Unit* menu item to reveal a dialog box that enables the user to label a new unit (crude, catalytic reforming, etc.) (Figure 2.8). The dialog box will show the number of the next unit to be added. This may either be overwritten or extended by users according to their preference. Beneath the unit I.D. box is the list of available estimation procedures. For the current unit to be modeled, click on the estimation procedure to be used for estimating emissions from drains in the current process unit. For this illustrative discussion, select the *AP-42 emission factors*. Following this selection, click on the *Add* button of the dialog box.

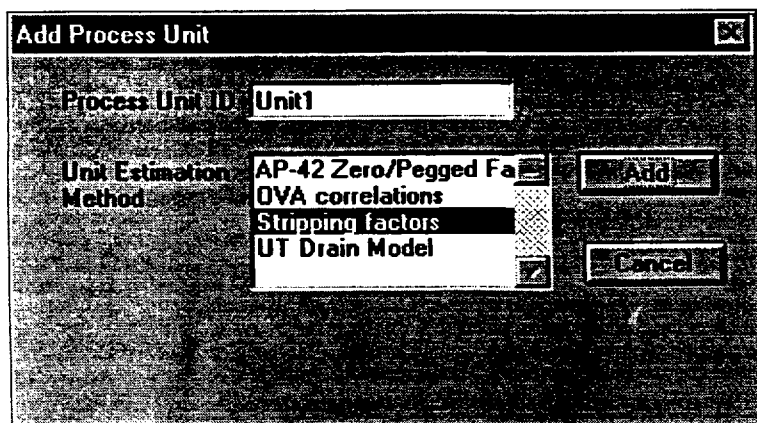


Figure 2.8 Add Process Unit Dialog

At this time, the process unit emission worksheet will appear (Figure 2.9). This sheet identifies the process unit in the upper left hand corner. Then moving to the right, along the worksheet is the unit estimation method, and finally the total emission rate summary for the different estimation procedures selected. Note that the emission rate is provided in units of pounds/year **per drain** in this summary sheet.

Status		Drain Info	Operating Time		OVA Model	AP-42 Estimated	AP-42 Zero and Pegged Factors		EPA OVA Correlation		OVA Correlation SCAQMD inactive drains only		Stripping Factor sealed drains only		Total
In	Service	Drain ID	Identical Hours	Days/Week	Screen Value (ppm)	Screen Value (ppm)	Actual	Potential	Actual	Potential	Actual	Potential	Actual	Potential	
			Day	Week											
		Total Drains in Unit					Total Emissions from Unit								

Figure 2.9 Process Unit Worksheet Prior to Drain Entry

Below the unit estimation method, running in the background are the hours, days and weeks of operation. These values are not linked to the hours, days and weeks entered in the Facility Operation dialog box to provide greater modeling flexibility. While the whole facility may operate continuously on a year-round basis, certain process units may only be operated for part of the year. Separate identification of the time of operation of each process unit provides a more realistic estimation of chemical emissions.

To begin entry to the Process Unit sheet, click on the *Process Unit* menu item to see the available options. These include:

- *Change the unit name;*
- *Add a new drain;*
- *Edit a selected drain;*
- *Delete a selected drain;*
- *Rename a selected drain;*
- *Return to Facility Emissions summary.*

If this is the initial characterization of the process units, click on the *Add a new drain* item for designation of the drain (Figure 2.10). At the bottom of the dialog box, the unit name previously specified and the sequential drain number appears. This name can be accepted as is, or a user designation (1a, crude-1a, 01-1-1-1, etc.) can be entered.

If a user edits the drain name using the keyboard arrow keys, a cell reference may show in the entry box as indicated in Figure 2.11. This is a function of the programming code and may be overcome by highlighting the characters to be deleted with the left mouse button, then pressing the delete key. The drain name may then be correctly entered.

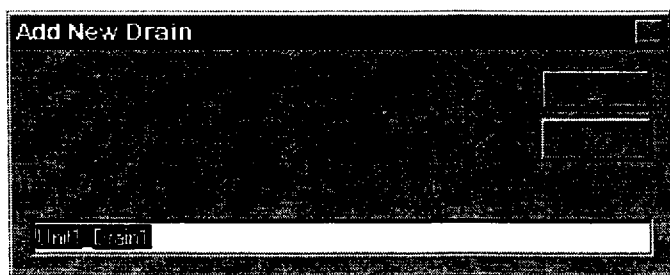


Figure 2.10 Add New Drain Dialog Box

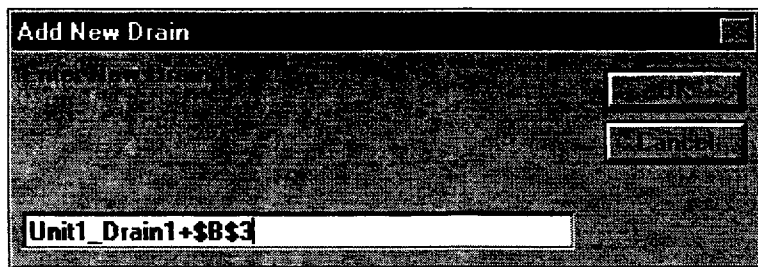


Figure 2.11 Example of Drain I.D. After Use of Arrow Key to Edit Name

Click on OK to accept the drain name. The screen returns to the process unit summary, showing that the first drain has been entered (Figure 2.12). The current emission estimation procedure is displayed to the right of the process unit description. If the estimation method procedure has been entered incorrectly, or needs to be changed, click on the estimation procedure showing, and a drop-down box appears showing the available estimation procedures. Click on the desired procedure, and the spreadsheet will update the estimation procedure for the drains in that process unit. Save the file again if necessary.