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Development Document for Final Effluent Limitations Guidelines and Standards for the Landfills Point Source Category

DEVELOPMENT DOCUMENT
FOR
FINAL EFFLUENT LIMITATIONS
GUIDELINES AND STANDARDS
FOR THE
LANDFILLS
POINT SOURCE CATEGORY

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LANDFILLS DEVELOPMENT DOCUMENT
TABLE OF CONTENTS

1.0 LEGAL AUTHORITY 1-1
1.1 Legal Authority 1-1
1.2 Background 1-1
1.2.1 Clean Water Act (CWA) 1-1
1.2.1.1 Best Practicable Control Technology Currently Available (BPT) 1-1
1.2.1.2 Best Conventional Pollutant Control Technology (BCT) 1-2
1.2.1.3 Best Available Technology Economically Achievable (BAT) . 1-2
1.2.1.4 New Source Performance Standards (NSPS) 1-3
1.2.1.5 Pretreatment Standards for Existing Sources (PSES) 1-3
1.2.1.6 Pretreatment Standards for New Sources (PSNS) 1-4
1.2.2 Section 304(m) Requirements 1-4

2.0 SUMMARY AND SCOPE 2-1
2.1 Introduction 2-1
2.2 Subcategorization 2-1
2.3 Scope of Final Regulation 2-2
2.4 Best Practicable Control Technology Currently Available (BPT) 2-4
2.5 Best Conventional Pollutant Control Technology (BCT) 2-4
2.6 Best Available Technology Economically Achievable (BAT) 2-4
2.7 New Source Performance Standards (NSPS) 2-5
2.8 Pretreatment Standards for Existing Sources (PSES) 2-5
2.9 Pretreatment Standards for New Sources (PSNS) 2-5
2.10 Implementation of the Rule for Contaminated Ground Water Flows and Wastewater from Recovering Pumping Wells 2-5
2.11 Implementation of the Rule for Storm Water Discharges 2-7
2.12 Exclusion for Captive Landfill Facilities 2-10
2.13 Determination of Similar Wastes for Captive Landfill Facilities 2-16

3.0 INDUSTRY DESCRIPTION 3-1
3.1 Regulatory History of the Landfills Industry 3-3
3.1.1 RCRA Subtitle C 3-3
3.1.1.1 Land Disposal Restrictions 3-4
3.1.1.2 Minimum Technology Requirements 3-6
3.1.2 RCRA Subtitle D 3-6
3.1.2.1 40 CFR Part 257, Subpart A - Criteria for Classification of Solid Waste Disposal Facilities and Practices 3-7

TABLE OF CONTENTS

3.1.2.2 40 CFR Part 257, Subpart B - Conditionally Exempt Small Quantity Generator Revised Criteria 3-8
3.1.2.3 40 CFR Part 258 Revised Criteria for Municipal Solid Waste Landfills 3-8
3.1.3 Current Wastewater Regulations 3-9
3.2 Industry Profile 3-10
3.2.1 Industry Population 3-11
3.2.2 Number and Location of Facilities 3-12
3.2.2.1 Captive Landfill Facilities 3-13
3.2.3 General Information on Landfill Facilities 3-14
3.2.4 Waste Receipts and Types 3-15
3.2.5 Sources of Wastewater 3-16
3.2.5.1 Landfill Leachate 3-16
3.2.5.2 Landfill Gas Condensate 3-17
3.2.5.3 Drained Free Liquids 3-17
3.2.5.4 Truck/Equipment Washwater 3-18
3.2.5.5 Laboratory-Derived Wastewater 3-18
3.2.5.6 Storm Water 3-19
3.2.5.7 Contaminated Ground Water 3-19
3.2.5.8 Recovering Pumping Wells 3-20
3.2.6 Leachate Collection Systems 3-20
3.2.7 Pretreatment Methods 3-21
3.2.8 Baseline Treatment 3-22
3.2.9 Discharge Types 3-22

4.0 DATA COLLECTION ACTIVITIES 4-1
4.1 Introduction 4-1
4.2 Preliminary Data Summary 4-1
4.3 Clean Water Act (CWA) Section 308 Questionnaires 4-3
4.3.1 Screener Surveys 4-4
4.3.1.1 Recipient Selection and Mailing 4-4
4.3.1.2 Information Collected 4-5
4.3.1.3 Data Entry, Coding, and Analysis 4-6
4.3.1.4 Mailout Results 4-6
4.3.2 Detailed Technical Questionnaires 4-6
4.3.2.1 Recipient Selection and Mailing 4-7
4.3.2.2 Information Collected 4-7
4.3.2.3 Data Entry, Coding, and Analysis 4-8

TABLE OF CONTENTS

4.3.2.4 Mailout Results 4-9
4.4 Detailed Monitoring Questionnaire 4-9
4.4.1 Recipient Selection and Mailing 4-9
4.4.2 Information Collected 4-10
4.4.3 Data Entry, Coding, and Analysis 4-10
4.5 Engineering Site Visits 4-10
4.6 Wastewater Characterization Site Visits 4-11
4.7 EPA Week-Long Sampling Program 4-12
4.8 Other Data Sources 4-13
4.8.1 Industry Supplied Data 4-13
4.8.2 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA) Ground Water Data 4-13
4.8.3 POTW Study 4-14
4.8.4 National Risk Management Research Laboratory Data 4-15
4.9 QA/QC and Other Data Editing Procedures 4-15
4.9.1 QA/QC Procedures 4-16
4.9.2 Analytical Database Review 4-16
4.9.2.1 Data Review Narratives 4-16
4.9.2.2 Completeness Checks 4-16
4.9.2.3 Trip Blanks and Equipment Blanks 4-17
4.9.2.4 Field Duplicates 4-18
4.9.2.5 Grab Samples 4-19
4.9.2.6 Non-Detect Data 4-19
4.9.2.7 Bi-Phasic Samples 4-20
4.9.2.8 Conversion of Weight/Weight Data 4-20
4.9.2.9 Average Concentration Data 4-21
4.9.3 Detailed Questionnaire Database Review 4-21
4.9.4 Detailed Monitoring Questionnaire Review 4-22

5.0 INDUSTRY SUBCATEGORIZATION 5-1
5.1 Subcategorization Approach 5-1
5.2 Landfills Subcategories 5-2
5.3 Other Factors Considered for Basis of Subcategorization 5-3
5.3.1 Types of Wastes Received 5-3
5.3.2 Wastewater Characteristics 5-7
5.3.3 Facility Size 5-8
5.3.4 Ownership 5-9

TABLE OF CONTENTS

5.3.5 Geographic Location 5-9
5.3.6 Facility Age 5-11
5.3.7 Economic Characteristics 5-14
5.3.8 Treatment Technologies and Costs 5-14
5.3.9 Energy Requirements 5-15
5.3.10 Non-Water Quality Impacts 5-15

6.0 WASTEWATER GENERATION AND CHARACTERIZATION 6-1
6.1 Wastewater Generation and Sources of Wastewater 6-1
6.2 Wastewater Flow and Discharge 6-4
6.2.1 Wastewater Flow and Discharge at Subtitle D Non-Hazardous Landfills 6-5
6.2.2 Wastewater Flow and Discharge at Subtitle C Hazardous Landfills . . . 6-6
6.3 Wastewater Characterization 6-7
6.3.1 Background Information 6-8
6.3.1.1 Landfill Leachate 6-8
6.3.1.1.1 Additional Sources of Non-Hazardous Leachate Characterization Data 6-12
6.3.1.2 Landfill Gas Condensate 6-13
6.3.1.3 Drained Free Liquids 6-14
6.3.1.4 Truck and Equipment Washwater 6-14
6.3.2 Pollutant Parameters Analyzed at EPA Sampling Episodes 6-15
6.3.3 Raw Wastewater Characterization Data 6-17
6.3.4 Conventional, Toxic, and Selected Nonconventional Pollutant Parameters 6-18
6.3.5 Toxic Pollutants and Remaining Nonconventional Pollutants 6-20
6.3.6 Raw Wastewater at Subtitle D Non-Hazardous Landfills 6-21
6.3.6.1 Raw Wastewater at Subtitle D Municipal Landfills 6-21
6.3.6.2 Raw Wastewater at Subtitle D Non-Municipal Landfills 6-21
6.3.6.3 Dioxins and Furans in Raw Wastewater at Subtitle D Non-Hazardous Landfills 6-23
6.3.7 Raw Wastewater at Subtitle C Hazardous Landfills 6-24
6.3.7.1 Dioxins and Furans in Raw Wastewater at Subtitle C Hazardous Landfills 6-25

7.0 POLLUTANT PARAMETER SELECTION 7-1
7.1 Introduction 7-1
7.2 Pollutants Considered for Regulation 7-1

TABLE OF CONTENTS

7.3 Selection of Pollutants of Interest 7-2
7.4 Development of Pollutant Discharge Loadings 7-3
7.4.1 Development of Current Discharge Concentrations 7-3
7.4.1.1 Alternate Methodology for Non-Hazardous Subcategory: Subtitle D Non-Municipal 7-5
7.4.1.2 Alternate Methodology for the Hazardous Subcategory 7-5
7.4.2 Development of Pollutant Mass Loadings 7-6
7.5 Assessment of Pollutants of Interest 7-7
7.6 Selection of Pollutants to be Regulated for Direct Dischargers 7-7
7.6.1 Non-Hazardous Subcategory Pollutants to be Regulated for Direct Dischargers 7-8
7.6.2 Hazardous Subcategory Pollutants to be Regulated for Direct Dischargers 7-14
7.7 Selection of Pollutants to be Regulated for Indirect Dischargers 7-22
7.7.1 Pass-Through Analysis for Indirect Dischargers 7-22
7.7.2 Non-Hazardous Subcategory Pollutants to be Regulated for Indirect Dischargers 7-25
7.7.3 Hazardous Subcategory Pollutants to be Regulated for Indirect Dischargers 7-27

8.0 WASTEWATER TREATMENT TECHNOLOGY DESCRIPTION 8-1
8.1 Available BAT and PSES Technologies 8-1
8.1.1 Best Management Practices 8-1
8.1.2 Physical/Chemical Treatment 8-3
8.1.2.1 Equalization 8-3
8.1.2.2 Neutralization 8-4
8.1.2.3 Flocculation 8-5
8.1.2.4 Gravity Assisted Separation 8-6
8.1.2.5 Chemical Precipitation 8-8
8.1.2.5.1 Iron (Fe) Coprecipitation 8-11
8.1.2.6 Chemical Oxidation/Reduction 8-11
8.1.2.6.1 Breakpoint Chlorination 8-12
8.1.2.7 Air Stripping 8-14
8.1.2.8 Filtration 8-14
8.1.2.8.1 Sand Filtration 8-15
8.1.2.8.2 Diatomaceous Earth 8-17
8.1.2.8.3 Multimedia Filtration 8-17
8.1.2.8.4 Membrane Filtration 8-18

TABLE OF CONTENTS

8.1.2.8.4.1 Ultrafiltration 8-18
8.1.2.8.4.2 Reverse Osmosis 8-19
8.1.2.8.5 Fabric Filters 8-21
8.1.2.9 Carbon Adsorption 8-21
8.1.2.10 Ion Exchange 8-23
8.1.3 Biological Treatment 8-24
8.1.3.1 Lagoon Systems 8-26
8.1.3.2 Anaerobic Systems 8-30
8.1.3.3 Attached-Growth Biological Treatment Systems 8-31
8.1.3.4 Activated Sludge 8-34
8.1.3.5 Powder Activated Carbon Biological Treatment 8-38
8.1.3.6 Sequencing Batch Reactors (SBRs) 8-39
8.1.3.7 Nitrification Systems 8-40
8.1.3.8 Denitrification Systems 8-41
8.1.3.9 Wetlands Treatment 8-41
8.1.4 Sludge Handling 8-41
8.1.4.1 Sludge Slurrying 8-42
8.1.4.2 Gravity Thickening 8-42
8.1.4.3 Pressure Filtration 8-42
8.1.4.4 Sludge Drying Beds 8-43
8.1.5 Zero Discharge Treatment Options 8-44
8.2 Treatment Performance and Development of Regulatory Options 8-45
8.2.1 Performance of EPA Sampled Treatment Processes 8-46
8.2.1.1 Treatment Performance for Episode 4626 8-46
8.2.1.2 Treatment Performance for Episode 4667 8-48
8.2.1.3 Treatment Performance for Episode 4721 8-49
8.2.1.4 Treatment Performance for Episode 4759 8-50
8.2.1.5 Treatment Performance for Episode 4687 8-51

9.0 ENGINEERING COSTS 9-1
9.1 Evaluation of Cost-Estimation Techniques 9-1
9.1.1 Cost Models 9-1
9.1.2 Vendor Data 9-2
9.1.3 Other EPA Effluent Guideline Studies 9-3
9.1.4 Benchmark Analysis and Evaluation Criteria 9-3
9.1.5 Selection of Final Cost-Estimation Techniques 9-5
9.2 Engineering Costing Methodology 9-6
9.2.1 Treatment Costing Methodology 9-7

TABLE OF CONTENTS

9.2.1.1 Retrofit Costs 9-9
9.2.2 Land Costs 9-9
9.2.3 Residual Disposal Costs 9-9
9.2.4 Monitoring Costs 9-10
9.2.5 Off-Site Disposal Costs 9-11
9.3 Development of Cost Estimates for Individual Treatment Technologies 9-11
9.3.1 Equalization 9-12
9.3.2 Flocculation 9-13
9.3.3 Chemical Feed Systems 9-14
Sodium Hydroxide Feed Systems 9-15
Phosphoric Acid Feed Systems 9-17
Polymer Feed Systems 9-18
9.3.4 Primary Clarification 9-19
9.3.5 Activated Sludge Biological Treatment 9-20
9.3.6 Secondary Clarification 9-22
9.3.7 Multimedia Filtration 9-23
9.3.8 Reverse Osmosis 9-24
9.3.9 Sludge Dewatering 9-25
9.3.10 Granular Activated Carbon 9-26
9.3.11 Breakpoint Chlorination 9-27
9.4 Costs for Regulatory Options 9-28
9.4.1 Facility Selection 9-28
9.4.2 BPT Regulatory Costs 9-29
9.4.2.1 Subtitle D Non-Hazardous Subcategory BPT Costs 9-29
9.4.2.2 Subtitle C Hazardous Subcategory BPT Costs 9-30
9.4.3 BCT Regulatory Costs 9-30
9.4.3.1 Subtitle D Non-Hazardous Subcategory BCT Costs 9-30
9.4.3.2 Subtitle C Hazardous Subcategory BCT Costs 9-31
9.4.4 BAT Regulatory Costs 9-31
9.4.4.1 Subtitle D Non-Hazardous Subcategory BAT Costs 9-31
9.4.4.2 Subtitle C Hazardous Subcategory BAT Costs 9-32
9.4.5 NSPS Regulatory Costs 9-32
9.4.5.1 Subtitle D Non-Hazardous Subcategory NSPS Costs 9-32
9.4.5.2 Subtitle C Hazardous Subcategory NSPS Costs 9-33

10.0 NON-WATER QUALITY IMPACTS 10-1
10.1 Air Pollution 10-1
10.2 Solid and Other Aqueous Wastes 10-3

TABLE OF CONTENTS

10.3 Energy Requirements 10-5

11.0 DEVELOPMENT OF EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS 11-1
11.1 Development of Long-Term Averages, Variability Factors, and Effluent Limitations 11-1
11.1.1 Calculation of Long-Term Averages 11-2
11.1.2 Calculation of Variability Factors 11-5
11.1.3 Calculation of Effluent Limitations 11-6
11.2 Best Practicable Control Technology Currently Available (BPT) 11-6
11.2.1 BPT Technology Options for the Subtitle D Non-Hazardous Subcategory 11-8
11.2.2 BPT Limits for the Subtitle D Non-Hazardous Subcategory 11-11
11.2.3 BPT Technology Options for the Subtitle C Hazardous Subcategory 11-20
11.2.4 BPT Limits for the Subtitle C Hazardous Subcategory 11-23
11.3 Best Conventional Pollutant Control Technology (BCT) 11-27
11.4 Best Available Technology Economically Achievable (BAT) 11-28
11.4.1 BAT Limits for the Subtitle D Non-Hazardous Subcategory 11-29
11.4.2 BAT Limits for the Subtitle C Hazardous Subcategory 11-31
11.5 New Source Performance Standards (NSPS) 11-31
11.6 Pretreatment Standards for Existing Sources (PSES) 11-32
11.6.1 EPA's Decision Not to Establish PSES for the Subtitle D Non-Hazardous Subcategory 11-34
11.6.1.1 EPA's Rationale for Not Establishing PSES for Ammonia 11-35
11.6.1.2 EPA's Rationale for Not Establishing PSES for Benzoic Acid 11-41
11.6.1.3 EPA's Rationale for Not Establishing PSES for P-Cresol 11-43
11.6.1.4 EPA's Rationale for Not Establishing PSES for Phenol 11-44
11.6.1.5 Public Comments to the Proposed Rule Regarding Non-Hazardous PSES 11-45
11.6.2 EPA's Decision Not to Establish PSES for the Subtitle C Hazardous Subcategory 11-48
11.7 Pretreatment Standards for New Sources (PSNS) 11-53

12.0 REFERENCES 12-1

TABLE OF CONTENTS

APPENDIX A Section 308 Survey for Landfills - Industry Population Analysis

APPENDIX B Definitions, Acronyms, and Abbreviations

LIST OF TABLES

2-1 Final Concentration Limitations for Hazardous Landfill Subcategory, Direct Discharges 2-20
2-2 Final Concentration Limitations for Hazardous Landfill Subcategory, Direct Discharges 2-21
2-3 Grouping of Subchapter N Effluent Guidelines and Standards 2-22
3-1 Number of Landfills per U.S. State 3-24
3-2 Ownership Status of Landfill Facilities 3-25
3-3 Total Landfill Facility Area 3-26
3-4 Landfill Facility Land Area Ranges 3-27
3-5 Number of Landfill Cells 3-28
3-6 Household and Non-Household Population Served 3-29
3-7 Household vs. Non-Household Customers 3-30
3-8 Wastes Received by Landfills in the United States 3-31
3-9 Total Volume of Waste Received by Landfills in 1992 by Regulatory Classification 3-32
3-10 Annual Tonnage of Waste Accepted by Landfills 3-33
3-11 Wastewater Flows Generated by Individual Landfills 3-34
3-12 Type of Leachate Collection Systems Used at Individual Landfills 3-35
3-13 Pretreatment Methods in Use at Individual Landfills 3-36
3-14 Types of Wastewater Treatment Employed by the Landfills Industry 3-37
3-15 Wastewater Treatment Facility Hours of Operation per Day 3-38
3-16 Wastewater Treatment Facility Average Hours of Operation per Day 3-39
3-17 Wastewater Treatment Facility Days of Operation per Week 3-40
3-18 Wastewater Treatment Facility Average Days of Operation per Week 3-41
3-19 Total Number of Facilities by Discharge Type 3-42
4-1 Screener Questionnaire Strata 4-5
4-2 Types of Facilities Included in EPA's Characterization and Engineering Site Visits . 4-23
4-3 Types of Facilities Included in EPA's Field Sampling Program 4-24
4-4 Episode Numbers for the Engineering Site Visits and Field Sampling Efforts 4-25
5-1 Subcategorization of the EPA Landfills Database 5-16
5-2 Raw Wastewater Median Concentrations of Pollutants of Interest Common to Both the Hazardous and Non-Hazardous Landfill Subcategories 5-20
5-3 Comparison of Subtitle D Non-Municipal and Municipal Raw Wastewater Pollutant Concentrations 5-22
5-4 Summary of EPA Sampling Data for Subtitle D Monofills, Average Raw Leachate Data for Selected Pollutants 5-24
5-5 Average Contaminated Ground Water Pollutant Concentrations at Hazardous Landfills in the EPA Database 5-25

LIST OF TABLES

5-6 Average Contaminated Ground Water Pollutant Concentrations at Non-Hazardous Landfills in the EPA Database 5-27
5-7 Age of Landfills in EPA Sampling Database 5-28
5-8 Median Raw Wastewater Characteristics at Non-Hazardous Landfills of Varying Age 5-30
6-1 Wastewater Generated in 1992: Hazardous Subcategory 6-26
6-2 Wastewater Generated in 1992: Non-Hazardous Subcategory Municipal Facilities . . 6-27
6-3 Wastewater Generated in 1992: Non-Hazardous Subcategory Non-Municipal Facilities 6-29
6-4 Quantity of In-Scope Wastewater Generated in 1992 6-30
6-5 Contaminant Concentration Ranges in Municipal Leachate as Reported in Literature Sources 6-31
6-6 Landfill Gas Condensate (from Detailed Questionnaire) 6-32
6-7 EPA Sampling Episode Pollutants Analyzed 6-33
6-8 EPA Sampling Episode List of Analytes Never Detected 6-37
6-9 Subtitle D Non-Hazardous Subcategory Median Raw Wastewater Concentration File 6-49
6-10 Subtitle C Hazardous Subcategory Median Raw Wastewater Concentration File . . . 6-50
6-11 Range of Conventional and Selected Nonconventional Pollutants Raw Wastewater Average Concentrations 6-51
6-12 Range of Metals and Toxic Pollutants Raw Wastewater Average Concentrations . . . 6-52
6-13 Range of Organic Pollutants Raw Wastewater Average Concentrations 6-53
6-14 Dioxins and Furans at Non-Hazardous EPA Sampling Episodes by Episode and Sample Point 6-54
6-15 Dioxins and Furans at Hazardous EPA Sampling Episodes by Episode and Sample Point 6-55
7-1 Non-Hazardous Subcategory Pollutants of Interest 7-29
7-2 Hazardous Subcategory Pollutants of Interest 7-30
7-3 Non-Hazardous Subcategory - POTW Percent Removals 7-31
7-4 Hazardous Subcategory - POTW Percent Removals 7-31
7-5 Non-Hazardous Subcategory - BAT Performance Data 7-32
7-6 Pass-Through Analysis for the Non-Hazardous Subcategory 7-33
7-7 Hazardous Subcategory - BAT Performance Data 7-34
7-8 Pass-Through Analysis for the Hazardous Subcategory 7-35
8-1 Wastewater Treatment Technologies Employed at In-Scope Landfill Facilities 8-53
8-2 Treatment Technology Performance for Facility 4626 - Subtitle D Municipal 8-54
8-3 Treatment Technology Performance for Facility 4667 - Subtitle D Municipal 8-55
8-4 Treatment Technology Performance for Facility 4721 - Subtitle C Hazardous 8-56
8-5 Treatment Technology Performance for Facility 4759 - Subtitle C Hazardous 8-58
8-6 Treatment Technology Performance for Facility 4687 - Subtitle D Municipal 8-60

LIST OF TABLES

9-1 Cost Comparison 9-34
9-2 Costing Source Comparison 9-35
9-3 Breakdown of Costing Method by Treatment Technology 9-36
9-4 Additional Cost Factors 9-37
9-5 Analytical Monitoring Costs 9-38
9-6 Subtitle D Non-Hazardous Facilities Costed for Off-Site Disposal 9-39
9-7 Unit Process Breakdown by Regulatory Option 9-40
9-8 Chemical Addition Design Method 9-41
9-9 Treatment Chemical Costs 9-42
9-10 Sodium Hydroxide Requirements for Chemical Precipitation 9-43
9-11 BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory 9-44
9-12 BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory 9-49
9-13 BAT Option III Subtitle D Non-Hazardous Subcategory 9-54
11-1 Removal of Pollutant of Interest Metals in the Non-Hazardous Subcategory 11-54
11-2 List of Subtitle D Municipal Solid Waste Facilities Employing Biological Treatment Considered for BPT in the Non-Hazardous Subcategory 11-55
11-3 Comparison of Raw Wastewater Mean Concentrations of Non-Hazardous Pollutants of Interest for Municipal Solid Waste Landfills and Hazardous Facility 16041 11-56
11-4 Candidate BPT Facilities for the Non-Hazardous Subcategory Eliminated from BPT Consideration Because No BOD_5 Effluent Data Was Available 11-57
11-5 Treatment Systems In Place at Landfill Facilities Considered for BPT in the Non-Hazardous Subcategory which Supplied BOD_5 Effluent Data 11-58
11-6 Landfill Facilities Considered for BPT in the Non-Hazardous Subcategory which Supplied BOD_5 Effluent Data: Flows, Concentration Data, and Reason for Elimination 11-59
11-7 Selected BPT Facilities for the Non-Hazardous Subcategory 11-60
11-8 TSS Data from Landfill Facilities Selected for BPT in the Non-Hazardous Subcategory 11-61
11-9 Facilities and Sample Points Used for the Development of BPT/BAT Effluent Limitations for the Non-Hazardous Subcategory 11-62
11-10 BPT Facility Data Excluded from the Calculation of Non-Hazardous BPT/BAT Limitations 11-64
11-11 BPT/BAT Limitations for the Non-Hazardous Subcategory 11-68
11-12 National Estimates of Pollutant of Interest Reductions for BPT/BAT Options for Municipal Solid Waste Landfills - Direct Dischargers 11-69
11-13 National Estimates of Pollutant of Interest Reductions for BPT/BAT Options for Non-Municipal Solid Waste Landfills - Direct Dischargers 11-70
11-14 Annual Pollutant Discharge Before and After the Implementation of BPT for Subtitle D Municipal Solid Waste Landfill Facilities in the Non-Hazardous Subcategory 11-71

LIST OF TABLES

11-15 Annual Pollutant Discharge Before and After the Implementation of BPT for Subtitle D Non-Municipal Solid Waste Landfill Facilities in the Non-Hazardous Subcategory 11-72
11-16 Selected BPT Facilities for the Hazardous Subcategory 11-73
11-17 Facilities and Sample Points Used for the Development of BPT/BAT Effluent Limitations for the Hazardous Subcategory 11-74
11-18 BPT Facility Data Excluded from the Calculation of Hazardous BPT/BAT Limitations 11-75
11-19 BPT/BAT Limitations for the Hazardous Subcategory 11-80
11-20 Comparison of Long-Term Averages for Nonconventional and Toxic Pollutants Regulated Under BAT for the Non-Hazardous Subcategory 11-81

LIST OF FIGURES

3-1 Development of National Estimates for the Landfills Industry 3-43
7-1 Development of Pollutants of Interest 7-36
7-2 Selection of Pollutants to be Regulated 7-37
8-1 Equalization 8-61
8-2 Neutralization 8-61
8-3 Clarification System Incorporating Coagulation and Flocculation 8-62
8-4 Calculated Solubilities of Metal Hydroxides 8-63
8-5 Chemical Precipitation System Diagram 8-64
8-6 Cyanide Destruction 8-65
8-7 Chromium Reduction 8-66
8-8 Typical Air Stripping System 8-67
8-9 Multimedia Filtration 8-68
8-10 Ultrafiltration System Diagram 8-69
8-11 Tubular Reverse Osmosis Module 8-70
8-12 Granular Activated Carbon Adsorption 8-71
8-13 Ion Exchange 8-72
8-14 Aerated Lagoon 8-73
8-15 Facultative Pond 8-74
8-16 Completely Mixed Digester System 8-75
8-17 Rotating Biological Contactor Cross-Section 8-76
8-18 Trickling Filter 8-77
8-19 Fluidized Bed Reactor 8-78
8-20 Activated Sludge System 8-79
8-21 Powdered Activated Carbon Treatment System 8-80
8-22 Sequencing Batch Reactor Process Diagram 8-81
8-23 Gravity Thickening 8-82
8-24 Plate-and-Frame Pressure Filtration System Diagram 8-83
8-25 Drying Bed 8-84
8-26 EPA Sampling Episode 4626 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations 8-85
8-27 EPA Sampling Episode 4667 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations 8-86
8-28 EPA Sampling Episode 4721 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations 8-87
8-29 EPA Sampling Episode 4759 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations 8-88
8-30 EPA Sampling Episode 4687 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations 8-89

LIST OF FIGURES

9-1 Option Specific Costing Logic Flow Diagram 9-59
9-2 Equalization Capital Cost Curve 9-60
9-3 Flocculation Capital Cost Curve 9-61
9-4 Flocculation O&M Cost Curve 9-62
9-5 Sodium Hydroxide Capital Cost Curve 9-63
9-6 Sodium Hydroxide O&M Cost Curve 9-64
9-7 Phosphoric Acid Feed Capital Cost Curve 9-65
9-8 Phosphoric Acid Feed O&M Cost Curve 9-66
9-9 Polymer Feed Capital Cost Curve 9-67
9-10 Polymer Feed O&M Cost Curve 9-68
9-11 Primary Clarifier Capital Cost Curve 9-69
9-12 Primary Clarifier O&M Cost Curve 9-70
9-13 Aeration Basin Capital Cost Curve 9-71
9-14 Air Diffusion System Capital Cost Curve 9-72
9-15 Air Diffusion System O&M Cost Curve 9-73
9-16 Secondary Clarifier Capital Cost Curve 9-74
9-17 Secondary Clarifier O&M Cost Curve 9-75
9-18 Multimedia Filtration Capital Cost Curve 9-76
9-19 Multimedia Filtration O&M Cost Curve 9-77
9-20 Reverse Osmosis Capital Cost Curve 9-78
9-21 Sludge Drying Beds Capital Cost Curve 9-79
9-22 Sludge Drying Beds O&M Cost Curve 9-80
9-23 GAC Capital Cost Curve 9-81
9-24 GAC O&M Cost Curve 9-82
9-25 Breakpoint Chlorination Capital Cost Curve 9-83
9-26 Breakpoint Chlorination O&M Cost Curve 9-84
11-1 BPT/BCT/BAT/PSES/PSNS Non-Hazardous Subcategory Option I Flow Diagram 11-82
11-2 BPT/BCT/BAT Non-Hazardous Subcategory Option II & NSPS Flow Diagram . . . 11-83
11-3 BPT/BCT/BAT Hazardous Subcategory Option II & NSPS Flow Diagram 11-84
11-4 BAT Non-Hazardous Subcategory Option III Flow Diagram 11-85

1.0 LEGAL AUTHORITY

1.1 Legal Authority

Effluent limitations guidelines and standards for the Landfills industry are promulgated under the authority of Sections 301, 304, 306, 307, 308, 402, and 501 of the Clean Water Act, 33 U.S.C. 1311, 1314, 1316, 1317, 1318, 1342, and 1361.

1.2 Background

1.2.1 Clean Water Act (CWA)

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101(a)). To implement the Act, EPA is to issue effluent limitations guidelines, pretreatment standards, and new source performance standards for industrial dischargers. These guidelines and standards are summarized briefly in the following sections.

1.2.1.1 Best Practicable Control Technology Currently Available (BPT) (Section 304(b)(1) of the CWA)

In the guidelines for an industry category, EPA defines BPT effluent limits for conventional, priority,[1] and nonconventional pollutants. In specifying BPT, EPA looks at a number of factors. EPA first considers the cost of achieving effluent reductions in relation to the effluent reduction benefits. The Agency also considers: the age of the equipment and facilities; the processes employed and any required process changes; engineering aspects of the control technologies; non-water quality environmental impacts (including

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[1] In the initial stages of EPA CWA regulation, EPA efforts emphasized the achievement of BPT limitations for control of the "classical" pollutants (e.g., TSS, pH, BOD_5). However, nothing on the face of the statute explicitly restricted BPT limitation to such pollutants. Following passage of the Clean Water Act of 1977 with its requirement for points sources to achieve best available technology limitations to control discharges of toxic pollutants, EPA shifted its focus to address the listed priority pollutants under the guidelines program. BPT guidelines continue to include limitations to address all pollutants.

energy requirements); and such other factors as the Agency deems appropriate (CWA 304(b)(1)(B)). Traditionally, EPA establishes BPT effluent limitations based on the average of the best performances of facilities within the industry of various ages, sizes, processes or other common characteristics. Where, however, existing performance is uniformly inadequate, EPA may require higher levels of control than currently in place in an industrial category if the Agency determines that the technology can be practically applied.

1.2.1.2 Best Conventional Pollutant Control Technology (BCT) (Section 304(b)(4) of the CWA)

The 1977 amendments to the CWA required EPA to identify effluent reduction levels for conventional pollutants associated with BCT technology for discharges from existing industrial point sources. In addition to other factors specified in Section 304(b)(4)(B), the CWA requires that EPA establish BCT limitations after consideration of a two part "cost-reasonableness" test. EPA explained its methodology for the development of BCT limitations in July 1986 (51 FR 24974).

Section 304(a)(4) designates the following as conventional pollutants: biochemical oxygen demand (BOD_5), total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 FR 44501).

1.2.1.3 Best Available Technology Economically Achievable (BAT) (Section 304(b)(2) of the CWA)

In general, BAT effluent limitations guidelines represent the best economically achievable performance of plants in the industrial subcategory or category. The factors considered in assessing BAT include the cost of achieving BAT effluent reductions, the age of equipment and facilities involved, the process employed, potential process changes, and non-water quality environmental impacts, including energy requirements. The Agency retains considerable discretion in assigning the weight to be accorded these factors. Unlike

BPT limitations, BAT limitations may be based on effluent reductions attainable through changes in a facility's processes and operations. As with BPT, where existing performance is uniformly inadequate, BAT may require a higher level of performance than is currently being achieved based on technology transferred from a different subcategory or category. BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice.

1.2.1.4 New Source Performance Standards (NSPS) (Section 306 of the CWA)

NSPS reflect effluent reductions that are achievable based on the best available demonstrated control technology. New facilities have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the most stringent controls attainable through the application of the best available control technology for all pollutants (i.e., conventional, nonconventional, and priority pollutants). In establishing NSPS, EPA is directed to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements.

1.2.1.5 Pretreatment Standards for Existing Sources (PSES) (Section 307(b) of the CWA)

PSES are designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of publicly owned treatment works (POTWs). The CWA authorizes EPA to establish pretreatment standards for pollutants that pass through POTWs or interfere with treatment processes or sludge disposal methods at POTWs. Pretreatment standards are technology-based and analogous to BAT effluent limitations guidelines.

The General Pretreatment Regulations, which set forth the framework for the implementation of categorical pretreatment standards, are found at 40 CFR Part 403. These regulations contain a definition of pass

through that addresses localized rather than national instances of pass through and establish pretreatment standards that apply to all non-domestic dischargers (see 52 FR 1586, January 14, 1987).

1.2.1.6 Pretreatment Standards for New Sources (PSNS) (Section 307(b) of the CWA)

Like PSES, PSNS are designed to prevent the discharges of pollutants that pass through, interfere-with, or are otherwise incompatible with the operation of POTWs. PSNS are to be issued at the same time as NSPS. New indirect dischargers have the opportunity to incorporate into their plants the best available demonstrated technologies. The Agency considers the same factors in promulgating PSNS as it considers in promulgating NSPS.

1.2.2 Section 304(m) Requirements

Section 304(m) of the CWA, added by the Water Quality Act of 1987, requires EPA to establish schedules for (1) reviewing and revising existing effluent limitations guidelines and standards ("effluent guidelines") and (2) promulgating new effluent guidelines. On January 2, 1990, EPA published an Effluent Guidelines Plan (55 FR 80) that established schedules for developing new and revised effluent guidelines for several industry categories. One of the industries for which the Agency established a schedule was the Hazardous Waste Treatment Industry.

The Natural Resources Defense Council (NRDC) and Public Citizen, Inc. filed suit against the Agency, alleging violation of Section 304(m) and other statutory authorities requiring promulgation of effluent guidelines (NRDC et al. v. Reilly, Civ. No. 89-2980 (D.D.C.)). Under the terms of the consent decree in that case, as amended, EPA agreed, among other things, to propose effluent guidelines for the "Landfills and Industrial Waste Combusters" category by November 1997 and final action by November 1999. Although the Consent Decree lists "Landfills and Industrial Waste Combusters" as a single entry, EPA is publishing separate regulations for Industrial Waste Combusters and for Landfills.

2.0 SUMMARY AND SCOPE

2.1 Introduction

The final regulation for the Landfills industry establishes effluent limitations guidelines and standards for the control of wastewater pollutants. This document presents the information concerning, and rationale supporting, these effluent limitations guidelines and standards. Section 2.2 discusses the subcategorization approach, Section 2.3 describes the scope of the regulation, Sections 2.4 through 2.9 summarize the final effluent limitations and pretreatment standards, and Sections 2.10 through 2.13 discuss several of the implementation issues associated with this rule.

2.2 Subcategorization

For the final rule, EPA decided that a single set of limitations and standards was not appropriate for the landfills industry and, thus, developed different limitations and standards for subcategories within the industry. These subcategories are summarized below:

<u>RCRA Subtitle C Hazardous Waste Landfill Subcategory</u>

Subpart A of 40 CFR Part 445, "RCRA Subtitle C Hazardous Waste Landfill Subcategory," applies to wastewater discharges from a solid waste disposal facility subject to the criteria in 40 CFR Part 264 Subpart N - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities and 40 CFR Part 265 Subpart N -Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. Hazardous waste landfills are subject to requirements outlined in 40 CFR Parts 264 and 265 that include the requirement to maintain a leachate collection and removal systems during the active life and post-closure period of the landfill. For a discussion of these criteria, see the Preamble to the proposed landfill guideline at 63 FR 6426, 6430-31. (February 6, 1998).

<u>RCRA Subtitle D Non-Hazardous Waste Landfill Subcategory</u>

Subpart B of 40 CFR Part 445, "RCRA Subtitle D Non-Hazardous Waste Landfill Subcategory," applies

to wastewater discharges from all landfills classified as RCRA Subtitle D non-hazardous landfills subject to either of the criteria established in 40 CFR Parts 257 (Criteria for Classification of Solid Waste Disposal Facilities and Practices) or 258 (Criteria for Municipal Solid Waste Landfills). For a discussion of these criteria, see the Preamble to the proposed landfill guideline at 63 FR 6426, 6431-32. (February 6, 1998).

2.3 Scope of Final Regulation

The final limitations and standards cover pollutants in wastewater discharges associated only with the operation and maintenance of those landfills regulated under Subtitles C and D of the Resource Conservation and Recovery Act (RCRA).[1] The rule applies to wastewater generated at both active as well as closed landfills regulated under Subtitle C or Subtitle D of RCRA.

Furthermore, this rule does not apply to wastewater discharges associated with the operation and maintenance of land application or treatment units, surface impoundments, underground injection wells, waste piles, salt dome or bed formations, underground mines, caves or corrective action units.[2] Additionally, this guideline does not apply to waste transfer stations, or any wastewater not directly attributed to the operation and maintenance of Subtitle C or Subtitle D landfill units. Consequently, wastewater, such as that generated in off-site washing of vehicles used in landfill operations, is not within the scope of this guideline.

The wastewater covered by the rule includes leachate, gas collection condensate, drained free liquids, laboratory-derived wastewater, contaminated storm water, and contact washwater from truck exteriors and surface areas which have come in direct contact with solid waste at the landfill facility. However,

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[1] EPA's Subtitle C and Subtitle D regulations define "landfill". See 40 CFR 257.2, 258.2 ("municipal solid waste landfill") and 260.10. Permitted Subtitle C landfills are authorized to accept hazardous wastes as defined in 40 CFR Part 261. Subtitle D landfills are authorized to receive municipal, commercial or industrial waste that is not hazardous (as well as hazardous waste excluded from regulation under Subtitle C).

[2] These terms are defined at 40 CFR 257.2 and 260.10.

ground water and wastewater from recovery pumping well operations which have been contaminated by a landfill and are collected and discharged are excluded from this guideline. Section 2.10 discusses the exclusion from the rule for contaminated ground water flows and for wastewater from recovering pumping wells. Discharges of non-contaminated storm water, as defined by this guideline, are also not covered by the rule. EPA defines non-contaminated storm water and discusses the rationale for not covering it in this guideline at Section 2.11.

The rule does not apply to wastewater discharges generated at a landfill that is associated with an industrial or commercial operation -- so-called "captive" landfills -- in most circumstances. The following describes the applicability of the final rule to captive landfills. The final rule does not apply to discharges of landfill wastewater from captive landfills so long as one or more of the following conditions are met:

a) The captive landfill is operated in conjunction with other industrial or commercial operations, and it only receives wastes generated by the industrial or commercial operation directly associated with the landfill.

b) The landfill is operated in conjunction with other industrial or commercial operations and it receives both wastes generated by the industrial or commercial operation directly associated with the landfill as well as other wastes and the other wastes received for landfill disposal are generated by a facility that is subject to the same provisions in 40 CFR Subchapter N as the receiving facility directly associated with the landfill.

c) The landfill is operated in conjunction with other industrial or commercial operations and it receives wastes generated by the industrial or commercial operation directly associated with the landfill as well as other wastes and the other wastes are similar in nature to the wastes generated by the industrial or commercial operation directly associated with the landfill.

d) The landfill is operated in conjunction with a Centralized Waste Treatment (CWT) facility subject to 40 CFR Part 437 so long as the CWT facility commingles the landfill wastewater with other non-landfill wastewater for treatment. If a CWT facility discharges landfill wastewater separately from other CWT wastewater or commingles the wastewater from its landfill only with wastewater from other landfills, then the landfill discharge is subject to the landfill effluent guidelines.

e) The landfill is operated in conjunction with other industrial or commercial operations, and it receives wastes from public service activities (as defined in Appendix B) and the landfill does not receive a fee or other remuneration for the disposal service.

Section 2.12 discusses in detail EPA's rationale for adopting the conditions described above for the captive landfill exclusion.

2.4 Best Practicable Control Technology Currently Available (BPT)

EPA established BPT effluent limitations guidelines for conventional, priority, and nonconventional pollutants for both subcategories. For RCRA Subtitle C hazardous waste landfills, EPA promulgated effluent limitations standards based on a treatment system consisting of equalization, chemical precipitation, biological treatment, and multimedia filtration. For RCRA Subtitle D non-hazardous waste landfills, EPA promulgated effluent limitations standards based on the following treatment: equalization, biological treatment, and multimedia filtration. Table 2-1 and Table 2-2 list the final effluent limitations and standards for the Hazardous subcategory and the Non-Hazardous subcategory, respectively.

2.5 Best Conventional Pollutant Control Technology (BCT)

EPA established BCT effluent limitations guidelines equivalent to the BPT guidelines for the control of conventional pollutants (BOD_5, TSS, and pH) for both subcategories. The effluent limitations are the same as those specified for BOD_5, TSS, and pH in Table 2-1 and Table 2-2 for the Hazardous subcategory and the Non-Hazardous subcategory, respectively

2.6 Best Available Technology Economically Achievable (BAT)

EPA established BAT effluent limitations guidelines equivalent to the BPT guidelines for control of priority and nonconventional pollutants for both subcategories. Any existing hazardous landfill subject to this guideline must achieve the following effluent limitations which represent the application of BAT: Limitations

for ammonia (as N), alpha terpineol, aniline, benzoic acid, naphthalene, p-cresol, phenol, pyridine, arsenic, chromium and zinc are the same as the corresponding limitations specified in Table 2-1.

Any existing non-hazardous landfill subject to this guideline must achieve the following effluent limitations which represent the application of BAT: Limitations for ammonia (as N), alpha terpinol, benzoic acid, *p*-cresol, phenol and zinc are the same as the corresponding limitations specified in Table 2-2.

2.7 New Source Performance Standards (NSPS)

EPA established NSPS effluent limitations guidelines equivalent to the BPT, BCT, and BAT guidelines for the control of conventional, priority and nonconventional pollutants for both subcategories. Table 2-1 and Table 2-2 list the final effluent limitations and standards for the Hazardous subcategory and the Non-Hazardous subcategory, respectively.

2.8 Pretreatment Standards for Existing Sources (PSES)

EPA did not establish PSES for either subcategory. Any source subject to this rule that introduces wastewater pollutants into a publicly owned treatment works (POTW) must comply with 40 CFR Part 403.

2.9 Pretreatment Standards for New Sources (PSNS)

EPA did not establish PSNS for either subcategory. Any new source subject to this rule that introduces wastewater pollutants into a POTW must comply with 40 CFR Part 403.

2.10 Implementation of the Rule for Contaminated Ground Water Flows and Wastewater from Recovering Pumping Wells

During development of the rule, EPA considered whether it should also include contaminated ground water flows within the scope of this guideline. Historically, many landfill operations have caused the contamination

of local ground water, mostly as a result of leakage from unlined landfill units in operation prior to the minimum technology standards for landfills established by RCRA Subtitle C and D regulations. Subsequently, State and Federal action under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) has required facilities to clean up contaminated ground water. In many cases, this has resulted in the collection, treatment, and discharge of treated ground water to surface waters. In addition, in the case of RCRA Subtitle C hazardous waste landfills and municipal solid waste landfills (MSWLFs), applicable regulatory standards require ground water monitoring and post-closure care and, in the event of ground water contamination, corrective action measures. These requirements may also result in treatment of contaminated ground water by such landfill facilities.

EPA, however, has not included contaminated ground water flows within its assessment for this guideline. Several reasons support EPA's decision not to include contaminated ground water as a regulated waste stream for this rule.

EPA evaluated flows, pollutant concentrations, treatment in place, and current treatment standards for discharges of contaminated ground water from landfills. From this evaluation, EPA concluded that pollutants in contaminated ground water flows are often very dilute or are treated to very low levels prior to discharge. EPA concluded that, whether as a result of corrective action measures taken pursuant to RCRA authority or State action to clean up contaminated landfill sites, landfill discharges of treated contaminated ground water are being adequately controlled. Consequently, further regulation under this rule would be redundant and unnecessary.

EPA is aware that there are landfill facilities that collect and treat both landfill leachate and contaminated ground water flows. In the case of such facilities, EPA has concluded that decisions regarding the appropriate discharge limits should be left to the judgment of the permit writer. As indicated by data collected through the questionnaires and EPA sampling, ground water characteristics are often site specific and may contain very few contaminants or may, conversely, exhibit characteristics similar in nature to

leachate. In cases where the ground water is very dilute, the Agency is concerned that contaminated ground water may be used as a dilution flow. In these cases, the permit writer should develop "best professional judgment" (BPJ) permit limits based on separate treatment of the flows, or develop BPJ limits based on a flow-weighted building block approach, in order to prevent dilution of the regulated leachate flows. However, in cases where the ground water may exhibit characteristics similar to leachate, commingled treatment may be appropriate, cost effective, and environmentally beneficial. EPA recommends that the permit writer consider the characteristics of the contaminated ground water before making a determination if commingling ground water and leachate for treatment is appropriate. EPA recommends that the permit writer refer to the leachate characteristics data in Chapter 6 in order to determine whether contaminated ground water at a landfill has characteristics similar to leachate.

Recovering pumping well wastewater is generated as a result of the various ancillary operations associated with ground water pumping operations. These operations include construction and development, well maintenance, and well sampling (i.e. purge water). The wastewater will have very similar characteristics to contaminated ground water. Therefore, for the same reasons that EPA did not include contaminated ground water as a regulated wastewater, these regulations do not apply to wastewater from recovering pumping well operations.

2.11 Implementation of the Rule for Storm Water Discharges

EPA received extensive comments on its proposal to include contaminated storm water as a regulated waste stream under the landfills effluent guidelines. Several commenters stated that contaminated storm water (storm water that comes into contact with solid waste at the landfill site) should not be subject to the landfills effluent limitations guidelines because this is already covered by the Final National Pollutant Discharge Elimination System Storm Water Multi-sector General Permit (MSGP) for Industrial Activities (September 29, 1995; 60 FR 50803), in States where it applies, or by an equivalent general permit issued by an NPDES authorized State.

In an effort to clarify the types of storm water runoff that are subject to the landfills effluent guidelines, EPA revised the definition of contaminated and non-contaminated storm water in the final rule. EPA defines these terms as follows:

> *Contaminated storm water*: Storm water which comes in direct contact with landfill wastes, the waste handling and treatment areas, or wastewater that is subject to the limitations and standards.
>
> *Non-contaminated storm water*: Storm water which does not come in direct contact with landfill wastes, the waste handling and treatment areas, or wastewater that is subject to the limitations and standards. Non-contaminated storm water includes storm water which flows off the cap, cover, intermediate cover, daily cover, and/or final cover of the landfill.

The Storm Water Pollution Prevention Plan (SWPPP) required by the storm water MSGP or an authorized State's equivalent general permit requires landfill facilities to identify all of the sources of storm water contamination at the landfill and then implement measures and controls (such as good housekeeping for materials storage, sediment and erosion controls - particularly from intermediate and final covers) in an effort to prevent storm water contamination. EPA believes that the storm water MSGP (or an authorized State's equivalent general permit) adequately controls pollutants from storm water runoff from covered areas of the landfill. Covered areas of the landfill include the following: capped, final cover, intermediate cover, and daily cover areas. The Agency believes that the SWPPP and the monitoring requirements in the storm water MSGP provide adequate controls for reducing the level of pollutants in storm water from these areas of landfills.

EPA recognizes that there may be some incidental contact with wastes when storm water flows over a daily or intermediate cover. However, EPA concluded that such contact will not lead to any meaningful "contamination" of the storm water so long as the landfill complies with the requirements of the storm water MSGP or an authorized State's equivalent general permit. For example, the Best Management Practices (BMPs) outlined in Table L-1 and L-2 of the storm water MSGP (60 FR 50940) and the monitoring requirements in Table L-5 and L-6 for TSS and total recoverable iron (60 FR 50943) provide adequate

controls for the pollutants that would most likely be associated with runoff from covered areas of non-hazardous landfills.

Similarly, for hazardous landfills, BMPs and monitoring requirements outlined in Table K-2 (60 FR 50935) and Table K-3 (60 FR 50936), respectively, also require controls for pollutants associated with runoff from covered areas of a landfill. In EPA's view, BMPs provide a fair degree of control of these pollutants and the monitoring requirements of the MSGP provide a tool for evaluating the effectiveness of the Storm Water Pollution Prevention Plan.

As part of the Agency's continuing effort to improve its environmental and pollution control programs, EPA has concluded that, although the MSGP provides some control for contaminated storm water runoff, the landfills effluent limitations guidelines provide a more comprehensive level of control for storm water runoff that has come in direct contact with solid waste, waste handling and treatment areas, or wastewater flows that are controlled under this rule. Although the storm water MSGP considered circumstances in which untreated leachate may be incidently commingled with storm water, the Agency explicitly acknowledged in the MSGP that insufficient data were available to establish numeric limits for storm water that might be contaminated based on best available technology for MSWLFs (60 FR 50942), non-hazardous industrial landfills (60 FR 50943), and hazardous landfills (60 FR 50935).

However, EPA has now concluded that the data collected in support of the landfills effluent limitations guidelines provide the basis for establishing appropriate numeric limitations for contaminated storm water. EPA specifically noted in the Preamble for the storm water MSGP that it was developing these guidelines and that where the guidelines applied to discharges, facilities must comply with them (60 FR 50942). In addition, EPA intends to propose a reissuance of the storm water MSGP which would include the promulgated landfills effluent limitations for contaminated storm water (as defined by this landfill guideline).

2.12 Exclusion for Captive Landfill Facilities

As discussed in Section 2.3 above, the rule does not apply to captive landfills in most circumstances. In developing the proposed guidelines, an important question EPA addressed was how to treat landfill leachate generated at a landfill that is associated with an industrial or commercial operation -- so-called "captive" landfills. Currently, in the case of wastewater sources that are not subject to effluent limitations guidelines and standards, NPDES permit writers must impose limitations on discharges of these wastewater sources that are developed on a case-by-case, best professional judgment (BPJ) basis. Similarly, an indirect discharger may not introduce any pollutants to a POTW from these sources that will pass through or interfere with the POTW's operations. Generally, each POTW is required to develop a pretreatment program and enforce the prohibition on pass through and interference through specific local limits.

EPA initially considered development of effluent guidelines to address any landfill discharging directly to surface waters of the United States or introducing pollutants into a POTW. Consequently, EPA's technical evaluation for the proposal included an assessment of virtually all landfill facilities which collect wastewater as a result of landfilling operations. EPA proposed to exclude wastewater discharges from captive landfills located at industrial facilities in specific circumstances. In the proposal, a captive landfill would not have been subject to the guidelines if: 1) it commingled landfill process wastewater with non-landfill process wastewater for treatment, and 2) the landfill received only waste generated on site or waste generated from a similar activity at another facility under the same corporate structure.

For the final rule, EPA determined that these requirements are too restrictive and therefore the Agency has decided not to include captive landfills within the scope of this guideline except in a limited number of circumstances. The effect of this decision for the final rule is not to allow these wastewater sources to escape treatment. Landfill wastewater at captive facilities is and will remain subject to treatment and controls on its discharge. The Clean Water Act (CWA) requires wastewater discharges to meet technology-based effluent limitations on the discharge whether the mechanism for imposing these limitations

is EPA-established national effluent limitations guidelines or a permit writer's imposition on a case-by-case basis of BPJ limitations. In like manner, in order to prevent pass through or interference, indirect dischargers must limit their introduction of pollutants to a POTW whether EPA has established national categorical pretreatment standards for the discharge or a POTW has established local limits.
For the final rule, EPA has modified the proposal to remove the requirement that a facility must commingle its wastewater from a captive landfill with the facility's non-landfill process wastewater for treatment in order not to be subject to the landfills effluent guideline, in most circumstances. For the reasons described in detail below, EPA did not remove the commingling requirement for CWTs. In addition, EPA also changed the conditions under which captive landfills may accept off-site wastes and not be subject to this guideline.

In the proposal, EPA stated that the commingling requirement ensures that wastewater from captive landfills will undergo adequate treatment (treatment that is comparable to the level of treatment that would be required by the landfills effluent guideline) prior to discharge. EPA determined that the commingling of landfill wastewater with industrial wastewater for treatment was an unnecessary requirement to impose in nationally applicable regulations for the reasons discussed below. Permit writers are establishing appropriate limits on these discharges by either applying the effluent limitations guidelines applicable to the associated industrial activity to the discharge or developing other BPJ limitations. EPA recommends that permit writers use this guideline when developing these BPJ limitations.

From the information developed by the Agency for this rulemaking and confirmed by comments on the proposal, EPA has concluded that landfill wastewater generated by captive landfills operated in conjunction with and receiving the bulk of their waste from an industrial or commercial operation will have a similar pollutant profile to the wastewater generated in the industrial or commercial operation. EPA has further concluded that the wastewater generated by landfill operations at most of the captive facilities are already subject to effluent guidelines. In the circumstances in which the wastewater is not expressly subject to effluent guidelines, EPA has determined that permit writers generally impose BPJ limitations on the

discharge of landfill wastewater that are similar to the limitations applicable to the discharge of industrial process wastewater whether commingled or not. EPA has compared the wastewater treatment technologies employed at many of the industrial facilities operating landfills in conjunction with industrial or commercial operations to the treatment technologies that EPA used as the basis for the BPT/BAT limits in this effluent guideline. The Agency's review of such situations shows that the landfill wastewater receives treatment that is comparable or better than the level of treatment that would be required by the landfills effluent guideline.

Consequently, EPA has decided to eliminate the requirement of commingling as a condition for a captive landfill not to be subject to landfill limitations and standards (except in the case of CWTs). EPA has concluded that landfill wastewater at captive landfills is now and will continue to receive adequate treatment because the landfill wastewater generally must meet the same effluent limitations that would have been required had the waste streams been commingled. In cases where the permit writer is establishing BPJ limitations for the discharge of captive landfill wastewater that is not commingled for treatment, the permit writer should look at the effluent guidelines applicable to the associated industrial operation and the landfills effluent guidelines for potential guidance in setting those limitations.

Because of the nature of most CWTs, EPA determined that the reasons that generally supported exclusion of other captive landfills would not apply in the case of CWTs. As explained above, EPA concluded that a captive landfill which only received wastes generated in an industrial or commercial operation directly associated with the landfill or similar wastes would generate a leachate with a similar pollutant profile to the other wastewater streams produced at the industrial operation. In such circumstances, the data reviewed by EPA showed that the landfill wastewater and other industrial wastewater are generally commingled for treatment and subject to the same discharge limitations. In these circumstances, it was appropriate not to subject the landfill to this guideline.

Because a CWT, by its very nature, may generate a wide array of different solid wastes for landfill disposal, it may generate a leachate that varies significantly from other streams being treated at the CWT at the time the leachate is collected. Therefore, EPA concluded that the basis for the exclusion -- the similarity in wastewater -- would not necessarily apply in the case of CWTs. EPA decided that, in order to ensure that the CWT landfill wastewater is treated adequately, the landfill wastewater from a CWT landfill should be commingled with other CWT wastewater for treatment.

It is worth noting that the majority of industrial facilities that operate captive landfills do commingle their landfill process wastewater with other industrial wastewater for treatment. (February 6, 1998; 63 FR 6430). A review by EPA of individual NPDES permits for captive and intracompany facilities found that, for the most part, landfill waste streams are mixed with categorical wastes and subject to limitations comparable to the final limitations for landfills.

Most captive landfill facilities choose to commingle their landfill process wastewater for treatment for several reasons. First of all, wastewater flows from captive landfills are usually quite small in comparison to the wastewater flows from other industrial operations at the captive facility. EPA's data show that the landfill wastewater flows are often less than one percent and typically less than three percent of the industrial wastewater flows. Therefore, most facilities choose to commingle the relatively small volume of landfill wastewater with the larger industrial wastewater volumes rather than maintaining and operating a completely separate wastewater treatment system for the landfill wastewater. Second, as mentioned above, it is likely that leachate from landfills at industrial operations will reflect a pollutant profile similar to the facility's industrial process wastewater. Therefore, based on the similarity of the waste streams, facilities often choose to commingle these streams for treatment. In fact, most of the captive facilities identified in EPA's database commingle their leachate with other industrial process wastewater for treatment. Comments submitted in response to the proposed rule suggest that situations do exist where a captive landfill may not commingle the landfill wastewater with other process wastewater for treatment. In circumstances where a facility chooses not to commingle landfill leachate for treatment with the other

process wastewater generated, EPA has concluded, based on comments submitted, that this wastewater will still be subject to categorical or Best Professional Judgment (BPJ) limits reflecting comparable removals in most instances.

Lastly, industrial facilities with captive landfills often choose to commingle their waste streams for treatment in order to avoid additional NPDES or pretreatment requirements that would be necessary if the waste streams were treated and discharged separately. EPA concluded that the wastewater generated by landfill operations at most of the captive facilities are already subject to categorical effluent limitations (or pretreatment standards). Information gathered by EPA prior to proposal and in comments received on the proposed rule support the conclusion that these wastewater flows were either assessed and evaluated for the effluent limitations guideline applicable to the facility, or are subject to a "building block approach" (for directs) or the "combined waste stream formula" (for indirects) for developing BPJ limits or standards established by the permit writer or local control authority. This review indicates that, for the most part, these landfill waste streams are mixed with categorical wastes for treatment and subject to limitations comparable to the final landfill regulation.

Based on comments received, the Agency also determined that the requirement in the proposal that solid wastes deposited in the captive landfill must either be generated on site or from an off-site facility under the same corporate structure was too restrictive and could often prohibit a company from safely and properly disposing of solid wastes accepted from tolling, remediation, product stewardship, and public service activities.

In the proposal, EPA narrowly limited the universe of captive landfills that fall outside the scope of this rule to captive landfills that only accepted wastes from on site or from off-site facilities under the same corporate structure. The reason for this was essentially to ensure that the captive landfills were only accepting wastes that would be similar to those wastes generated on site. This in turn would provide some degree of assurance that the leachate generated from these wastes would be compatible with the on-site industrial

wastewater treatment. However, from the comments submitted on this issue, EPA determined this waste acceptance criterion for the captive exclusion was too restrictive. Those commenting on this issue identified several waste acceptance practices that are commonly used by captive landfills that would not meet the proposed exclusion criteria but are consistent with EPA's objective that landfill leachate receive treatment compatible with its expected constituents. Many of these current waste disposal practices are activities that EPA encourages and, therefore, EPA has revised the exclusion criteria pertaining to waste acceptance for captive/intracompany landfills in order to accommodate these disposal practices.

Specifically, several commenters requested that EPA broaden the criteria for determining those captive landfills that fall outside the scope of this rule to include waste acceptance from tolling and contract manufacturers, product stewardship, company partnerships, and remediation activities. EPA concluded that waste disposal at captive landfills from these types of activities will, in most cases, result in leachate that will be adequately controlled through the implementation of categorical or BPJ limitations at the facility. However, EPA remains concerned that there are circumstances in which inter-company waste products deposited in the landfill may result in contaminants in the leachate that may not be compatible with the existing industrial wastewater treatment system or may not be covered adequately by the existing industrial effluent guideline. Therefore, one of the alternative conditions for the revised applicability provisions of the guideline described above for captive landfills provides that waste accepted at the captive landfill must be of a similar nature to the wastes generated at the operation with the associated landfill. Thus, the permitting authority must determine that wastes accepted for disposal at a captive landfill are of a similar nature to the waste generated at the facility directly associated with the captive landfill. Factors that the permit writer should consider in determining whether a waste is similar are described at Section 2.13.

In addition, commenters also requested that EPA include the acceptance of wastes for disposal as a public service as a category of landfill practices that qualify for the captive exclusion. EPA agrees and has included such a provision. EPA applauds the efforts of manufacturing facilities who provide members of their communities with a cost effective and environmentally safe means for disposing of their solid waste.

Therefore, in the final rule, EPA determined that this rule shall not apply to those landfills operated in conjunction with other industrial or commercial operations which receive other wastes from public service activities so long as the company owning the landfill does not receive a fee or other remuneration for the disposal service. EPA's decision not to subject captive landfills that accept off-site wastes for disposal as a public service is not inconsistent with its decision generally to condition non-applicability on the similarity of wastes accepted for disposal. Based on its review of data collected for this guideline and comments received, EPA concluded that the quantity of wastes accepted for disposal as a public service would not in any measurable way affect the pollutant profile of the leachate generated by the landfill even if dissimilar. Of course, these wastewater flows still remain subject to treatment to achieve BPJ permit limits reflecting the landfill contribution to the facility discharge.

The Agency has determined that whether captive landfills accepting wastes from off site or from a company not within the same corporate structure on a non-commercial basis should be subject to the landfills effluent guideline should hinge on the ability of the captive landfill to handle the waste in an appropriate manner. Therefore, the Agency concluded that the waste acceptance criterion for determining those captive landfills that fall outside the scope of this rule should be based on the similarity of the waste accepted for disposal from another facility to the waste generated by the industrial or commercial operation directly associated with the landfill. In the case of captive landfills treating similar wastes, the permit writer should base permit limits on limitations for the guideline to which the industrial or commercial operation is subject or establish BPJ limitations. Again, the permit writer, if developing BPJ limitations, should consider these landfill guidelines as guidance in this effort.

2.13 Determination of Similar Wastes for Captive Landfill Facilities

As discussed at Sections 2.3 and 2.12 above, the Agency concluded that discharges from captive landfills should not be subject to the guidelines if the captive landfills only accepted waste for disposal from another facility that was similar to the waste generated by the industrial or commercial operation directly associated with the landfill. This section offers guidance to permit writers for determining whether a solid waste

received for disposal in a captive landfill is similar to those wastes generated by the facility directly associated with the landfill.

According to EPA's database, many of the industrial or commercial facilities that operate captive landfills are subject to effluent limitations guidelines in 40 CFR Subchapter N. For the most part, facilities subject to a particular industrial category effluent guideline produce similar types of wastes. Therefore, EPA decided that this rule does not apply to landfills operated in conjunction with other industrial or commercial operations when the landfill receives wastes generated by the industrial or commercial operation directly associated with the landfill and also receives other wastes generated by a facility that is subject to the same provisions in 40 CFR Subchapter N as the waste-receiving facility. However, there are cases where a captive landfill is directly associated with an industrial or commercial operation that is not subject to an effluent guideline. Or, a facility, subject to an effluent guideline, may operate a landfill in conjunction with industrial or commercial operations, but may also accept other wastes from facilities that are not subject to the same effluent guideline or not subject to an effluent guideline at all. In these cases, the permit writer must determine whether the other wastes received for disposal are of similar nature to the wastes generated by the industrial or commercial operation directly associated with the landfill. In cases where the permit writer determines that the other waste accepted by the captive landfill is not similar to the waste generated by the industrial or commercial activity directly associated with the landfill, the landfill wastewater will be subject to the landfills effluent limitations. However, if the permit writer determines that the wastes are similar, then the wastewater from the captive landfill should be subject to the same categorical effluent guideline (or BPJ limitations) as the industrial or commercial facility.

A permit writer should consider the following factors in deciding whether other wastes received by a captive landfill are similar to those wastes generated by the industrial or commercial operation directly associated with the landfill:

1. Are the other wastes received from facilities that are subject to the same provisions in 40 CFR Subchapter N as the facility directly associated with the captive landfill?

If so, then the landfills effluent guidelines do not apply to this captive landfill. If not, then the permit writer should consider the other factors listed below.

2. Are the other wastes received from facilities that are part of the same effluent guidelines "grouping" as shown in Table 2-3?

   If so, it is likely that the wastes are similar and the landfills effluent guidelines do not apply. Table 2-3 groups the industrial categories under Subchapter N into the following six groups: Organics, Metals, Inorganics and Non-Metals, Pesticides, Explosives, and Asbestos. It is likely that industries within the same industrial effluent guideline "grouping" will generate similar types of constituents in the solid wastes, and the leachate resulting from the disposal of these wastes will be controlled adequately by the effluent limitation for the industrial or commercial facility directly associated with the captive landfill. However, this may not always be the case and, therefore, EPA left to the local control authority the determination of whether the landfills effluent guideline should apply to a captive landfill that accepts wastes from other facilities that are not subject to the same provisions in 40 CFR Subchapter N. The local permitting authority will determine whether a captive landfill which accepts wastes from other industrial activities, apart from those directly associated with the landfill, is subject to the landfills effluent guidelines based on the similarity of the other wastes and the likelihood that these wastes will result in leachate that is compatible with the wastewater treatment technology used to treat the landfill leachate.

3. In the case of hazardous captive landfills, do the other wastes being received have the same hazardous waste codes as those generated at the facility directly associated with the landfill?

   If so, it is possible that the wastes are similar. However, this may not always be the case and, therefore, EPA left to the local control authority the determination of whether the landfills effluent guideline should apply to a captive landfill that accepts wastes from other facilities that are not subject to the same provisions in 40 CFR Subchapter N.

4. Is a significant portion of the waste deposited in the landfill from the industrial or commercial operation that is directly associated with the captive landfill?

   The control authority should analyze the number of customers and the amount of the off-site or inter-company waste deposited relative to the quantity of on-site or intracompany waste placed in the captive landfill. Again, the main reason for the exclusion for captive landfills is that their leachate should resemble the industrial wastewater of the operation directly associated with the landfill and, therefore, the landfill leachate will be adequately controlled by the applicable industrial effluent guidelines. However, this logic is only applicable when the bulk of the waste placed in the landfill is of similar content to that being produced by the industrial facility directly associated with the landfill. Therefore, when

applying the captive exclusion, the control authority should analyze the volume and characteristics of waste received from inter-company waste transfers in determining whether the leachate generated by the captive landfill will have similar characteristics to the industrial wastewater generated by the company owning the landfill.

5. Is the facility that is directly associated with the captive landfill deriving any revenues from waste disposal at the landfill?

In developing the exclusion for captive landfills, EPA's intent was to exclude those non-commercial landfills that are directly associated with an industrial or commercial operation and whose leachate is currently being adequately addressed by the facility's categorical or BPJ limitations. EPA believes that where any revenues are being derived from the collection of fees for solid waste disposal at a captive landfill, the facility is accepting wastes on a commercial basis - - wastes that may well be dissimilar to that being disposed of at the landfill. The captive exception is premised on the fact that, in most cases, leachate from a landfill associated with an industrial operation will resemble the industrial process wastewater generated by the industrial operation and, therefore, the landfill leachate will be adequately controlled by the applicable industrial effluent guidelines or BPJ limitations. However, this is a reasonable assumption only in circumstances where the waste placed in the landfill is of similar content to that being produced by the industrial operation directly associated with the landfill. It is likely that a commercial landfill may accept significant volumes of waste that are not similar to the wastes generated by the industrial operation directly associated with the landfill.

6. Is the industrial or commercial facility directly associated with the captive landfill accepting wastes for disposal as part of public service activities?

If so, and the facility does not receive a fee or other remuneration for the disposal service, the captive landfill is not subject to this rule. EPA defines public service activities in Appendix B.

Table 2-1: Final Concentration Limitations for Hazardous Landfill Subcategory, Direct Discharges

Pollutant or Pollutant Property	Maximum for 1 day (mg/L)	Monthly average shall not exceed (mg/L)
BOD_5	220	56
TSS	88	27
Ammonia	10	4.9
Arsenic (Total)	1.1	0.54
Chromium (Total)	1.1	0.46
Zinc (Total)	0.535	0.296
Alpha Terpineol	0.042	0.019
Aniline	0.024	0.015
Benzoic Acid	0.119	0.073
Naphthalene	0.059	0.022
p-Cresol	0.024	0.015
Phenol	0.048	0.029
Pyridine	0.072	0.025
pH	Shall be in the range 6.0 - 9.0 pH units.	

Table 2-2: Final Concentration Limitations for Non-Hazardous Landfill Subcategory, Direct Discharges

Pollutant or Pollutant Property	Maximum for 1 day (mg/L)	Monthly average shall not exceed (mg/L)
BOD_5	140	37
TSS	88	27
Ammonia	10	4.9
Zinc	0.20	0.11
Alpha Terpineol	0.033	0.016
Benzoic Acid	0.12	0.071
p-Cresol	0.025	0.014
Phenol	0.026	0.015
pH	Shall be in the range 6.0 - 9.0 pH units.	

Table 2-3: Grouping of Subchapter N Effluent Guidelines and Standards

Industrial Category	Part #	Characteristics					
		Organics	Metals	Inorganics Non-metal	Pesticides	Explosives	Asbestos
Dairy products and processing	405	X					
Grain mills	406	X					
Canned and preserves fruits and vegetables	407	X					
Canned and preserved seafood	408	X					
Sugar processing	409	X					
Textile mills	410	X	X				
Cement manufacturing	411		X	X			
Feedlots	412	X					
Electroplating	413		X				
Organic chemicals, plastics and synthetic fibers	414	X					
Inorganic chemicals manufacturing	415			X			
Soap and detergent manufacturing	417	X					
Fertilizer manufacturing	418			X			
Petroleum refining	419	X					
Iron and steel manufacturing	420		X				
Nonferrous metals manufacturing	421		X				
Phosphate manufacturing	422			X			
Steam electric power plants	423	X	X				
Ferroalloy manufacturing	424		X				
Leather tanning and finishing	425	X	X				
Glass manufacturing	426			X			
Asbestos manufacturing	427						X
Rubber processing	428	X					
Timber products processing	429	X					
Pulp, paper and paperboard	430	X					
Builder's paper and board mills	431	X					
Meat products	432	X					
Metal finishing	433		X				
Coal mining	434			X			
Oil and gas extraction	435	X					
Mineral mining and processing	436		X				
Pharmaceutical preparations	439	X					
Ore mining	440		X				
Paving and roofing materials (tars & asphalt)	443	X		X			
Paint formulation	446	X	X				
Ink formulation	447	X					
Gum and wood chemicals	454	X	X				
Pesticides	455				X		
Explosives manufacturing	457					X	
Carbon black manufacturing	458	X					
Photographic equipment and supplies	459		X				
Hospital	460	X					

3.0 INDUSTRY DESCRIPTION

The Landfills industry consists of facilities that receive wastes either as commercial or municipal operations or as on-site (captive) operations owned by waste generators. These landfill facilities generate wastewater and discharge it to surface waters, publicly owned treatment works (POTWs), or use some other form of zero or alternative disposal. The Resource Conservation and Recovery Act (RCRA) defines a landfill as "an area of land or an excavation in which wastes are placed for permanent disposal, and that is not a land application unit, surface impoundment, injection well, or waste pile" (40 CFR 257.2). RCRA classifies landfills as either Subtitle C hazardous or Subtitle D non-hazardous. Wastewater generated and discharged by landfills can include, but is not limited to, leachate, gas collection condensate, contaminated ground water, contaminated storm water, drained free liquids, truck/equipment washwater, laboratory-derived wastewater, and wastewater recovered from pumping wells.

Landfills are commonly classified by the types of wastes they accept and/or by their ownership status. Some of the terms used to describe a landfill include municipal, sanitary, chemical, industrial, RCRA, hazardous waste, Subtitle C, and Subtitle D. Although non-hazardous landfills do not knowingly accept hazardous wastes, these facilities may contain hazardous wastes due to disposal practices that occurred prior to 1980 and before the enactment of RCRA and its associated regulations. The following section provides descriptions of landfills in terms of ownership type and regulatory type.

Ownership Status

- ***Municipal:*** Municipally-owned landfills are those that are owned by local governments. Municipally-owned landfills may be designed to accept either Subtitle D or Subtitle C wastes (see "Regulatory Type").

- ***Commercial:*** Commercial landfills are privately-owned facilities and can be designed to receive either municipal, hazardous, or non-hazardous industrial wastes. Typical non-hazardous industrial wastes include packaging and shipping materials, construction and demolition debris, ash, and sludge.

- ***Captive:*** Captive landfills are operated in conjunction with other industrial or commercial operations, and receive the bulk of their wastes from the industrial or commercial operations. Captive landfills are located on, or adjacent to, the facility they service and are common at major hazardous waste generators, such as chemical and petrochemical manufacturing plants.

- ***Intra-company:*** Landfill facilities operated in conjunction with other industrial or commercial operations which only receive waste from off-site facilities under the same corporate structure, ownership, or control. These landfills are similar to captive sites but receive wastes from multiple locations of one company.

Regulatory Type

- ***Subtitle C:*** Subtitle C landfills are those disposal operations authorized by RCRA to accept hazardous wastes as defined in 40 CFR Part 261. Subtitle C landfills are subject to the criteria in 40 CFR Part 264 Subpart N - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities and 40 CFR Part 265 Subpart N - Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. Hazardous waste landfills are subject to requirements outlined in 40 CFR Parts 264 and 265 that include the requirement to maintain a leachate collection and removal systems during the active life and post-closure period of the landfill. Section 3.1 presents more details on the regulatory requirements of Subtitle C.

- ***Subtitle D:*** Subtitle D landfills are those disposal operations that are subject to either of the criteria established in 40 CFR Parts 257 (Criteria for Classification of Solid Waste Disposal Facilities and Practices) or 258 (Criteria for Municipal Solid Waste Landfills). The wastes received at Subtitle D landfills include municipal refuse, ash, sludge, construction and demolition debris, and non-hazardous industrial waste. These facilities were not designed to receive hazardous wastes; however, prior to 1980 and the enactment of RCRA, older landfills may have received waste later classified as hazardous under RCRA. Any Subtitle D landfill accepting municipal refuse after October 9, 1993 is classified as a Municipal Waste Disposal Unit, and is regulated under 40 CFR 258. Any Subtitle D landfill not accepting municipal waste after October 9, 1993 continues to be regulated under 40 CFR 257. For the purposes of this document, Subtitle D landfills not accepting municipal refuse are referred to as "Subtitle D non-municipal" landfills.

The following discussions present a regulatory history of this industry and past EPA studies.

3.1 Regulatory History of the Landfills Industry

Depending on the type of wastes disposed of at a landfill, the landfill may be subject to regulation and permitting under either Subtitle C or Subtitle D of RCRA. Subtitle C facilities receive wastes that are identified or listed as hazardous wastes at 40 CFR Part 261. Subtitle D landfills can only accept wastes that are not defined as hazardous wastes at 40 CFR Part 261. The following sections outline some of the key regulations that have been developed to control the environmental impacts of Subtitle C and Subtitle D landfills.

3.1.1 RCRA Subtitle C

Subtitle C of the RCRA of 1976 directed EPA to promulgate regulations to protect human health and the environment from the improper management of hazardous wastes. Based on this statutory mandate, the goal of the RCRA program was to provide comprehensive, "cradle-to-grave" management of hazardous waste. These regulations establish a system for tracking the disposal of hazardous wastes and special design requirements for landfills depending on whether a landfill accepted hazardous or non-hazardous waste. Key statutory provisions in RCRA Subtitle C include the following:

- Section 3001: Requires the promulgation of regulations identifying the characteristics of hazardous waste and listing particular hazardous wastes.
- Section 3002: Requires the promulgation of standards, such as manifesting, record keeping, etc., applicable to generators of hazardous waste.
- Section 3003: Requires the promulgation of standards, such as manifesting, record keeping, etc., applicable to transporters of hazardous waste.
- Section 3004: Requires the promulgation of performance standards applicable to the owners and operators of facilities for the treatment, storage, or disposal of hazardous waste.
- Section 3005: Requires the promulgation of regulations requiring each person owning or operating a treatment, storage, or disposal facility to obtain a permit.

These regulations establish a system for tracking the disposal of hazardous wastes and performance and design requirements for landfills accepting hazardous waste. Under RCRA, requirements are initially triggered by a determination that a waste is hazardous as defined in 40 CFR Part 261. Any party, including the original generator, that treats, stores, or disposes of a hazardous waste must notify EPA and obtain an EPA identification number. EPA established performance regulations governing the operation of hazardous waste landfills at 40 CFR Parts 264 and 265. RCRA Subtitle C hazardous waste regulations apply to landfills that presently accept hazardous wastes or have accepted hazardous waste at any time after November 19, 1980.

3.1.1.1 Land Disposal Restrictions

The Hazardous and Solid Waste Amendments (HSWA) to RCRA, enacted on November 8, 1984, largely prohibit the land disposal of untreated hazardous wastes. Once a hazardous waste is prohibited from land disposal, the statute provides only two options for legal land disposal: 1) meet the EPA-established treatment standard for the waste prior to land disposal, or 2) dispose of the waste in a land disposal unit that has been found to satisfy the statutory no-migration test. A no- migration unit is one from which there will be no migration of hazardous constituents for as long as the waste remains hazardous. (RCRA Sections 3004 (d),(e),(g)(5)).

Under Section 3004 of RCRA, the treatment standards that EPA develops may be expressed as either constituent concentration levels or as specific methods of treatment. Under RCRA Section 3004(m)(1), the criteria for these standards is that they must substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized. For purposes of the restrictions, the RCRA program defines land disposal to include, among other things, any placement of hazardous waste in a landfill. Land disposal restrictions are published in 40 CFR Part 268.

EPA has used hazardous waste treatability data as the basis for land disposal restrictions standards. EPA has identified Best Demonstrated Available Treatment Technology (BDAT) for each listed hazardous waste. BDAT is the treatment technology that EPA finds to be the most effective in treating a waste and that also is readily available to generators and treaters. In some cases, EPA has designated as BDAT for a particular waste stream a treatment technology shown to have successfully treated a similar but more difficult to treat waste stream. This ensured that the land disposal restrictions standards for a listed waste stream were achievable since they always reflected the actual treatability of the waste itself or of a more refractory waste.

As part of the Land Disposal Restrictions (LDRs), EPA promulgated Universal Treatment Standards (UTS) as part of the RCRA phase two final rule (July 27,1994). The UTS are a series of concentrations for wastewater and non-wastewater that provide a single treatment standard for each constituent. Previously, the LDR regulated constituents according to the identity of the original waste; thus, several numerical treatment standards existed for each constituent. The UTS simplified the standards by having only one treatment standard for each constituent in any waste residue. The LDR and the UTS restricted the concentrations of wastes that could be disposed of in landfills, thus improving the environmental quality of the leachate from landfills.

The LDR treatment standards established under RCRA may differ from the Clean Water Act effluent guidelines both in their format and in the numerical values set for each constituent. The differences result from the use of different legal criteria for developing the limits and resulting differences in the technical and economic criteria and data sets used for establishing the respective limits.

The difference in format of the LDR and effluent guidelines is that LDR establishes a single daily limit for each pollutant parameter while effluent guidelines establish monthly and daily limits. Additionally, the effluent guidelines provide for several types of discharge, including new and existing sources, and indirect and direct discharge.

The differences in numerical limits established under the Clean Water Act may differ, not only from LDR and UTS, but also from point-source category to point-source category (e.g., Electroplating, 40 CFR 413; and Metal Finishing, 40 CFR 433). The effluent guidelines limitations and standards are industry-specific, subcategory-specific, and technology-based. The numerical limits are typically based on different data sets that reflect the performance of specific wastewater management and treatment practices. Differences in the limits reflect differences in the following statutory factors that the Administrator is required to consider in developing technically and economically achievable limitations and standards: manufacturing products and processes (which for landfills involves types of waste disposed), raw materials, wastewater characteristics, treatability, facility size, geographic location, age of facility and equipment, non-water quality environmental impacts, and energy requirements. A consequence of these differing approaches is that similar or identical waste streams are regulated at different levels dependent on the receiving body of the wastewater (e.g. a POTW, a surface water, or a land disposal facility).

3.1.1.2 Minimum Technology Requirements

To further protect human health and the environment from the adverse affects of hazardous waste disposed of in landfills, the 1984 HSWA to RCRA established minimum technology requirements for landfills receiving hazardous waste. These provisions required the installation of double liners and leachate collection systems at new landfills, at replacements of existing units, and at lateral expansions of existing units. The Amendments also required all hazardous waste landfills to install ground water monitoring wells by November 8, 1987. Performance regulations governing the operation of hazardous waste landfills are included at 40 CFR Parts 264 and 265.

3.1.2 RCRA Subtitle D

Landfills managing non-hazardous wastes are currently regulated under the RCRA Subtitle D program. These landfills include municipal, private intra-company, private captive, and commercial facilities used for the management of municipal refuse, incinerator ash, sewage sludge, and a range of non-hazardous industrial wastes.

3.1.2.1 40 CFR Part 257, Subpart A - Criteria for Classification of Solid Waste Disposal Facilities and Practices

EPA promulgated the criteria on September 13, 1979 (44 FR 53460) under the authority of RCRA Sections 1008(a) and 4004(a) and Sections 405(d) and (e) of the Clean Water Act. The criteria in §257.1 through 257.4 were adopted for determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health and the environment, and the criteria in §257.5 through 257.30 were adopted to ensure that non-municipal non-hazardous waste disposal units that receive conditionally exempt small quantity generator (CESQG) waste do not present risks to human health and the environment taking into account the practicable capability of such units. These criteria apply to all solid waste disposal facilities and practices. However, certain facilities and practices are not covered by the criteria, such as agricultural wastes returned to the soil as fertilizers or soil conditioners, overburden resulting from mining operations intended for return to the mine site, land application of domestic sewage or treated domestic sewage, the location and operation of septic tanks, hazardous waste disposal facilities which are subject to regulations under RCRA Subtitle C (discussed above), municipal solid waste landfills that are subject to the revised criteria in 40 CFR Part 258 (discussed below), and use or disposal of sewage sludge on the land when the sewage sludge is used or disposed of in accordance with 40 CFR Part 503 (See 40 CFR Part 257.1(c)(1) - (11)).

The criteria include general environmental performance standards addressing the following eight major areas: flood plains, protection of endangered species, protection of surface water, protection of ground water, limitations on the land application of solid waste, periodic application of cover to prevent disease vectors, air quality standards (prohibition against open burning), and safety practices ensuring protection from explosive gases, fires, and bird hazards to airports. Facilities that fail to comply with any of these criteria are considered open dumps, which are prohibited by RCRA Section 4005. Those facilities that meet the criteria are considered sanitary landfills under RCRA Section 4004(a). Landfill wastewater generated at solid waste disposal facilities that are subject to the requirements of 40 CFR Part 257 Subpart A are subject to the effluent limitations for the Non-Hazardous subcategory.

3.1.2.2 40 CFR Part 257, Subpart B - Conditionally Exempt Small Quantity Generator Revised Criteria

A conditionally-exempt small-quantity generator is generally defined as one who generates no more than 100 kilograms of hazardous waste per month in a calendar year (40 CFR 261.5(a)). Such conditionally-exempt small-quantity generators (with certain exceptions) are not subject to RCRA Subtitle C requirements. However, on July 1, 1996, EPA did the following: (1) amended Part 257 to establish criteria that must be met by non-municipal, non-hazardous solid waste disposal units that receive conditionally-exempt small-quantity generator waste and (2) established separate management and disposal standards (in 40 CFR 261.5(f)(3) and (g)(3)) for those who generate conditionally-exempt small-quantity generator waste (see 61 FR 342169). The conditionally-exempt small-quantity generator revised criteria for such disposal units include location standards, ground water monitoring, and corrective action requirements. Landfill wastewater generated at solid waste disposal facilities that are subject to the requirements of 40 CFR Part 257 Subpart B are subject to the effluent limitations for the Non-Hazardous subcategory.

3.1.2.3 40 CFR Part 258 Revised Criteria for Municipal Solid Waste Landfills

On October 9, 1991, EPA promulgated revised criteria for municipal solid waste landfills in accordance with the authority provided in RCRA Sections 1008(a)(3), 4004(a), 4010 (c) and Clean Water Act (CWA) Sections 405(d) and (e) (see 56 FR 50978). Under the terms of these revised criteria, municipal solid waste landfills are defined to mean a discrete area of land or an excavation that receives household waste, and is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined in 40 CFR 257.2 and 258.2. In addition to household waste, a municipal solid waste landfill unit also may receive other types of RCRA Subtitle D wastes, such as commercial solid waste, non-hazardous sludge, and industrial solid waste. Such a landfill may be publicly or privately owned. A municipal solid waste landfill unit may be a new unit, existing municipal solid waste landfill unit, or a lateral expansion.

The municipal solid waste landfill revised criteria include location standards (Subpart B), operating criteria (Subpart C), design criteria (Subpart D), ground water monitoring and corrective action (Subpart E), closure and post-closure care criteria (Subpart F), and financial assurance requirements (Subpart G). The design criteria specify that new municipal solid waste landfill units and lateral expansions of existing units (as defined in Section 258.2) must be constructed in accordance with either (1) a design approved by a Director of a State whose municipal solid waste landfill permit program has been approved by EPA and which satisfies a performance standard to ensure that unacceptable levels of certain chemicals do not migrate beyond a specified distance from the landfill (Sections 258.40(a)(1), (c), (d), Table 1) or (2) a composite liner and a leachate collection system (Sections 258.40(a)(2), (b)). The ground water monitoring criteria generally require owners or operators of municipal solid waste landfills to monitor ground water for contaminants and generally implement a corrective action remedy when monitoring indicates that a ground water protection standard has been exceeded. However, certain small municipal solid waste landfills located in arid or remote locations are exempt from both design and ground water monitoring requirements. The closure standards require that a final cover be installed to minimize infiltration and erosion. The post-closure provisions generally require, among other things, that ground water monitoring continue and that the leachate collection system be maintained and operated for 30 years after the municipal solid waste landfill is closed. The Director of an approved State may increase or decrease the length of the post-closure period.

Again, as is the case with solid waste disposal facilities that fail to meet the requirements in 40 CFR Part 257, Subpart A, municipal solid waste landfills that fail to satisfy the revised criteria in Part 258 constitute open dumps and are therefore prohibited by RCRA Section 4005 (40 CFR 258.1(h)). Landfill wastewater generated at solid waste disposal facilities (i.e., municipal solid waste landfills) that are subject to the requirements in 40 CFR Part 258 are subject to the effluent limitations for the Non-Hazardous subcategory.

3.1.3 Current Wastewater Regulations

Prior to this regulation, EPA had not promulgated national effluent limitations guidelines for the discharge

of wastewater from the Landfills industry. In the absence of these guidelines, permit writers have had to rely on a combination of their own best professional judgement (BPJ), water quality standards, and technology transfer from other industrial guidelines in setting permit limitations for landfills discharging to surface waters. In addition, local control authorities also have had to rely on their own best professional judgement, pass-through analyses, and other local factors in establishing pretreatment standards for the discharge of landfill wastewater to their municipal sewage systems and POTWs.

In 1989, EPA completed a preliminary study of the Landfills industry. In a report entitled "Preliminary Data Summary for the Hazardous Waste Treatment Industry," EPA concluded that wastewater discharges from landfills can be a significant source of toxic pollutants being discharged to surface waters and POTWs. In a consent decree between NRDC and EPA, dated January 31, 1992, EPA agreed, among other things, to propose effluent guidelines for the "Landfills and Industrial Waste Combusters" category by November 1997 and final action by November 1999.

3.2 Industry Profile

The growth of the Landfills industry is a direct result of RCRA and subsequent EPA and State regulations that establish the conditions under which solid waste may be disposed. The implementation of the increased control measures required by RCRA has had a number of ancillary effects on the Landfills industry.

The RCRA requirements have affected the Landfills industry in different ways. On the one hand, it has forced many landfills to close because they lacked adequate on-site controls to protect against migration of hazardous constituents from the landfill, and it was not economical to upgrade the landfill facility. As a result, a large number of landfills, especially facilities serving small populations, have closed rather than incur the significant expense of upgrading.

Conversely, large landfill operations have taken advantage of economies of scale by serving wide geographic areas and accepting an increasing portion of the nation's solid waste. For example, responses

to the EPA's Waste Treatment Industry Survey indicated that 75 percent of the nation's municipal solid waste is deposited in large landfills representing only 25 percent of the landfill population.

EPA has identified several trends in the waste disposal industry that may increase the quantity of leachate produced by landfills. More stringent RCRA regulations and the restrictions on the management of wastes have increased the amount of waste disposed at landfills as well as the number of facilities choosing to send wastes off site to commercial facilities in lieu of pursuing on-site management options. This will increase treated leachate discharges from the nation's landfills, thus, potentially putting at risk the integrity of the nation's waters. Further, as a result of the increased number of leachate collection systems, the volume of leachate requiring treatment and disposal has greatly increased.

3.2.1 Industry Population

In developing the initial landfill population to be studied for this regulation, EPA used various sources such as State environmental and solid waste departments, the National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities respondent list, Environmental Ltd.'s "1991 Directory of Industrial and Hazardous Waste Management Firms", and other sources discussed in Chapter 4. EPA identified 10,477[1] landfill facilities as the initial landfill population in the United States in 1992. Of this group, 9,882 were Subtitle D non-hazardous landfills and 595 were Subtitle C hazardous landfills. Table 3-1 presents the total number of landfill facilities by state in EPA's mailing list database. EPA solicited technical information from a sample of this initial population via screener surveys, and the Agency sent Detailed Technical Questionnaires to a statistical sample of the screener survey respondents. A total of 252 landfill facilities received Detailed Technical Questionnaires and 220 facilities responded with sufficient technical data to be included in the questionnaire database. Chapter 4, Section 4.3 presents a detailed discussion of screener survey and Detailed Questionnaire strata.

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[1] The initial landfill population of 10,477 does not include one pre-test facility which was included as a screener survey respondent.

Because EPA only sent Detailed Technical Questionnaires to a statistical sample of the initial industry population, the Agency scaled up the information provided by questionnaire respondents to represent the entire Landfills industry. By matching up the screener survey stratum with the Detailed Technical Questionnaire stratum, EPA calculated a weighting factor for each questionnaire respondent and scaled up any data provided by the respondent by this factor. Therefore, throughout this chapter, EPA presents national estimates based on the Detailed Technical Questionnaire respondents' data scaled up by their individual weighting factors. The Agency based the national estimates presented in the tables in this chapter on all 220 facilities included in the questionnaire database. Figure 3-1 presents the logic used for the development of the national estimates. EPA presents the methodology for calculating national estimates in the Final Statistical Development Document for the Landfills Industry (EPA-821-B-99-007).

3.2.2 Number and Location of Facilities

Many of the landfill facilities presented in Table 3-1 do not generate and/or collect wastewater that is subject to this regulation. Landfill generated wastewater subject to this regulation includes leachate, gas collection condensate, truck/equipment washwater, drained free liquids, laboratory-derived wastewater, floor washings, and contaminated storm water. Non-contaminated storm water, contaminated ground water, and wastewater from recovering pumping wells are not subject to this regulation.

National estimates of the Landfills industry indicate that only 1,662 of the total population of landfill facilities collect landfill generated wastewater. EPA limited its survey of the industry to those facilities that collect landfill generated wastewater, or about 16 percent of the total number of landfills located in the U.S. Table 3-2 presents the Subtitle D and Subtitle C landfills that collect landfill generated wastewater by ownership type. The national estimates for the industry indicate that approximately 43 percent of these landfills are municipally-owned facilities, 41 percent are commercially-owned, and 13 percent are non-commercial captives. Table 3-2 also shows that the majority of non-hazardous landfills are municipally- or commercially-owned facilities, whereas hazardous landfills are primarily commercially-owned or captive facilities.

3.2.2.1 Captive Landfill Facilities

Based on EPA's survey of the Landfills industry for this guideline, the Agency identified over 200 captive and intra-company facilities that operated landfills. This rule does not apply to captive landfills in most circumstances. See Chapter 2 for EPA's rationale for not including captive landfills under this guideline.

EPA's survey showed that a majority of these landfills were at industrial facilities that are or will be subject to the following three effluent guidelines: Pulp and Paper (40 CFR Part 430), Centralized Waste Treatment (proposed 40 CFR Part 437, 64 FR 2280 January 13, 1999), or Organic Chemicals, Plastics and Synthetic Fibers (40 CFR Part 414). In addition, EPA identified approximately 30 landfills subject to one or more of the following categories: Nonferrous Metals Manufacturing (40 CFR Part 421), Petroleum Refining (40 CFR 419), Timber Products Processing (40 CFR Part 429), Iron and Steel Manufacturing (40 CFR Part 420), Transportation Equipment Cleaning (proposed 40 CFR Part 442, 63 FR 34685 June 25, 1998), and Pesticide Manufacturing (40 CFR Part 455).

Industry supplied data estimates that there are over 118 Pulp and Paper facilities with on-site landfills and that over 90 percent commingle landfill leachate with process wastewater for treatment on site. The wastewater flow originating from landfills typically represents less than one percent of the total flow through the facilities' wastewater treatment plant and, in no case, exceeds three percent of the treated flow. Approximately six percent of pulp and paper mills send landfill generated wastewater to a POTW along with process wastewater.

Based on responses to the "1992 Waste Treatment Industry: Landfills Questionnaire", EPA estimates that there are more than 30 facilities subject to the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) guideline with on-site landfills. At OCPSF facilities with on-site landfills, landfill leachate typically represents less than one percent of the industrial flow at the facility, in no case exceeds six percent of the flow, and is typically commingled with process wastewater for treatment.

3.2.3 General Information on Landfill Facilities

EPA estimates that landfill facilities located throughout the U.S. cover approximately 726,000 acres of land area, 20 percent of which is actual disposal area (landfill), 3 percent is for wastewater treatment operations, and 63 percent is undeveloped land. Table 3-3 presents national estimates of the total landfill area covered by non-hazardous and hazardous landfill facilities. National estimates indicate that, as of 1992, hazardous facilities had, on average, used less of their total facility area for waste disposal, only about 5 percent, than non-hazardous facilities, which, on average, had used approximately 30 percent of their total facility area for waste disposal. However, since there are far more non-hazardous landfills in the U.S. than hazardous landfills, Subtitle D landfills have more future capacity than Subtitle C landfills (see Section 3.2.4). Table 3-4 presents facility land area ranges for non-hazardous and hazardous facilities, as well as totals for the industry. These frequency distributions show that a typical facility is 100 to 1,000 acres in size, and the actual landfill covers between 10 and 100 acres of that area. As of 1992, the majority of non-hazardous and hazardous landfill facilities had from 10 acres to 1,000 acres of undeveloped land available; larger facilities had as much as 1,000 to 10,000 acres of undeveloped land.

Landfills are made up of individual cells which may be dedicated to one type of waste or may accept many different types of waste. When a landfill cell reaches capacity volume, it is closed and is referred to as an "inactive" cell. "Active" cells are landfill cells that are not at capacity and continue to accept waste. Table 3-5 presents national estimates of the number of landfill cells, both active and inactive, at non-hazardous and hazardous landfills. National estimates of landfill facilities in the U.S. indicate that the average number of cells in a landfill in 1992 was approximately six. The national average of active cells in 1992 was 2.75, and the national average of inactive cells was 6.05. For hazardous facilities, the average number of cells in 1992 was 7.6, with an average of 4.2 active cells and 8.2 inactive cells. For non-hazardous facilities, the average number of cells in 1992 was 5.7, with an average of 2.5 active cells and 5.4 inactive cells. EPA's survey indicated that there were fewer active landfills in the U.S. than inactive, or closed landfills. As discussed in Section 3.2, a large number of landfills, especially facilities serving small populations, have closed rather than incur the significant expense of complying with RCRA requirements.

The number and type of customers helps to define the size of a landfill. Table 3-6 presents the national estimates of the household and non-household population served by landfills that collect landfill generated wastewater. The total population served by the Landfills industry is 46.3 million household and 5.2 million non-household customers. Non-hazardous landfills serve 99 percent of these customers. Hazardous landfills account for only 307,000 household customers and 170,000 non-household customers. Table 3-7 presents the frequency distributions of the number of household and non-household customers for the non-hazardous and hazardous subcategories as well as for both subcategories combined. Most non-hazardous facilities serve between 100 and 1,000 non-household customers and 10,000 to 100,000 household customers. EPA's survey indicates that hazardous facilities serve between zero and 10,000 non-household customers, but serve very few household customers.

3.2.4 Waste Receipts and Types

Wastes received by landfills in the United States vary from municipal solid waste to highly toxic materials. Table 3-8 presents the national estimates of the types of waste received at landfills and the percentage each waste represents of the total waste received during the following three periods: pre-1980, 1980-1985, and 1986-1992. Sixty-one percent of the waste landfilled during the pre-1980 time period was municipal solid waste and industrial wastes, while 17 percent was commercial solid waste and construction and demolition debris. Similar types of waste were disposed in landfills after 1980; however, the percentage of municipal solid waste and industrial waste decreased, and the amount of commercial solid waste, incinerator residues, PCB/TSCA wastes, and asbestos-containing wastes increased. The disposal in landfills of "other" waste types (such as contaminated soils, auto shredder scrap, and tires) also increased after 1980.

Table 3-9 presents the national estimates of wastes received by the Landfills industry in 1992 by regulatory classification. These data indicate that landfills contained approximately 6.1 billion tons of waste in 1992, and project a future capacity of 8.3 billion tons. However, the estimated future capacity of Subtitle D landfills is much larger than the future capacity of Subtitle C landfills. On average, Subtitle D landfills represent over 97 percent of the future capacity of U.S. landfills.

Table 3-10 presents the national estimates of the annual tonnage of waste accepted by landfills from 1988 through 1992. In 1988, the annual tonnage of waste accepted by Subtitle C and Subtitle D landfills was 221 million tons and, by 1992, the amount of waste accepted annually increased to 315 million tons. The annual tonnage of waste accepted by the entire landfill industry increased 20 percent from 1989 to 1990 and 14 percent from 1990 to 1991. However, when considering Subtitle C landfills alone, EPA's survey found that hazardous landfills experienced a much larger increase in the amount of waste disposed. In 1990, the amount of waste disposed in Subtitle C landfills increased 30 percent from 1989 and, in 1991, the amount of hazardous waste disposed increased 75 percent from 1990. Over the three year period from 1989 to 1991, the annual tonnage of waste landfilled in Subtitle C landfills increased 127 percent. Conversely, the annual tonnage of waste accepted by Subtitle D landfills increased 18 percent from 1989 to 1990 and then increased by only 4 percent from 1990 to 1991. Over the same three year period, from 1989 to 1991, the annual tonnage of waste landfilled in Subtitle D landfills increased by only 23 percent. The greater increase in annual waste deposited in Subtitle C landfills may be the result of more stringent RCRA regulations and stricter waste acceptance criteria (Subtitle C hazardous waste is restricted from being disposed in Subtitle D landfills).

3.2.5 Sources of Wastewater

As noted earlier, a number of landfill operations generate wastewater. In general, the types of wastewater generated by activities include leachate, landfill gas condensate, truck/equipment washwater, drained free liquids, laboratory-derived wastewater, floor washings, storm water, contaminated ground water, and wastewater from recovering pumping wells. Table 3-11 presents the national estimates of the number of landfills that generate each type of wastewater and the minimum, maximum, and median flows. Each of these wastewater sources are discussed below.

3.2.5.1 Landfill Leachate

Landfill leachate is liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste. Over time, the potential for certain pollutants

to move into the wider environment increases. As water passes through the landfill, it may "leach" pollutants from the disposed waste, moving them deeper into the soil. This presents a potential hazard to public health and the environment through ground water contamination and other means. One measure used to prevent the movement of toxic and hazardous waste constituents from a landfill is a landfill liner operated in conjunction with a leachate collection system. Leachate is typically collected from a liner system placed at the bottom of the landfill. Leachate also may be collected through the use of slurry walls, trenches, or other containment systems. The leachate generated varies from site to site, based on a number of factors including the types of waste accepted, operating practices (including shedding, daily cover and capping), the depth of fill, compaction of wastes, annual precipitation, and landfill age. Based on EPA's survey of the industry, a total of 1,989 landfills generate leachate at flows ranging from one gallon per day to 533,000 gallons per day, with a median daily flow of approximately 5,620 gallons. Landfill leachate is subject to this regulation.

3.2.5.2 Landfill Gas Condensate

Landfill gas condensate is a liquid that has condensed in the landfill gas collection system during the extraction of gas from within the landfill. Gases such as methane and carbon dioxide are generated due to microbial activity within the landfill and must be removed to avoid hazardous, explosive conditions. In the gas collection systems, gases containing high concentrations of water vapor condense in traps staged throughout the gas collection network. The gas condensate contains volatile compounds and accounts for a relatively small percentage of flow from a landfill. The national estimates presented on Table 3-11 report a total of 158 landfills that generate landfill gas condensate at daily flows ranging from 3 gallons to 11,700 gallons. The median flow of landfill gas condensate for the Landfills industry is approximately 343 gallons per day. Landfill gas condensate is subject to the landfills effluent limitations guidelines.

3.2.5.3 Drained Free Liquids

Drained free liquids are aqueous wastes drained from waste containers (e.g., drums, trucks, etc.) or wastewater resulting from waste stabilization prior to landfilling. Landfills that accept containerized waste

may generate this type of wastewater. Wastewater generated from these waste processing activities is collected and usually combined with other landfill generated wastewater for treatment at the wastewater treatment plant. National estimates presented on Table 3-11 identify 33 landfills that generate drained free liquids at a median daily flow of 253 gallons. Daily flows range from a minimum of one gallon per day to a maximum of 82,000 gallons per day. Drained free liquids are subject to the landfills effluent limitations guidelines.

3.2.5.4 Truck and Equipment Washwater

Truck and equipment washwater is generated during either truck or equipment washes at landfills. During routine maintenance or repair operations, trucks and/or equipment used within the landfill (e.g., loaders, compactors, or dump trucks) are washed, and the resultant wastewater is collected for treatment. In addition, it is common practice for many facilities to wash the wheels, body, and undercarriage of trucks used to deliver the waste to the open landfill face upon leaving the landfill. On-site wastewater treatment equipment and storage tanks also are periodically cleaned. It is estimated that 416 landfills generate truck and equipment washwater at a median flow of 118 gallons per day and at daily flows ranging from 5 gallons per day to 15,000 gallons per day.

Floor washings are also generated during routine cleaning and maintenance of landfill facilities. National estimates presented on Table 3-11 indicate there are 70 landfills that generate and collect floor washings at flows ranging from 10 gallons per day to 5,450 gallons per day. The median flow of floor washings for the Landfills industry is approximately 743 gallons per day. Both truck and equipment washwater and floor washings are subject to this rule.

3.2.5.5 Laboratory-Derived Wastewater

Laboratory-derived wastewater is generated from on-site laboratories that characterize incoming waste streams and monitor on-site treatment performance. This source of wastewater is minimal and is usually

combined with leachate and other wastewater prior to treatment at the wastewater treatment plant. Laboratory-derived wastewater is subject to the landfills effluent limitations guidelines.

3.2.5.6 Storm Water

There are two types of storm water, contaminated and non-contaminated. Contaminated storm water is storm water which comes in direct contact with landfill wastes, the waste handling and treatment areas, or wastewater that is subject to the limitations and standards. Some specific areas of a landfill that may produce contaminated storm water include (but are not limited to) the following: the open face of an active landfill with exposed waste (no cover added), the areas around wastewater treatment operations, trucks, equipment or machinery that has been in direct contact with the waste, and waste dumping areas. Non-contaminated (non-contact) storm water is storm water that does not come in direct contact with landfill wastes, the waste handling and treatment areas, or wastewater that is subject to the limitations and standards. Non-contaminated storm water includes storm water which flows off the cap, cover, intermediate cover, daily cover, and/or final cover of the landfill. National estimates indicate that there are 1,135 landfills that generate storm water at flows ranging from 10 gallons per day to 2 million gallons per day, with a median daily flow of approximately 26,800 gallons. Storm water that does not come into contact with the wastes would not be subject to the limitations and standards, as discussed in Chapter 2 of this document.

3.2.5.7 Contaminated Ground Water

Contaminated ground water is water below the land surface in the zone of saturation that has been contaminated by landfill leachate. Contamination of ground water may occur at landfills without liners or at facilities that have released contaminants from a liner system into the surrounding ground water. Ground water also can infiltrate the landfill or the leachate collection system if the water table is high enough to penetrate the landfill area. EPA identified approximately 163 landfills that generate contaminated ground water. Daily flows ranged from 6 gallons per day to 987,000 gallons per day, with a median daily flow of

approximately 12,800 gallons. EPA excluded contaminated ground water from regulation under this guideline as discussed in Chapter 2 of this document.

3.2.5.8 Recovering Pumping Wells

In addition to the contaminated ground water generated during ground water pumping operations, there are various ancillary operations that also generate a wastewater stream. These operations include well construction and development, well maintenance, and well sampling (i.e. purge water). This wastewater will have very similar characteristics to the contaminated ground water. EPA's survey of the Landfills industry identified 50 landfills that generate wastewater from recovering pumping wells. Daily flows range from a minimum of 0.3 gallons to a maximum 80,200 gallons and a median daily flow of 136 gallons. EPA excluded wastewater recovered from pump wells from regulation under this guideline as discussed in Chapter 2 of this document.

3.2.6 Leachate Collection Systems

Most facilities subject to the landfills effluent guidelines generate and collect landfill leachate. To prevent waste material, products of waste decomposition, and free moisture from traveling beyond the limits of the disposal site, landfill facilities utilize some type of leachate collection system. The leachate collection system also reduces the depth of leachate buildup or level of saturation over the liner.

The leachate collection system usually contains several individual components. Two main leachate collection systems may be necessary, an underdrain system and a peripheral system. The underdrain system is constructed prior to landfilling and consists of a drainage system that removes the leachate from the base of the fill. The peripheral system can be installed after landfilling has occurred and, as such, is commonly used as a remedial method. The underdrain system includes a drainage layer of high permeability granular material, drainage tiles to collect the diverted flow laterally, and a low permeability liner underlying the system to retard the leachate that percolates vertically through the unsaturated zone of refuse. Where the leachate meets the low permeability layer, saturated depths of leachate develop and hydraulic gradients govern the leachate flow within the drainage layer (see reference 8).

There are several different types of leachate collection systems employed by the Landfills industry. Table 3-12 presents the different types of leachate collection systems and the national estimates of the number of landfills which employ each system. A simple gravity flow drain field is the most basic and commonly used type of collection system, employed by 50 percent of the industry. According to EPA's 1992 survey, compound leachate collection systems consisting of a liner system and collection pipes are used by 20 percent of the industry. French drains, which are gravel channels used to facilitate leachate drainage, are used by 15 percent of the landfills in the U.S. Other types of leachate collection systems utilized by 10 percent of the Landfills industry include collection sumps and risers, combined gas/leachate extraction wells, perforated toe drains to pump stations, and gravity flow in pipes to a holding pond, basin, or pump station to storage tanks.

3.2.7 Pretreatment Methods

Several types of waste accepted by landfills for disposal may require some type of pretreatment. Wastes that may require pretreatment include free liquids, containerized waste, and bulk wastes. Free liquids may be drained, removed, or stabilized. Containerized waste and bulk wastes may be shredded, stabilized, or solidified. Table 3-13 presents the types of pretreatment methods currently in use by the Landfills industry and national estimates of the number of landfills that pretreat these wastes.

Approximately 75 percent of non-hazardous landfills do not accept free liquids and, of those that do, 20 percent do not pretreat the liquids before treatment at an on-site wastewater treatment facility or treatment off site. In comparison, approximately 65 percent of hazardous landfills accept free liquids and pretreat by stabilizing, draining, or removing the liquid. Forty percent of non-hazardous landfills accept containerized waste, compared to almost 75 percent of hazardous landfills. The most common type of pretreatment for containerized waste is solidification followed by stabilization. Most landfills accept bulk wastes, although many facilities do not pretreat this type of waste. Bulk wastes are usually treated by stabilization or solidification and stabilization. Other types of pretreatment for bulk wastes include compaction, chemical treatment, flocculation, macro/microencapsulation, and recycling.

3.2.8 Baseline Treatment

Many landfills in the United States currently have wastewater treatment systems in place. The most common treatment system used to treat landfill wastewater is biological treatment. However, chemical precipitation and combinations of biological treatment, chemical precipitation, equalization, and filtration also are used widely. Table 3-14 presents the types of treatment and the national estimates of the number of landfills in the industry that employ each type of wastewater treatment. As expected, indirect and zero dischargers often do not employ on-site treatment because they either ship their wastewater off site or use alternate disposal methods such as deep well injection, incineration, evaporation, land application, or recirculation. Chapter 8 presents a detailed discussion of treatment technology and performance.

EPA's survey of the Landfills industry solicited wastewater treatment facility operating information from non-hazardous and hazardous landfills. Table 3-15 presents the national estimates of the number of landfill facilities that operate wastewater treatment systems between 1 and 24 hours per day. Direct and zero or alternative discharge facilities tend to operate treatment systems continuously, whereas many indirect discharge facilities operate less than 24 hours per day. Table 3-16 presents the average daily hours of operation of a typical on-site wastewater treatment facility. Table 3-17 presents the national estimates of the number of landfill facilities that operate wastewater treatment systems between 1 and 7 days per week. Again, direct and zero or alternative discharge facilities commonly operate their treatment systems continuously, whereas indirect dischargers do not. Table 3-18 presents the average number of days per week a typical wastewater treatment facility is in operation.

3.2.9 Discharge Types

EPA's Detailed Technical Questionnaire identified landfills that discharged wastewater directly to a surface water, indirectly to POTWs, and others that disposed of their landfill wastewater through zero or alternative discharge. Direct discharge facilities are those that discharge their wastewater directly to a receiving stream or body of water. Indirect discharging facilities discharge their wastewater indirectly to a POTW. Zero or alternative discharge facilities use treatment and disposal practices that result in no discharge of

wastewater to surface waters. Zero or alternative disposal options for landfill generated wastewater include off-site treatment at another landfill wastewater treatment system or a Centralized Waste Treatment facility, deep well injection, incineration, evaporation, land application, solidification, and recirculation.

Table 3-19 presents the national estimates of the number of landfill facilities grouped by discharge type. These estimates show that the majority of non-hazardous facilities responding to the survey were indirect dischargers, whereas the majority of hazardous facilities were zero dischargers. Although EPA identified hazardous landfills discharging directly to surface waters, none of these facilities are subject to the landfills effluent limitations guidelines.

Table 3-1: Number of Landfills per U.S. State

State	Subtitle D Landfills	Subtitle C Landfills	Total Landfills
Alabama	238	38	276
Alaska	201	1	202
Arizona	90	2	92
Arkansas	134	3	137
California	630	16	646
Colorado	216	12	228
Connecticut	125	22	147
Delaware	8	14	22
Florida	91	9	100
Georgia	277	17	294
Hawaii	15	1	16
Idaho	112	6	118
Illinois	182	14	196
Indiana	101	29	130
Iowa	118	13	131
Kansas	118	8	126
Kentucky	121	33	154
Louisiana	73	17	90
Maine	291	2	293
Maryland	50	5	55
Massachusetts	722	1	723
Michigan	762	9	771
Minnesota	257	4	261
Mississippi	97	3	100
Missouri	128	7	135
Montana	257	1	258
Nebraska	41	8	49
Nevada	127	3	130
New Hampshire	58	0	58
New Jersey	467	8	475
New Mexico	121	7	128
New York	565	10	575
North Carolina	244	39	283
North Dakota	85	1	86
Ohio	119	24	143
Oklahoma	189	7	196
Oregon	231	10	241
Pennsylvania	41	22	63
Rhode Island	12	0	12
South Carolina	127	9	136
South Dakota	193	0	193
Tennessee	112	9	121
Texas	601	70	671
Utah	92	7	99
Vermont	73	0	73
Virginia	440	8	448
Washington	72	9	81
West Virginia	57	5	62
Wisconsin	183	3	186
Wyoming	218	45	263
Puerto Rico	0	3	3
Guam	0	1	1
Total	9,882	595	10,477

Table 3-2: Ownership Status of Landfill Facilities

Ownership Status	Number of Landfill Facilities		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
Commercial	506	171	677
Non-Commercial (intra-company)	5	48	53
Non-Commercial (captive)	121	94	215
Municipal	708	2	710
Federal Government	4	2	6
Government (other than Federal or Municipal)	0	0	0
Indian Tribal Interest	0	0	0
Other	1	0	1
Total	1,345	317	1,662

Table 3-3: Total Landfill Facility Area

Facility Land Type	Landfill Facility Area (acres)		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
Total Facility Area	416,733	309,194	725,927
Wastewater Treatment Area	9,424	10,147	19,571
Waste Disposal Area (landfill)	119,700	16,552	136,323
Undeveloped Land	254,610	207,085	459,811

Table 3-4: Landfill Facility Land Area Ranges

Subcategory	Land Area Range (acres)	Number of Landfill Facilities			
		Total Facility Area	Wastewater Treatment Area	Waste Disposal Area (landfill)	Undeveloped Land
All Facilities	0	0	747	28	110
	>0-1	0	320	16	2
	>1-10	9	437	126	69
	>10-100	490	136	1,128	561
	>100-1,000	1,044	22	362	745
	>1,000-10,000	119	0	0	85
	Total	1,662	1,662	1,660	1,662
Subtitle C Hazardous	0	0	38	5	49
	>0-1	0	128	14	0
	>1-10	2	70	47	2
	>10-100	95	65	199	99
	>100-1,000	136	15	52	106
	>1,000-10,000	84	0	0	60
	Total	317	316	317	316
Subtitle D Non-Hazardous	0	0	708	23	61
	>0-1	0	191	2	2
	>1-10	7	366	79	67
	>10-100	395	72	930	551
	>100-1,000	909	7	310	638
	>1,000-10,000	34	0	0	25
	Total	1,345	1,344	1,344	1,344

Table 3-5: Number of Landfill Cells

Subcategory	Type of Landfill Cell	Number of Cells	
		Estimated Mean	Estimated Total
All Facilities	Total cells	6.12	13,299
	Active cells	2.75	4,608
	Inactive cells	6.05	8,690
Subtitle C Hazardous	Total cells	7.64	3,776
	Active cells	4.23	1,112
	Inactive cells	8.24	2,663
Subtitle D Non-Hazardous	Total cells	5.68	9,523
	Active cells	2.48	3,496
	Inactive cells	5.41	6,027

Table 3-6: Household and Non-Household Population Served

Population Served	Number of Customers		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
Non-Household	5,043,542	170,420	5,213,962
Household	46,007,775	307,243	46,315,018

Table 3-7: Household vs. Non-Household Customers

	Number of Landfill Facilities		
Number of Non-Household Customers	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
0	76	123	205
1	83	40	124
>1-10	33	12	45
>10-100	202	4	203
>100-1,000	544	87	628
>1,000-10,000	351	51	400
>10,000-100,000	55	0	54
>100,000-1,00,000	2	0	2
Total	1,346	317	1,661
Number of Household Customers			
0	180	313	506
1	0	0	0
>1-10	55	0	55
>10-100	29	0	28
>100-1,000	42	0	42
>1,000-10,000	195	2	195
>10,000-100,000	742	0	733
>100,000-1,00,000	102	2	103
Total	1,345	317	1,662

Table 3-8: Wastes Received by Landfills in the United States

Waste Type	Mean % for Time Period Pre-1980	Mean % for Time Period 1980-85	Mean % for Time Period 1986-92
Municipal Solid Waste	38.3	33.4	33.9
Household Hazardous Waste	0.217	0.218	0.215
Yard Waste	4.76	4.39	3.76
Commercial Solid Waste	8.56	9.92	9.94
Institutional Wastes	1.36	1.43	2.14
Industrial Wastes	22.8	19.6	17.4
Agricultural Waste	0.340	0.297	0.284
Pesticides	0.033	0.009	0.321
PCB, TSCA Wastes	0.192	1.12	0.980
Asbestos-Containing Waste	0.905	3.73	3.42
Radioactive Waste	0.019	0.002	0.001
Medical or Pathogenic Waste	0.255	0.182	0.123
Superfund Clean-Up Wastes	0.000	0.021	0.014
Mining Wastes	0.519	0.47	0.180
Incinerator Residues	1.01	1.43	3.14
Fly Ash, Not Incinerator Waste	4.49	5.82	6.30
Construction/Demolition Debris	8.40	5.91	7.95
Sewage Sludge	1.81	3.15	2.88
Dioxin Waste	0.000	0.039	0.024
Other Sludge	4.89	4.90	2.91
Other Waste Types	1.23	4.49	5.25
Industry Total	100.09	100.528	101.132

Table 3-9: Total Volume of Waste Received by Landfills in 1992 by Regulatory Classification

Time Frame	Regulatory Class	All Facilities		Subtitle C Hazardous Subcategory		Subtitle D Non-Hazardous Subcategory	
		Estimated Total Number Landfills	Total Volume Landfilled (tons)	Estimated Total Number Landfills	Total Volume Landfilled (tons)	Estimated Total Number Landfills	Total Volume Landfilled (tons)
Current	Pre 1980	561	954,273,421	190	155,418,921	370	798,854,500
	RCRA Subtitle C	333	159,252,888	323	158,994,443	10	258,445
	RCRA Subtitle D	906	1,501,319,521	115	249,656,514	791	1,251,663,007
	TSCA	108	53,167,884	102	52,654,468	6	513,416
	NRC	.	.	.	.	.	.
	Local Regulation	461	2,365,983,720	57	6,374,393	404	2,359,609,326
	CERCLA	4	10,507,627	2	72,587	2	10,435,040
	Other Regulation	560	1,018,656,724	114	36,250,349	446	982,406,374
	Total Volume Landfilled	2,146	6,063,161,789	491	659,421,679	1,655	5,403,740,110
			Future Capacity (tons)		Future Capacity (tons)		Future Capacity (tons)
Future	Pre 1980	86	101,032,485	.	.	86	101,032,485
	RCRA Subtitle C	201	66,313,422	193	65,192,737	8	1,120,685
	RCRA Subtitle D	884	6,056,763,187	33	96,321,683	851	5,960,441,504
	TSCA	34	11,202,929	28	10,897,045	6	305,884
	NRC	2	300,860	.	.	2	300,860
	Local Regulation	293	962,479,373	57	4,710,196	236	957,769,177
	CERCLA	50	4,297,618	50	4,297,618	.	.
	Other Regulation	501	1,126,823,595	127	30,749,439	374	1,096,074,156
	Total Volume Landfilled	1,706	8,329,213,474	266	212,168,721	1,441	8,117,044,753

Table 3-10: Annual Tonnage of Waste Accepted by Landfills

Year	Annual Tonnage of Waste (tons)		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
1988	185,184,608	36,305,235	221,489,843
1989	196,377,576	28,867,681	225,245,257
1990	232,535,432	37,413,692	269,949,125
1991	241,454,300	65,402,768	306,857,068
1992	252,101,069	63,022,850	315,123,919

Table 3-11: Wastewater Flows Generated by Individual Landfills

Type of Wastewater Generated	Number of Landfills	Minimum Average Flow (gal/day)	Maximum Average Flow (gal/day)	Industry Median (gal/day)
Floor washing	70	10	5,450	743
Landfill leachate	1,989	1	533,000	5,620
Contaminated ground water	163	6	987,000	12,800
Storm water run-off	1,135	10	2,067,000	26,800
Landfill gas condensate	158	3	11,700	343
Recovering pumping wells	50	0.3	80,200	136
Truck/equipment washwater	416	5	15,000	118
Drained free liquids	33	1	82,000	253
Other	2	0	0	0
Total	4,016			

Table 3-12: Type of Leachate Collection Systems Used at Individual Landfills

Type of Leachate Collection	Number of Landfills		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
None	46	87	132
Simple Gravity Flow Drain Field	977	266	1,242
French Drain System	341	38	379
Compound Leachate Collection	416	93	509
Suction Lysimeters	0.	2	2
Other	196	49	246
Total	1,976	535	2,510

Table 3-13: Pretreatment Methods in Use at Individual Landfills

Type of Waste	Pretreatment Method	Number of Landfills		
		Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
Free Liquids	No Pretreatment	324	113	437
	None Accepted	1,277	283	1,560
	Drained or Removed	51	115	166
	Stabilization	38	172	211
	Other	17	84	101
	Total	1,707	767	2,475
Containerized Waste	No Pretreatment	515	100	616
	None Accepted	1,008	180	1,188
	Shredded	23	70	94
	Stabilized	6	135	141
	Solidified	41	138	179
	Other	110	80	190
	Total	1,703	703	2,408
Bulk Wastes	No Pretreatment	993	216	1,209
	None Accepted	414	61	475
	Baled	33	2	35
	Shredded	82	49	131
	Stabilized	15	201	216
	Solidified	74	126	200
	Other	100	38	138
	Total	1,711	693	2,404

Table 3-14: Types of Wastewater Treatment Employed by the Landfills Industry

Type of Treatment	Number of Landfills		
	Direct Discharge	Indirect Discharge	Zero Discharge
No treatment	81	691	468
Biological treatment	119	37	19
Chemical precipitation	63	45	8
Chemical precipitation and biological treatment	32	10	0
Filtration and biological treatment	45	4	5
Equalization and biological treatment	65	28	7
Equalization, biological treatment, and filtration	37	4	5
Equalization, chemical precipitation, and biological treatment	26	8	0
Equalization, chemical precipitation, biological treatment, and filtration	26	2	0

Table 3-15: Wastewater Treatment Facility Hours of Operation per Day

Hours of Operation (hours/day)	Subtitle D Non-Hazardous Subcategory			Subtitle C Hazardous Subcategory			Industry Total		
	Direct	Indirect	Zero	Direct	Indirect	Zero	Direct	Indirect	Zero
0	0	0	0	0	0	0	0	0	0
1-23	11	295	40	11	4	6	23	275	42
24	161	508	330	122	20	153	283	552	488
Total	172	803	370	133	24	159	306	827	530

Table 3-16: Wastewater Treatment Facility Average Hours of Operation per Day

Subcategory	Average Hours of Operation/Day		
	Direct Discharge	Indirect Discharge	Zero Discharge
All Facilities	22.80	19.16	22.55
Subtitle C Hazardous	22.78	22.18	23.46
Subtitle D Non-Hazardous	22.83	18.52	21.89

Table 3-17: Wastewater Treatment Facility Days of Operation per Week

Days of Operation (days/week)	Subtitle D Non-Hazardous Subcategory			Subtitle C Hazardous Subcategory			Industry Total		
	Direct	Indirect	Zero	Direct	Indirect	Zero	Direct	Indirect	Zero
0	0	0	0	0	0	0	0	0	0
1-6	7	225	40	19	2	6	30	203	42
7	165	578	330	115	22	153	275	624	488
Total	172	803	370	134	24	159	305	827	530

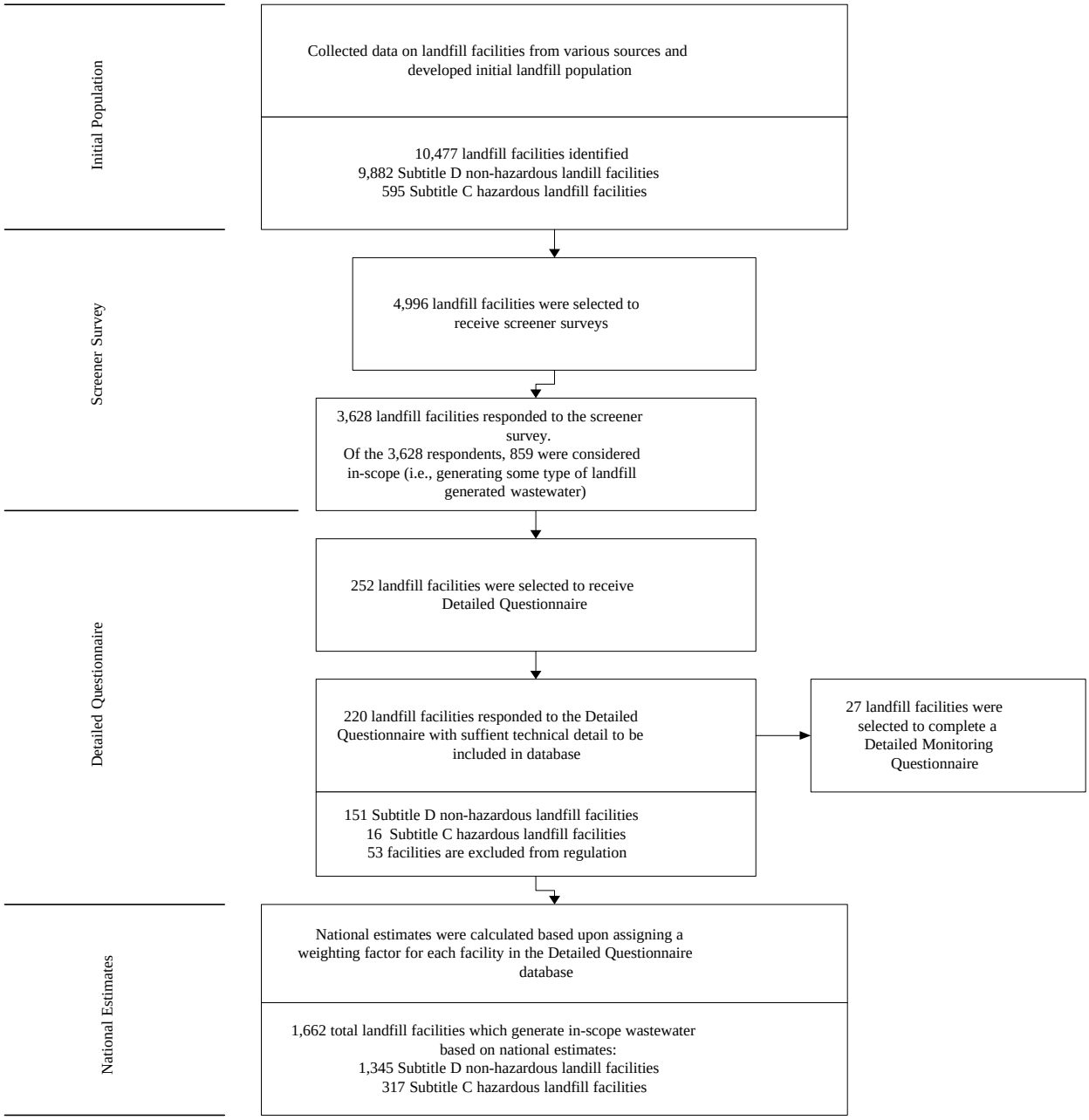
Table 3-18: Wastewater Treatment Facility Average Days of Operation per Week

Subcategory	Average Days of Operation/Week		
	Direct Discharge	Indirect Discharge	Zero Discharge
All Facilities	6.72	6.47	6.81
Subtitle C Hazardous	6.56	6.83	6.77
Subtitle D Non-Hazardous	6.94	6.39	6.84

Table 3-19: Total Number of Facilities by Discharge Type

Subcategory	Discharge Type			Total
	Direct	Indirect	Zero	
All Facilities	306	827	529	1,662
Subtitle C Hazardous	134	24	159	317
Subtitle D Non-Hazardous	172	803	370	1,345

Figure 3-1: Development of National Estimates for the Landfills Industry



4.0 DATA COLLECTION ACTIVITIES

4.1 Introduction

As part of the development of the Landfills effluent guideline, EPA collected data from a variety of different sources. These sources included existing data from previous EPA and other governmental data collection efforts, industry-provided information, new data collected from questionnaire surveys, and field sampling data. This chapter discusses each of these data sources, as well as EPA's quality assurance/quality control (QA/QC) efforts and data editing procedures. Chapters 5 through 11 present summaries and analyses of the data collected by EPA.

4.2 Preliminary Data Summary

EPA's initial effort to develop effluent limitations guidelines and pretreatment standards for the waste treatment industry began in 1986. EPA conducted a study of the hazardous waste treatment industry in which it determined the scope of the industry, the operations performed, the type of wastewater generated, and types of discharges. For this study, EPA looked at a hazardous waste treatment industry that included landfills with leachate collection and treatment facilities, incinerators with wet scrubbers, and aqueous hazardous waste treatment facilities. This study characterized the wastewater generated by facilities in the industry and the wastewater treatment technologies used to treat this wastewater. In addition, the study included industry profiles, the cost of wastewater control and treatment, and environmental assessments. EPA published the results of this study in a report entitled "Preliminary Data Summary for the Hazardous Waste Treatment Industry" (EPA 440/1-89-100), in September, 1989.

The Agency used data from the following sources in developing the preliminary data summary:

- EPA Office of Research and Development databases (includes field sampling data from 13 hazardous waste landfills in 1985).
- State Agencies (includes a Wisconsin sampling program of 20 municipal landfills in 1983).

- EPA Office of Emergency and Remedial Response Contract Laboratory Program (CLP) Statistical Database, “Most Commonly Occurring Analytes in 56 Leachate Samples.” 1980-83 data.

- National Enforcement Investigations Center (NEIC) sampling program conducted for the Hazardous Waste Groundwater Task Force during 1985.

- EPA sampling at 6 landfill facilities (1986-1987).

- Subtitle D leachate data for miscellaneous Subtitle D landfills, compiled by the EPA Office of Solid Waste.

The EPA Preliminary Data Summary identified 911 landfills that generate leachate. Of these, 173 discharged their leachate directly to surface waters, while 355 discharged indirectly through publicly owned treatment works (POTWs). The remaining 383 used other methods of leachate disposal. The most common "other" disposal method was contract hauling to a commercial aqueous waste treatment facility. However, some facilities land-applied their leachate (spraying of the leachate over the landfill) or injected it into a deep well for disposal.

The key findings of the EPA Preliminary Data Summary included:

- Some leachates were found to contain high concentrations (e.g., over 100,000 micrograms per liter (µg/l)) of toxic organic compounds.

- Raw leachates were found to contain high concentrations of BOD_5, COD, and TOC.

- Leachate flow rates varied widely due to climatic and geological conditions and landfill size. An average landfill was estimated to have a leachate generation rate of approximately 30,000 gallons per day (gpd).

- As a result of Resource Conservation and Recovery Act (RCRA) regulations, the number of leachate collection systems used at landfills was expected to increase.

- RCRA regulations also would cause solid waste generators to increase their use of commercial landfill facilities.

EPA found that a wide range of biological and physical/chemical treatment technologies were in use by landfills, capable of removing high percentages of conventional, nonconventional, and toxic pollutants. Advanced treatment technologies identified in this study include air stripping, ammonia stripping, activated carbon, and lime precipitation.

After a thorough analysis of the landfill data presented in the Preliminary Data Summary, EPA identified the need to develop an effluent guidelines regulation for the Landfills industry in order to set national guidelines and standards. EPA based its decision to develop effluent limitations guidelines on the Preliminary Data Summary's assessment of the current and future trends in the Landfills industry, its analysis of the concentrations of pollutants in the raw leachate, and the study's discussion on the treatment and control technologies available for effective pollution reduction in landfill leachate.

4.3 Clean Water Act (CWA) Section 308 Questionnaires

A major source of information and data used in developing effluent limitations guidelines and standards consisted of industry responses to detailed technical and economic questionnaires, and the subsequent detailed monitoring questionnaires, distributed by EPA under the authority of Section 308 of the CWA. These questionnaires requested information on each facility's industrial operations, ownership status, solid wastes disposed, treatment processes employed, and wastewater discharge characteristics. EPA first developed a database of various types of landfills in the United States using information collected from the following: 1) State environmental and solid waste departments, 2) other State agencies and contacts, 3) the National Survey of Hazardous Waste Treatment Storage, Disposal and Recycling Facilities respondent list, 4) Environmental Ltd.'s 1991 Directory of Industrial and Hazardous Waste Management Firms, 5) the Resource Conservation and Recovery Act (RCRA) 1992 list of Municipal Landfills, and 6) the Resource Conservation and Recovery Information System (RCRIS) National Oversight Database. Based upon these sources, EPA identified 10,477 landfill facilities in the U.S. in 1992. Of this group, 9,882 were Subtitle D landfills while 595 were Subtitle C landfills.

EPA entered all of these facilities into a database which served as the initial population for EPA to collect industry-provided data. EPA's data collection process involved the following three stages:

- Screener Surveys
- Detailed Technical Questionnaires
- Detailed Monitoring Questionnaires

The following sections discuss each of these data collection activities. A more detailed discussion of the landfills survey population can be found in Appendix A.

4.3.1 Screener Surveys

EPA developed a screener survey to collect data on all of the landfill sites in the U.S. identified by the sources above.

4.3.1.1 Recipient Selection and Mailing

EPA divided the 10,477 facilities into four strata for the purpose of determining the screener survey recipients. The Agency defined these strata as the following:

1. Subtitle C facilities.
2. Subtitle D facilities that are known wastewater generators.
3. Subtitle D facilities in states with less than 100 landfills and are not known to be wastewater generators.
4. Subtitle D facilities in states with more than 100 landfills and are not known to be wastewater generators.

The Agency decided that all of the facilities in strata 1, 2, and 3 would receive the screener survey, while only a random sample of the facilities in stratum 4 would receive the survey. Table 4-1 presents the sample frame, number of facilities sampled, and the number of respondents to receive the screener survey.

Table 4-1: Screener Questionnaire Strata

Screener Stratum (g)	Number in Frame (N_g)	Number Sampled (n_g)	Number of Responses (n'_g)
1	595	595	524
2	134	134	120
3	892	892	722
4	8,856	3,375	2,621
Total	10,477	4,996	3,987

4.3.1.2 Information Collected

Information collected by the screener surveys included the following:

- mailing address.
- landfill type, including types and amount of solid waste disposed and landfill capacity.
- wastewater generation rates as a result of landfill operations, including leachate, gas condensate, and contaminated ground water.
- regulatory classification and ownership status.
- wastewater discharge status.
- wastewater monitoring practices.
- wastewater treatment technology in use.

4.3.1.3 Data Entry, Coding, and Analysis

EPA operated a toll-free help line to assist the screener recipients with filling out the 3-page survey. The Agency responded to several thousand phone calls from facilities over a six week period. The help line answered questions regarding applicability, EPA policy, and economic and technical details.

EPA reviewed all screener surveys returned to the Agency to verify that each respondent completed the critical questions in the survey (e.g., wastewater generation and collection, number and types of landfills, discharge status, and wastewater treatment technology). The screeners were in a bubble-sheet format and were scanned directly into a computer database. Once entered, EPA checked the database for logical inconsistencies and contacted facilities to resolve any inconsistencies.

After the QA process, EPA divided the facilities in the database into the following two groups: 1) facilities that indicated they collected landfill generated wastewater; and 2) those that did not. EPA considered facilities that did not collect landfill generated wastewater to be out of the scope of this regulation and therefore did not investigate these facilities any further.

4.3.1.4 Mailout Results

Of the 4,996 screener questionnaires mailed by EPA, 3,628 responded, and of those, EPA determined that 3,581 were potentially in-scope and complete . The Agency entered these surveys into the screener database. Of these, EPA identified 859 facilities that generate and collect one or more types of landfill generated wastewater.

4.3.2 Detailed Technical Questionnaires

Once EPA analyzed the information from the screener surveys in the database, EPA developed a detailed technical and economic questionnaire to obtain more information from facilities that collect landfill generated wastewater.

4.3.2.1 Recipient Selection and Mailing

EPA used the 859 facilities that generated and collected landfill wastewater from the screener database, plus one pre-test questionnaire facility that was not in the screener database, as the frame for selection of facilities to be sent a Detailed Questionnaire. EPA divided these facilities into the following eight strata:

1. Commercial private, municipal, or government facilities that have wastewater treatment and are direct or indirect dischargers.
2. Commercial private, municipal, or government facilities that have wastewater treatment and are not direct or indirect dischargers.
3. Non-commercial private facilities with wastewater treatment
4. Facilities with no wastewater treatment
5. Commercial facilities that accept PCB wastes
6. Municipal hazardous waste facilities
7. Small businesses with no wastewater treatment
8. Pre-test facilities that were not in the screener population

The Agency decided all facilities in strata 1, 5, 6, 7, and 8 would receive the Detailed Questionnaire. EPA sent the Detailed Questionnaire to a random sample of the facilities in strata 2, 3, and 4.

These selection criteria resulted in a mailing of the Detailed Questionnaire to 252 facilities. Chapter 3, Section 3.2.1 briefly discusses the population analysis (referred to as national estimates) conducted from these questionnaire recipients.

4.3.2.2 Information Collected

The Detailed Questionnaire solicited technical and costing information regarding landfill operations at the

selected facilities. EPA divided the questionnaire into the following four main sections:

- Section A - Facility Identification and Operational Information:

  1. General facility information, including the following: ownership status, landfill type, the number of landfills on site, regulatory status, discharge status, when the landfill began accepting waste, and projected closure date.

  2. Landfill operation, including the following: types of waste accepted at the landfill, the amount of waste accepted, landfill capacity, how the waste was organized in the landfill, landfill caps, and landfill liners.

  3. Wastewater generation from landfill operations, including the following: the types of wastewater generated and the generation rates, and the ultimate disposal of the wastewater generated and collected.

- Section B - Wastewater Treatment:

  1. Description of treatment methods employed by the facility to treat the wastewater identified in Section A. This description includes a discussion of commingled wastewater, wastewater treatment technologies, residual waste disposal, and treatment plant capacities.

- Section C - Wastewater Monitoring Data:

  1. A summary of the monitoring data pertaining to the landfill generated wastewater identified in Section A that were collected in 1992 by the facility, including the following: minimum, maximum, averages, number of observations, and sampling and analytical methods.

- Section D - Detailed Wastewater Treatment Design Information:

  1. Detailed technical design, operation and costing information pertaining to the wastewater treatment technologies identified in Section B.

4.3.2.3 Data Entry, Coding, and Analysis

EPA operated a toll-free help line to assist the questionnaire recipients with filling out the Detailed Questionnaire. EPA responded to over one thousand phone calls from facilities over a three-month period.

While some calls pertained to questions of applicability, most were of a technical nature regarding specific questions in the questionnaire.

Once EPA received the completed questionnaires, the Agency thoroughly reviewed each one for technical accuracy and content. After review, the questionnaire was coded for double-key entry into the questionnaire database. EPA resolved all discrepancies between the two inputted values by referring to the original questionnaire.

EPA followed several QA/QC procedures when developing the questionnaire database, including a manual completeness and accuracy check of a random selection of 20 percent of the questionnaires and a database logic check of each completed questionnaire. These QA/QC procedures helped verify the questionnaires for completeness, resolve any internal consistencies, and identify outliers in the data. EPA checked all outliers for accuracy.

4.3.2.4 Mailout Results

Of the 252 recipients, 220 responded with sufficient technical and economic data to be included in the final EPA Detailed Questionnaire database.

4.4 Detailed Monitoring Questionnaire

In addition to the Detailed Questionnaire, EPA also requested detailed wastewater monitoring information from 27 facilities included in the Detailed Questionnaire database via a Detailed Monitoring Questionnaire.

4.4.1 Recipient Selection and Mailing

EPA selected facilities to receive Detailed Monitoring Questionnaires based upon their responses to the Detailed Questionnaire. EPA reviewed each facility's monitoring summary, discharge permit requirements, and their on-site treatment technologies. From these responses, EPA selected 27 facilities to receive a

Detailed Monitoring Questionnaire which could provide useful information on technology performance, pollutant removals, and wastewater characterization.

4.4.2 Information Collected

EPA requested recipients of the Detailed Monitoring Questionnaire to send analytical data (1992, 1993, and 1994 annual data) on daily equalized influent to their wastewater treatment system, as well as effluent data from the treatment system. The three years of analytical data assisted EPA in calculating the variability factors (discussed in Chapter 11) used in calculating the industry effluent limits. EPA also requested analytical data for intermediate waste treatment points for some facilities. In this manner, EPA was able to obtain performance information across individual treatment units in addition to the entire treatment train.

4.4.3 Data Entry, Coding, and Analysis

EPA conducted a thorough review of each Detailed Monitoring Questionnaire response to ensure that the data provided was representative of the facility's treatment system. EPA collected data from 24 semi-continuous and continuous treatment systems and 2 batch treatment systems. The Agency developed a Detailed Monitoring Questionnaire database which included all monitoring data submitted by the selected facilities.

4.5 Engineering Site Visits

EPA visited 19 facilities, including one facility outside the U.S. The purpose of these visits was to evaluate each facility as a potential week-long sampling candidate to collect treatment performance data. EPA selected these facilities based on the responses to the Detailed Questionnaire and attempted to include facilities from a broad cross section of the industry. EPA visited landfills of various ownership status (municipal, commercial, captive), landfills that accept various waste types (construction and demolition, ash, sludge, industrial, municipal, hazardous), and landfills in different geographic regions of the country. Facilities selected for engineering site visits employed various types of treatment processes, including the

following: equalization, chemical and biological treatment, filtration, air stripping, steam stripping, and membrane separation.

EPA visited each landfill for one day. During the engineering site visit, EPA obtained information on the following:

- the facility and its operations.
- the wastes accepted for treatment and the facility's acceptance criteria.
- the raw wastewater generated and its sources.
- the wastewater treatment on site.
- the location of potential sampling points.
- the site-specific sampling needs (access to facility and sample points, and required sampling safety equipment).

Table 4-2 presents a summary of the types of landfill facilities that EPA included in the engineering site visits.

4.6 Wastewater Characterization Site Visits

While conducting engineering site visits, EPA also collected samples for raw wastewater characterization at 15 landfills. EPA collected grab samples of untreated wastewater at various types of landfills and analyzed for constituents in the wastewater including conventionals, metals, organics, pesticides and herbicides, PCBs, and dioxins and furans. Chapter 6 presents the characterization data obtained by EPA.

Table 4-2 also presents a summary of the type of landfill facilities that EPA included in the characterization site visits and the number of wastewater characterization samples collected.

4.7 EPA Week-Long Sampling Program

To collect wastewater treatment performance data, EPA conducted week-long sampling efforts at six landfills. EPA selected these facilities based on the analysis of the information collected during the engineering site visits. Table 4-3 presents a summary of the types of landfills sampled and treatment technologies evaluated.

EPA prepared a detailed sampling plan for each sampling episode. The Agency collected wastewater samples at influent, intermediate, and effluent sample points throughout the entire on-site wastewater treatment system. Sampling at five of the facilities consisted of 24-hour composite samples for five consecutive days. For the sixth facility, EPA took composites of four completed batches over five days. At all facilities, the Agency collected individual grab samples for oil and grease. Volatile organic grab samples were composited in the laboratory prior to analysis.

EPA analyzed samples using EPA Office of Water approved analytical methods. The following table presents the pollutant group and the analytical method used:

Pollutant Group	Analytical Method
Conventional and Nonconventionals	Standard Methods
Metals	EPA 1620
Organics	EPA 1624, 1625
Herbicides, Pesticides, PCBs	EPA 1656, 1657,1658
Dioxins/Furans	EPA 1613

EPA used influent data to characterize raw wastewater for the industry and develop the list of pollutants of interest (see Chapter 6 for raw wastewater characterization and Chapter 7 for pollutant of interest selection). The Agency used influent, intermediate, and effluent data to evaluate performance of the wastewater treatment systems and develop current discharge concentrations, pollutant loadings, and the

best available treatment (BAT) options for the Landfills industry. EPA used effluent data to calculate long-term averages for each of the regulatory options.

Table 4-4 presents the facilities included in the engineering site visits, the raw wastewater characterization sampling effort, and the week-long sampling effort. Note that facilities utilized only for the engineering site visits do not have sampling episode numbers.

4.8 Other Data Sources

In addition to the original data collected by EPA, the Agency used other data sources to supplement the industry database. Each of these data sources is discussed below.

4.8.1 Industry Supplied Data

EPA requested the Landfills industry to provide relevant information and data. The Agency received leachate and ground water characterization and treatability studies from several facilities, including 25 discharge monitoring report (DMR) data packages. EPA used industry-supplied data to characterize the industry, develop pollutant loadings, and develop effluent limitations.

4.8.2 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA) Ground Water Data

EPA obtained ground water data from the "CERCLA Site Discharges To POTWs Treatability Manual" (EPA 540/2-90-007), prepared by the Industrial Technology Division of the EPA Office of Water Standards and Regulations for the EPA Office of Emergency and Remedial Response. The Agency used data from this study to supplement the ground water data collected during characterization and week-long sampling events. The purpose of the CERCLA study was to do the following:

- Identify the variety of compounds and concentration ranges present in ground water at CERCLA sites.

- Collect data on the treatability of compounds achieved by various on-site pretreatment systems.

- Evaluate the impact of CERCLA discharges to a receiving POTW.

For the CERCLA study, a total of eighteen CERCLA facilities were sampled. However, EPA only used data from facilities that received ground water contaminated as a result of landfilling activities in its analysis of contaminated ground water at landfill facilities. Based in part on this data and for the reasons discussed in Chapter 2, EPA decided not to include contaminated ground water as a regulated wastewater under this guideline. In addition, for the proposal, EPA combined the data from seven CERCLA facilities with EPA sampling data to help characterize the hazardous subcategory and to develop both the current discharge concentrations and pollutant loadings for facilities in the hazardous subcategory. However, since EPA did not include contaminated ground water as a wastewater subject to this guideline, for the final rule, EPA removed all CERCLA data from the Subtitle C raw wastewater characterization database. The data presented in subsequent chapters for hazardous wastewater characterization do not include CERCLA data.

4.8.3 POTW Study

The primary source of POTW percent removal data was the "Fate of Priority Pollutants in Publicly Owned Treatment Works" (EPA 440/1-82-303), commonly referred to as the "50-POTW Study." The 50-POTW Study presents data on 50 well-operated POTWs with secondary treatment in removing toxic pollutants. At most of these plants, a minimum of 6 days of 24-hour sampling of influent, effluent, and sludge streams was completed. Each sample was analyzed for conventional, selected non-conventional, and priority pollutants. The basic objective of the study was to generate, compile, and report data on the occurrence and fate of the 129 priority toxic pollutants in 50 POTWs. Preliminary evaluations of the data were also conducted. The report presents all of the collected data, results of the preliminary evaluations, and results of the calculations to determine the following: 1) the concentrations of priority pollutants in the

influent to POTWs, 2) the concentrations of priority pollutants discharged from the POTWs, 3) the concentrations of priority pollutants in the effluent from intermediate process streams, and 4) the concentrations of priority pollutants in the POTW sludge streams.

Some of the data collected for evaluating POTW removals in the 50-POTW Study included influent levels of pollutants that were close to the detection limit. EPA eliminated these values to reduce the possibility that low POTW removals might simply reflect low influent concentrations instead of being a true measure of treatment effectiveness. For further discussion on the editing rules EPA applied to the 50-POTW Study for use in the assessment of POTW removal, see Chapter 7, Section 7.7.1.

4.8.4 National Risk Management Research Laboratory Data

EPA's National Risk Management Research Laboratory (NRMRL) developed a treatability database (formerly called the Risk Reduction Engineering Laboratory (RREL) database). This computerized database provides information, by pollutant, on removals obtained by various treatment technologies. The database provides the user with the specific data source and the industry from which the wastewater was generated. EPA used the NRMRL database to augment the POTW database for certain pollutants which the 50-POTW Study did not evaluate. EPA edited the NRMRL data so that only treatment technologies representative of typical POTW secondary treatment operations were used. Additional edits applied by EPA are discussed in detail in Chapter 7, Section 7.7.1.

4.9 QA/QC and Other Data Editing Procedures

This section presents the quality assurance/quality control (QA/QC) procedures and editing rules used to analyze the different analytical data sets described in the previous sections (e.g., industry supplied data, Detailed Questionnaire data, Detailed Monitoring Questionnaire data, EPA field sampling, and analytical data collected by other EPA offices). For a complete discussion of all of the conventions used in calculating effluent limitations see the “Statistical Support Document for Final Effluent Limitations Guidelines and Standards for the Landfills Point Source Category” (EPA-821-B-99-007).

4.9.1 QA/QC Procedures

Each analytical data source received a QA/QC review before being included in the EPA analytical, Detailed Questionnaire, and Detailed Monitoring Questionnaire databases. The specific QA/QC activities completed for each analytical data source are discussed below.

4.9.2 Analytical Database Review

EPA's Sample Control Center (SCC) developed and maintained the analytical database, and provided a number of QA/QC functions. SCC documented the results of the QA/QC procedures in data review narratives. EPA then performed completeness checks to ensure the completeness of the analytical database. Both of these QA/QC activities are discussed below. In addition, the following paragraphs outline the editing procedures and data conventions used to finalize the landfill analytical database, to characterize each industry subcategory, and to develop current discharge information and pollutant loadings.

4.9.2.1 Data Review Narratives

The Sample Control Center performed a QA/QC data review and documented its findings in the data review narrative that accompanied each laboratory data package. The data review narrative identified missing data and any other data discrepancies encountered during the QA/QC review. EPA then checked the narratives against the data and sampling episode traffic reports to make sure SCC did not overlook any data discrepancies.

4.9.2.2 Completeness Checks

EPA performed a data completeness check of the analytical database by cross referencing the list of pollutants requested for analysis with the list of pollutants the laboratory actually analyzed at each sample point. To accomplish this, EPA prepared the following:

- a list of all requested analytical methods and method numbers.
- a list of all pollutants and CAS numbers specified under each requested analytical method.
- a schedule of analyses requested by episode for each sample point.

The purpose of the completeness check was to verify that the laboratory performed all of the analyses requested and that SCC posted the results to the database in a consistent manner. The completeness check resulted in identifying the following:

- any pollutant that was scheduled to be analyzed but was not analyzed.
- pollutants that were analyzed but were not scheduled to be analyzed.
- any pollutant for which the expected number of samples analyzed did not agree with the actual number of samples analyzed.

SCC evaluated and resolved discrepancies by subsequent QA/QC reviews. SCC documented all changes to data in the landfill analytical database in a status report entitled "Status of the Waste Treatment Industry: Landfills Database".

4.9.2.3 Trip Blanks and Equipment Blanks

SCC addressed qualifiers assigned to data as a result of trip blank and equipment blank contamination in the same way that it addressed contamination of lab method blanks, detailed below:

- Sample Results Less than Five Times Blank Results: When the sample result was less than five times the blank result, there were no means by which to ascertain whether the presence of the analyte could have attributed to blank contamination. Therefore, the result was included in the database as non-detect, with a nominal detection limit equal to the dilution-adjusted instrument detection limit.
- Sample Results Greater than Five Times but Less than Ten Times Blank Results: These data were of acceptable quality and were used to represent maximum values.

- Sample Results Greater than Ten Times Blank Results or Analyte not Detected in Sample: The presence of the analyte in the blank did not adversely affect the data in those cases where the sample results were greater than ten times the associated blank results or when the analyte was not detected in associated samples. Such data were acceptable without qualification.

4.9.2.4 Field Duplicates

EPA collected field duplicates during the EPA sampling episodes to help determine the accuracy and consistency of the sampling techniques employed in the field. In the analytical database, EPA represented field duplicate results by the letter "D" preceding the sample point number. The Agency combined duplicate samples that it considered acceptable on a daily basis using the following rules:

- If all duplicates were non-detect values, then the aggregate sample was labeled non-detect (ND), and the value of the aggregate sample was the maximum of the ND values.
- If the maximum detected value was greater than the maximum ND value, then the aggregate sample was labeled NC, and the value of the aggregate sample was the sum of the non-censored (NC) and ND values divided by the total number of duplicates for that independent sample.
- If the maximum NC value was less than or equal to the maximum ND value, then the aggregate sample was labeled ND and the value of the aggregate sample was the maximum of the ND values.
- If all duplicates were NC values, then the aggregate sample was labeled NC and the value of the aggregate sample was the average of the NC values.

In the laboratory, SCC calculated analytical precision by determining the relative percent difference of paired spiked samples. EPA considered data acceptable if the relative percent difference was within the laboratory criteria for analytical precision.

EPA considered duplicate relative percent difference values as acceptable if they were within the laboratory criteria for analytical precision plus or minus 10 percent.

4.9.2.5 Grab Samples

Most data presented in the analytical database represent composite sample results, but other types of results exist due to sampling requirements. Most grab sample results were represented by the letters "A", "B", or "C" following the sample point number in the analytical database for grabs collected on the same day. EPA collected grab samples of this nature only for oil and grease/hexane extractable material and EPA included these samples when calculating average concentrations of pollutants. The Agency averaged grab samples of any kind on a daily basis before using them in data analyses.

4.9.2.6 Non-Detect Data

EPA assigned non-detect data numeric values so that they could be used in the data analyses. In general, non-detect data can be set either at the method detection limit, at the instrument detection limit, at half of the method detection limit, or zero. Detection limits can be standardized (as in the method detection limit) or variable (as in the instrument detection limit or the sample detection limit, which may vary depending on dilution). The instrument detection limit is the lowest possible detection limit: the instrument cannot detect the contaminant below this level. In many cases, the method detection limit is significantly higher than the instrument detection limit.

For the Landfills effluent guideline, EPA defined all non-detect data collected from the EPA sampling episodes as follows: 1) the value used for non-detect data was represented by the detection limit reported in the analytical database, and 2) if the detection limit of the non-detect data was greater than the detected results, the average was calculated using all of the data, but the results were flagged for review on an individual basis. When flagged results were reviewed as a whole, the high detection limits were found to be on the same order of magnitude as the detect values; therefore, all flagged data were included in calculating averages.

4.9.2.7 Bi-Phasic Samples

In one sampling episode for a captive hazardous landfill at an industrial facility, some samples collected became bi-phasic. That is, EPA collected aqueous samples, but from the time that EPA collected the sample to the time EPA analyzed it, the sample formed a solid, organic phase. Therefore, the analyzed sample consisted of an aqueous portion and an organic portion. For these samples, EPA reported analytical results for each phase separately. The Agency calculated consolidated results for the bi-phasic samples by factoring the percent of each phase relative to the total sample volume with the results of each phase and adding the weighted results together. Pollutants were not always detected in both the aqueous and organic phases of a bi-phasic sample. In instances where EPA detected a pollutant in one phase and not in the other phase, the detection limit was set at zero, which removed the non-detect phase from the equation. When both phases were non-detect, EPA used the lowest of the two detection limits as the result.

4.9.2.8 Conversion of Weight/Weight Data

In some cases, EPA analyzed wastewater samples collected in the field as solids due to criteria specified in the analytical method. The Agency reported these results in the database in solids units of ug/kg or ng/kg. EPA converted these results to ug/L and ng/L, respectively, so that they could be used in data analysis.

The landfill analytical database contained a file called "solids" that contained percent solids values for those samples associated with a result that were reported on a weight/weight basis. This percent solids value was necessary to convert results from a weight/weight basis to a weight/volume basis.

The following formula was utilized to convert the "amount" from a weight/weight basis to a weight/volume basis. This formula assumed a density of 1:

$$\text{Amount (weight/weight)} \times [\text{Percent Solids}/100] = \text{Amount (weight/volume)}$$

where,

Amount = The result contained in the “amount” field in the “result” file.

Percent Solids = The percent solids result contained in the “percent” field in the “solids” file.

After conversion, the amount was expressed in weight/volume units as shown below:

Weight/Weight Units	Weight/Volume Units
pg/kg	pg/L
ng/kg	ng/L
ug/kg	ug/L
ug/g	ug/mL
mg/kg	mg/L

4.9.2.9 Average Concentration Data

EPA employed all data conventions discussed above when calculating the average concentration of a group of data. The Agency calculated average concentrations to develop raw waste loads, current discharge concentrations, and percent removal values. To calculate the average concentration of a pollutant at a particular sample point, the following hierarchy was used: 1) all non-detect data was set at the detection limit listed in the database, 2) all weight/weight units were converted to weight/volume units using the percent solids file, 3) all units were then converted to ug/L, 4) the bi-phasic sample results were combined into one consolidated result, 5) both duplicate pairs and grab samples were combined using the rules discussed above, and 6) the long-term average was calculated by adding all results and dividing by the number of results.

4.9.3 Detailed Questionnaire Database Review

EPA reviewed each Detailed Questionnaire for the following: 1) completeness, 2) internal consistency, and 3) outliers. Outliers refer to data values that are well outside those expected for this industry. For example,

EPA considered flow rates above 10 million gallons per day to be outliers. In cases such as this, the QA/QC reviewer would verify the accuracy and correctness of the data.

All information that EPA entered into a computer database was given a 100 percent QA/QC check to ensure that all data were inputted properly. This was accomplished by double key entry, and any discrepancies between the two inputted values compared with the original submission were corrected by the QA/QC reviewer.

Section 4.3.2 discusses additional handling procedures for Detailed Questionnaires.

4.9.4 Detailed Monitoring Questionnaire Data Review

EPA evaluated Detailed Monitoring Questionnaire data using the same procedures outlined for the Detailed Questionnaire process. The QA/QC steps included reviews for the following: 1) completeness, 2) internal consistency, and 3) outliers.

Section 4.4 discusses additional handling procedures for Detailed Monitoring Questionnaires.

Table 4-2: Types of Facilities Included in EPA's Characterization and Engineering Site Visits

Ownership Type	Characterization Site Visits	Engineering Site Visits*
Municipal	4	9
Commercial	9	8
Non-Commercial (captive, intra-company)	2	1
Waste Type	Characterization Samples Collected	
Subtitle D	13	15
Subtitle C	5	3
Landfill Type	Characterization Samples Collected	
Subtitle D Non-Hazardous	10	15
(Municipal)	(2)	(14)
(Non-Municipal)	(8)	(1)
Subtitle C Hazardous	5	3
Ground Water	3	0

*One engineering site visit was conducted outside the U.S.

Table 4-3: Types of Facilities Included in EPA's Field Sampling Program

Episode	Ownership Type			Waste Type		Landfill Subcategory		Treatment Technology
	Municipal	Commercial	Non-Commercial	Subtitle D	Subtitle C	Non-Hazardous	Hazardous	
4626	X			X		X		Equalization, chemical precipitation, biological treatment, filtration
4667	X			X		X		Equalization/stripper, chemical precipitation, biological treatment, GAC, filtration
4687	X			X		X		Equalization, filtration, reverse osmosis
4690			X		X		X	Air stripping Steam stripping
4721		X			X		X	Equalization, biological treatment
4759		X			X		X	Equalization, chemical precipitation, biological treatment

Table 4-4: Episode Numbers for the Engineering Site Visits and Field Sampling Efforts

Episode Number	Sampling/ Site Visits
4491	E, C
4503	C
4626	E, W
4630	C
4631	C
4638	C
4639	C
4644	C
4667	E, W
4683	C
4687	E, W
4738	C
4690	E, W, C
4721	E, W, C
4684	C
4685	C
4759/4682	E, W, C
4659	C
-	E
-	E
-	E
-	E
-	E
-	E
-	E
-	E
-	E
-	E
-	E
-	E

C = Raw Wastewater Characterization Sampling Episode (1-day sampling episode)
E = Engineering Site Visit
W = Five-day Sampling Episode

5.0 INDUSTRY SUBCATEGORIZATION

In developing technology-based regulations for the Landfills industry, EPA considered whether a single set of effluent limitations and standards should be established for the industry, or whether different limitations and standards were appropriate for subcategories within the industry. The Clean Water Act (CWA) requires EPA, in developing effluent limitations, to assess several factors, including manufacturing processes, products, the size and age of a site, wastewater use, and wastewater characteristics. The Landfills industry, however, is not typical of the industries regulated under the CWA. Therefore, EPA looked at additional factors that are specifically tailored to the characteristics of landfill operations in deciding appropriate limitations for landfill facilities. The factors considered for the subcategorization of the Landfills industry are listed below:

- Resource Conservation and Recovery Act (RCRA) Regulatory classification
- Types of wastes received
- Wastewater characteristics
- Facility size
- Ownership
- Geographic location
- Facility age
- Economic impacts
- Treatment technologies and costs
- Energy requirements
- Non-water quality impacts

5.1 Subcategorization Approach

Based on an evaluation of the above factors, EPA determined that there was a notable distinction between wastewater associated with Subtitle C landfills and those from Subtitle D landfills. A wider range of toxic

organic pollutants and higher concentration of metals was found at the Subtitle C landfills. Thus, the most significant differences observed in wastewater characteristics at landfills are directly correlated to the wastes received at the landfill which, in turn, are most obviously linked to the landfill's RCRA status. Therefore, EPA concluded that the most appropriate basis for subcategorization is by landfill classification under RCRA.

Additionally, the Agency believes that this subcategorization approach has the virtue of being easiest to implement because it follows the same classification previously established under RCRA and is currently in use (and widely understood) by permit writers and regulated entities. The Agency believes that any subcategorization at odds with existing RCRA classification approaches will potentially create unnecessary confusion to the regulated community. The subcategories are described below.

5.2 Landfills Subcategories

EPA is subcategorizing the Landfills industry into two subcategories as follows:

RCRA Subtitle C Hazardous Waste Landfill Subcategory

Subpart A of 40 CFR Part 445, "RCRA Subtitle C Hazardous Waste Landfill Subcategory," applies to wastewater discharges from a solid waste disposal facility subject to the criteria in 40 CFR Part 264 Subpart N - "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" and 40 CFR Part 265 Subpart N -"Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." Hazardous waste landfills are subject to requirements outlined in 40 CFR Parts 264 and 265 that include the requirement to maintain a leachate collection and removal systems during the active life and post-closure period of the landfill. For a discussion of these criteria, see Chapter 3, Section 3.1: "Regulatory History of the Landfills Industry", or see the Preamble to the proposed landfill guideline at 63 FR 6426, 6430-31. (February 6, 1998).

RCRA Subtitle D Non-Hazardous Waste Landfill Subcategory

Subpart B of 40 CFR Part 445, "RCRA Subtitle D Non-Hazardous Waste Landfill Subcategory," applies to wastewater discharges from all landfills classified as RCRA Subtitle D non-hazardous landfills subject to either of the criteria established in 40 CFR Parts 257 (Criteria for Classification of Solid Waste Disposal Facilities and Practices) or 258 (Criteria for Municipal Solid Waste Landfills). For a discussion of these criteria, see Chapter 3, Section 3.1: "Regulatory History of the Landfills Industry", or see the Preamble to the proposed landfill guideline at 63 FR 6426, 6431-32 (February 6, 1998).

Table 5-1 presents the subcategorization of all of the landfill facilities in the EPA database by questionnaire identification number. All landfill facilities included in this table completed a Detailed Questionnaire and collect wastewater; however, not all of the facilities included in this table are within the scope of the rule. Landfill facilities not covered by this rule include captive landfills, landfills that generate no in-scope wastewater, and zero or alternative discharge facilities. Chapter 2 discusses further the applicability of the rule.

5.3 Other Factors Considered for Basis of Subcategorization

EPA also evaluated the appropriateness and significance of developing subcategories based on the other factors presented earlier in this chapter. The following subsections present EPA's evaluation of each of these factors.

5.3.1 Types of Wastes Received

The type of solid waste that is deposited in a landfill often has a direct correlation to the characteristics of the leachate produced by that landfill. Wastes deposited in landfills range from municipal solid waste and non-hazardous materials to hazardous wastes containing contaminants such as pesticides. An analysis of the data collected as part of this study showed that there are differences in the wastewater generated by facilities that dispose of hazardous wastes as compared to non-hazardous wastes. These differences are reflected in both the number and types of pollutants of interest (as defined in Chapter 7) identified in each

subcategory and in the concentrations of these pollutants found in the wastewater generated. Tables presented in Chapters 6 (Tables 6-9 through 6-15) and 7 (Tables 7-1 and 7-2) of this document show these differences.

Specifically, the pollutants of interest list for the Non-Hazardous subcategory contains a total of 32 pollutants, whereas the pollutants of interest list for the Hazardous subcategory contains 63 pollutants (see Chapter 7 for discussion on pollutants of interest). In addition, there are more than twice as many pollutant-of-interest metals present in the hazardous landfill leachate (12) as in non-hazardous landfill leachate (5), and there are twice as many organic pollutants of interest present at hazardous landfills (28) than at non-hazardous landfills (14). Pollutants analyzed during EPA sampling episodes were detected approximately 47 percent of the time at hazardous facilities versus approximately 31 percent of the time at non-hazardous facilities. Tables 6-9 through 6-13 in Chapter 6 present the median, minimum, and maximum concentrations of the pollutants of interest for both subcategories and, although there are cases where the concentrations found at non-hazardous landfills are greater than the concentrations found at hazardous landfills, EPA detected higher concentrations of most pollutants of interest at hazardous landfills. In the proposed rule, EPA included data from numerous CERCLA facilities in the calculation of hazardous landfill raw wastewater pollutant characteristics. However, since these discharges consisted primarily of ground water and because the final rule does not cover ground water, EPA decided not to use the CERCLA data to characterize hazardous landfills. Table 5-2 presents the median concentrations of pollutants of interest common to both subcategories for hazardous and non-hazardous landfills.

In conclusion, EPA has determined that the most practical method of distinguishing the type of waste deposited in a landfill is achieved by utilizing the RCRA classification of landfills. As discussed in Section 5.1, the RCRA classification selected as the basis for subcategorization is based on the type of waste received by the landfill, hazardous or non-hazardous. Therefore, the type of waste disposed at a landfill is a factor that is taken into consideration because it is directly encompassed by the RCRA classification scheme -- the selected subcategorization method.

In addition to subcategorizing the Landfills industry based on RCRA classification, EPA also considered further subcategorizing the Subtitle D Non-Hazardous subcategory to account for differences between non-hazardous landfills and non-hazardous monofills. Subtitle D monofills, a class of non-hazardous landfills, accept only one type of waste that include, but are not limited to, construction and demolition debris, ash, and sludge. EPA decided not to further subcategorize Subtitle D landfill facilities. This decision is based on the following two considerations: (1) similarities in waste acceptance and leachate characteristics between monofills and other Subtitle D Non-Hazardous landfills; and (2) ease of implementation. First, EPA compared the number and type of pollutants present in Subtitle D municipal and non-municipal leachate. As shown in Table 6-9 in Chapter 6, there are nine pollutants of interest for Subtitle D non-municipal solid waste landfills whereas there are 32 pollutants of interest for Subtitle D municipal solid waste landfills. Although there were fewer pollutants of interest detected at non-municipal solid waste landfills, there were no pollutants of interest at non-municipal solid waste landfills that were not also present at municipal solid waste landfills. This is not unexpected, as the waste deposited in municipal solid waste landfills and dedicated monofills is not mutually exclusive. Although cells at a dedicated landfill may prohibit disposal of municipal refuse, a municipal solid waste landfill may also accept ash, sludge, and construction and demolition wastes. EPA also compared the median raw wastewater concentration data from Subtitle D municipal solid waste and non-municipal solid waste landfills in the EPA database in Table 6-9 and determined that the concentrations present at non-municipal solid waste landfills were equivalent to or less than the concentrations present at municipal solid waste landfills. EPA acknowledges that certain types of Subtitle D non-municipal solid waste landfills have a low organic content in their wastewater, and as a result some monofills, such as ash monofills, may not be able to operate biological treatment systems such as those selected for BPT/BAT for the Non-Hazardous subcategory. For those monofills that do not accept organic wastes, EPA found that many of the facilities could meet the subcategory limitations without treatment and, for those that could not, alternative technologies were available at costs no greater than those technologies EPA evaluated (and determined) to be economically achievable for the subcategory as a whole. EPA included the costs associated with these alternate technologies in the final cost impact analysis. See Chapter 11 for further discussion.

To further assess the differences between municipal solid waste and non-municipal solid waste landfills in the Non-Hazardous subcategory, EPA evaluated leachate characteristics from Subtitle D non-municipal solid waste landfills in published reports. Table 5-3 includes data from three reports[1] that analyzed construction and demolition monofills, ash monofills, and co-disposal sites and compares these data to the median raw wastewater data collected from non-hazardous municipal solid waste landfills as part of the Landfills industry study. The data contained in these reports indicate that the leachate characteristics at construction and demolition, co-disposal, and ash monofill facilities are comparable to the leachate characteristics from municipal solid waste landfills. Both the number and type of parameters in the leachate do not differ among these types of facilities, and concentration levels for all pollutants are comparable, with many parameters found at lower concentrations in the data from the construction and demolition, co-disposal, and ash monofill facilities. Therefore, EPA has concluded that untreated leachate characteristics at these facilities were not significantly different than at other non-hazardous landfill facilities and did not merit further subcategorization.

In addition, EPA collected data from six Subtitle D monofills during the EPA sampling program, including two sludge monofills, two ash monofills, and two construction and demolition monofills. Table 5-4 presents the average raw wastewater data for selected pollutants, along with the types of waste landfilled at each monofill. EPA evaluated its monofill data along with commenter submitted data and the data referenced in Table 5-3 and determined that there are differences in wastewater characteristics between different types of monofills. Most of these differences result from the fact that not all monofills accept the same types of waste. Some monofills accept primarily organic wastes (construction and demolition, sludge), others accept primarily inorganic wastes (ash, lime), and many monofills accept a combination of organic and inorganic wastes. As a result of the various types of monofills, EPA determined that a single subcategory for all monofills would still not address the situation where a certain class of constituents is regulated even

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[1] "A Study of Leachate Generated from Construction and Demolition Landfills", Department of Environmental Engineering Sciences, University of Florida, August 1996; "Characterization of Municipal Waste Combustion Ashes and Leachates from Municipal Solid Waste Landfills, Monofills, and Co-Disposal Sites", U.S. EPA, EPA 530-SW-87-028D, October 1987; "Characterization of Municipal Waste Combustion Ash, Ash Extracts, and Leachates", U.S. EPA, EPA 530-SW-90-029A, March 1990.

though not all types of monofills contain those constituents (e.g. a utility ash monofill with low raw wastewater BOD_5 concentrations would still be in the same subcategory as a sludge monofill which may contain moderate levels of BOD_5). Thus, EPA would need to establish a separate subcategory for each type of monofill to address the differences among them. Therefore, rather than develop multiple monofill subcategories, EPA decided that, since the types of pollutants and concentrations of pollutants found at monofills are, for the most part, equivalent to or less than those found at municipal solid waste landfills, a single subcategory is appropriate for Subtitle D landfills. EPA concluded that the pollutants regulated for the Subtitle D Non-Hazardous subcategory will control the discharges from all types of Subtitle D landfills, including monofills.

The second consideration was based on ease of implementation. As discussed in Section 5.2, the RCRA classification scheme selected as the basis for subcategorization clearly defines non-hazardous, hazardous, and municipal solid waste landfill facilities. However, RCRA does not make any further distinction nor further divide the Subtitle D landfill facilities based on whether they are monofills or if they receive multiple types of waste. Therefore, by further subcategorizing the Subtitle D facilities into monofills and multiple waste landfills, a new classification scheme would be introduced to permit writers and regulated facilities. EPA concluded that the current RCRA classification scheme is widely understood by permit writers and regulated landfill facilities, making it the easiest of the subcategorization approaches to implement. Additionally, there are many facilities that operate both dedicated cells (similar to monofills) and municipal solid waste cells at the same landfill and commingle the wastewater prior to treatment. Establishing one subcategory for all non-hazardous landfills will ease implementation issues and adequately control discharges from the Landfills industry.

5.3.2 Wastewater Characteristics

EPA concluded that leachate characteristics from non-hazardous and hazardous landfills differed significantly from each other in the types of pollutants detected and the concentrations of those pollutants. The tables supporting this conclusion are presented in Chapter 6 (Tables 6-9 through 6-13) and Chapter

7 (Tables 7-1 and 7-2) of this document. As expected, EPA found that the leachate from hazardous landfills contained a greater number of contaminants at higher concentrations than leachate from non-hazardous landfills, as discussed in Section 5.3.1. This conclusion supports subcategorization based on RCRA classification of hazardous and non-hazardous landfills.

In EPA's evaluation of contaminated ground water, the wastewater characteristics of contaminated ground water from hazardous landfills differed significantly from the contaminated ground water characteristics at non-hazardous waste landfills, as shown in Table 5-5 and Table 5-6, respectively. Contaminated ground water from non-hazardous landfills contained only 16 pollutants of interest (as defined in Chapter 7) compared to the contaminated ground water from hazardous waste landfills which contained a total of 54 pollutants of interest. In addition, effluent data collected in support of this rule demonstrate that contaminated ground water flows at hazardous and non-hazardous facilities are, in general, currently adequately treated as a result of existing corrective action programs under RCRA.

Due to the site-to-site variability of contaminated ground water, EPA has decided that the treatment of these flows is best addressed through the RCRA Corrective Actions program. RCRA Corrective Action programs at the federal, state, and local level have the ability to consider the site-to-site variability of the contaminated ground water and provide the most applicable treatment necessary to control the contaminants. Therefore, EPA has decided to exclude contaminated ground water from this regulation. Chapter 2 fully describes EPA's decision not to include contaminated ground water as a landfill wastewater covered by this regulation.

5.3.3 Facility Size

EPA considered subcategorization of the Landfills industry on the basis of facility size and found that landfills of varying sizes generate similar wastewater and use similar treatment technologies. Based upon a review of the industry-provided data in the landfills' database, there was no observed correlation between waste acceptance amount or wastewater flow rate and the selection of treatment technologies. For

example, a landfill facility can add cells or increase its waste receipt rate depending on the local market need without altering or changing the characteristics of the wastewater generated. In addition, the size of a landfill was not determined to be a factor in cost-effectiveness of the regulatory options considered by EPA. Finally, EPA has determined that wastewater from landfills can be treated to the same level regardless of facility size. EPA did not promulgate a de-minimis flow exemption for this guideline; however, EPA has accounted for landfill facilities that generate small volumes of wastewater by estimating compliance costs for the BPT/BAT options based on treating their wastewater off-site at a CWT facility (see Section 9.2.5).

5.3.4 Ownership

EPA considered subcategorizing the industry by ownership. A significant number of landfills are owned by state, local, or federal governments, while others are commercially or privately owned. Landfills generally fall into the following two major categories of ownership: municipal or private. Landfills owned by municipalities are primarily designed to receive non-hazardous solid waste such as municipal solid waste, non-hazardous industrial waste, construction and demolition debris, ash, and sludge. However, municipally-owned landfills may also be designed to accept hazardous wastes.

Privately-owned landfills can also provide for the disposal of non-hazardous solid waste such as those mentioned above, and, like municipally-owned facilities, may also be designed to accept hazardous wastes. EPA found that current commercially- and municipally-owned landfills generally accept and manage wastes strictly by the RCRA classification and, although there are distinct economic differences, there is no distinction in the wastewater characteristics and wastewater treatment employed at commercially- or municipally-owned landfills. Since all landfill types could be of either ownership status, EPA determined that subcategorization based upon municipal and private ownership was not appropriate.

5.3.5 Geographic Location

EPA considered subcategorizing the industry by geographic location. Landfill sites are not limited to any

one region of the United States. A table presenting the number of landfills by state is presented in Chapter 3 (Table 3-1). While EPA included landfills from all sections of the country in the Agency's survey efforts, collection of wastewater characterization data as part of EPA's sampling episodes was limited to landfill facilities in the Northeast, South, and Midwest, where annual precipitation is either average or above average. Although wastewater generation rates appear to vary with annual precipitation, which is indirectly related to geographic location, EPA could not establish a direct correlation between leachate characteristics and geographic location due to lack of sampling data from arid parts of the United States. However, the Agency believes that seasonal variations in rainfall cause only minor fluctuations in leachate characteristics due to dilution effects and volume of leachate generated. In addition, many landfill facilities have developed site-specific best management practices to control the amount of rainwater that enters a landfill and eventually becomes part of the leachate. These practices include proper contouring of landfill cells, extensive use of daily cover, and capping of inactive landfill cells to minimize the amount of rainwater that enters the landfill. EPA's data collection efforts indicate that landfill facilities in less arid climates are more likely to use these management practices to control their wastewater generation and flows to the on-site wastewater treatment plant. The data collected by EPA did not indicate any significant variations in wastewater treatment technologies employed by facilities in colder climates versus warmer climates.

EPA notes that geographic location may have a differential impact on the costs of operating a landfill. For example, the cost of additional equipment required for the operation of the landfill or treatment system or tipping fees charged for the hauling of waste may differ from region to region. These issues were addressed in the economic impact assessment of the final rule.

Therefore, since the effect of geographic location appears to have a minimal impact on wastewater characteristics or can be easily addressed at minimal effort and cost, EPA determined that subcategorization based upon geographic location was not appropriate.

5.3.6 Facility Age

EPA considered subcategorization based on the age-related changes in leachate concentrations of pollutants for different age classes of landfills based on the evaluation of several factors. Several considerations lead to the conclusion that age-related limits are not appropriate. First, a facility's wastewater treatment system typically receives and commingles leachate from several landfills or cells of different ages. The Agency has not observed any facility which has found it advantageous or necessary to treat age-related leachates separately. The Agency did, however, sample two landfill facilities that had only one cell. One of the facilities had been receiving wastes for nine years in its landfill cell, while the other facility had only been receiving waste for one year. EPA compared the raw wastewater concentrations of the constituents in these two cells and found the concentrations to be very similar. In addition, most of the constituents in both cells were close to the median raw wastewater concentration for the Non-hazardous subcategory. Second, based on responses to the questionnaire, discussions with landfill operators and historical data, EPA understands that leachate pollutant concentrations appear to change substantially over the first two to five years of operation but then change only slowly thereafter.

These two observations imply that treatment systems must be designed to accommodate the full range of concentrations expected in influent wastewater. EPA concluded that the BPT/BAT/NSPS treatment technologies are able to treat the variations in landfill wastewater likely to occur due to age-related changes. EPA has taken into account the ability of treatment systems to accommodate age-related changes in leachate concentrations, as well as short-term fluctuations by promulgating effluent limitations which reflect the variability observed in monitoring data spanning up to three years.

Additionally, EPA addressed age-related effects on treatment technologies, costs, and pollutant loads by utilizing data collected from a variety of landfills in various stages of age and operation (e.g. closed, inactive, active). EPA sampled landfills of various ages and stages of operation (active, inactive, closed), lined and unlined, and concluded that the landfill database used to develop the effluent limitations represents leachate typically found at Subtitle D landfills. In addition, EPA received comments from several commenters stating

that the leachate characterization data presented in the proposal was consistent with their own monitoring data.

However, several commenters on the proposed rule stated that EPA's sampling data did not represent adequately the age-related differences that can exist between leachates from landfills of different ages. Table 5-7 presents the age of the landfills sampled by EPA. The table includes the sampling episode number and RCRA classification of each landfill, the number of cells in each landfill, whether the landfill is lined or not, the year the landfill began accepting waste, the year it stopped accepting waste, and the projected landfill closure date, if available. All information on landfill ages were obtained from the Detailed Questionnaire or the sampling reports from these facility's sampling episodes. All of EPA's sampling episodes occurred during a two year period from 1993 to 1995. Grouping facilities shown in Table 5-7 according to the year the facility began accepting waste and by regulatory history, there are ten pre-1980 landfills (before 1980 Section 3001 of RCRA); five landfills that fall in the 1980 to 1983 range (before the 1984 Hazardous and Solid Waste Amendment to RCRA); five landfills that fall in the 1984 to 1988 range (before Land Disposal Restrictions (LDR)); and five landfills that are post-1988 (after LDR). The landfill facilities sampled by EPA were between one and 43 years of age at the time of sampling. As seen in Table 5-7, the majority of landfill facilities sampled contained more than one cell, and often more than one landfill, and many of these landfill facilities commingled the leachate discharges from cells and landfills of various ages. As mentioned above, the Agency sampled raw wastewater at two landfill cells of different ages and found the concentrations of constituents to be very similar. EPA did not identify any facility that treated leachates separately due to differences in age.

To determine if significant differences existed between landfills of various ages, EPA compared pollutant concentration data from Subtitle D landfill facilities of different ages in the EPA database. Table 5-8 presents the median raw wastewater concentration for selected conventional, nonconventional, organic and metal pollutants for non-hazardous landfills with available raw wastewater data in the EPA database by age group. EPA determined the raw wastewater median concentrations in the table by: 1) calculating the

average concentration of a pollutant at a landfill facility using data from EPA sampling episodes, Detailed Questionnaires, and Detailed Monitoring Questionnaires, and then 2) calculating the median concentration of the landfill facility average concentrations.

As seen in Table 5-8, when landfills of various ages from EPA's landfill effluent guidelines database are compared, it is difficult to pinpoint any particular trend (i.e. organic pollutant concentrations decrease significantly with age). The absence of any particular trend associated with pollutant concentrations across landfill facilities of various ages may be due to the fact that most of the older landfill facilities in EPA's database have newer landfill cells whose leachate is commingled for treatment with the leachate from the older landfill cells. EPA acknowledges that age-related changes in landfill leachate characteristics would be expected from individual landfill cells. Most of the older landfill cells have lower concentrations of BOD_5, COD, and most organic pollutants indicating a smaller amount of degradable compounds from the aged waste (reference 13). In addition, aged leachates contain high levels of chemically reduced compounds, such as ammonia, and high chlorides because of the anaerobic environment of the landfill. These trends tend to be true for individual landfill cells. Again, however, as mentioned above, the Agency sampled raw wastewater at two landfill cells of different ages and found the concentrations of constituents to be very similar. However, when looking at a landfill facility as a whole (where leachates from several cells of various ages are commingled for treatment), the landfills effluent guidelines database does not fully support such a trend. Furthermore, the time frame of these age-related changes is not consistent in every landfill. Several factors including size of a cell, composition and disposition of refuse, precipitation levels, and the influence of leachate from older cells on newer cells, can, and do, affect how a leachate's composition changes with time. However, in general, these pollutant concentrations are within the same order of magnitude and the Agency concluded that this age-related variability in wastewater characteristics can be adequately controlled by the BPT/BAT treatment options, as demonstrated by the BAT facilities sampled by EPA.

Based on this analysis of the effects of age on wastewater characteristics, EPA determined that subcategorization based on facility age is not appropriate.

5.3.7 Economic Characteristics

EPA also considered subcategorizing the industry based on the economic characteristics of the landfill facilities. If a group of facilities with common economic characteristics, such as revenue size, was in a much better or worse financial condition than others, EPA could consider subcategorization on economics. However, based on the results of the Detailed Questionnaires, financial conditions of facilities showed no significant pattern of variation across possible subcategories, such as municipally- and commercially-owned facilities. In addition, EPA determined that the economic impacts of the compliance costs associated with the BPT/BAT regulations did not inordinately effect any particular segment of the Landfills industry. Therefore, EPA determined that subcategorization based on the economic characteristics of landfills facilities was not justified.

5.3.8 Treatment Technologies and Costs

Wastewater treatment for this industry ranges from primary systems such as equalization, screening, and settling, to advanced tertiary treatment systems such as filtration, carbon adsorption, and membrane separation. EPA found that the selected treatment technology employed at a facility was dependent on wastewater characteristics and permit requirements. Landfills with more complex mixtures of toxic pollutants in their wastewater generally had more extensive treatment systems and may utilize several treatment processes (e.g., facilities with high levels of both organic and inorganic pollutants may employ both a chemical and biological treatment system). However, subcategorizing by the waste type received by a landfill as outlined in the RCRA classification of landfills is less difficult to implement and results in addressing the same factors as using treatment processes employed. As a result, EPA did not consider treatment technologies or costs to be a basis for subcategorization.

5.3.9 Energy Requirements

The Agency did not subcategorize based on energy requirements because energy usage was not considered a significant factor in this industry and is not related to wastewater characteristics. Energy costs resulting from this regulation were accounted for in the cost section of this development document (Chapter 9) and in the economic impact assessment.

5.3.10 Non-Water Quality Impacts

The Agency evaluated the impacts of this regulation on the potential for increased generation of solid waste and air pollution. The non-water quality impacts did not constitute a basis for subcategorization. Non-water quality impacts and costs of solid waste disposal are included in the economic analysis and regulatory impact analysis for this regulation. See Chapter 10 for more information regarding non-water quality impacts.

Table 5-1: Subcategorization of the EPA Landfills Database

Hazardous Subcategory Detailed Questionnaire ID Numbers	Non-Hazardous Subcategory Detailed Questionnaire ID Numbers	
16005	16001	16128
16007	16003	16129
16017	16008	16130
16018	16009	16131
16019	16011	16132
16031	16012	16135
16032	16013	16137
16034	16014	16139
16036	16015	16148
16037	16016	16150
16040	16020	16151
16041	16023	16152
16042	16024	16153
16044	16025	16154
16045	16026	16155
16051	16027	16156
16066	16028	16158
16067	16029	16159
16068	16033	16160
16069	16035	16161
16081	16038	16162
16086	16039	16163
16087	16043	16164
16094	16046	16165
16095	16047	16166

Table 5-1: Subcategorization of the EPA Landfills Database (continued)

Hazardous Subcategory Detailed Questionnaire ID Numbers	Non-Hazardous Subcategory Detailed Questionnaire ID Numbers	
16101	16048	16170
16104	16049	16171
16105	16050	16173
16106	16052	16174
16108	16053	16175
16110	16054	16176
16134	16055	16177
16136	16056	16180
16140	16057	16184
16141	16058	16185
16142	16059	16186
16143	16060	16187
16144	16061	16189
16145	16062	16190
16146	16063	16191
16147	16064	16193
16149	16065	16196
16167	16070	16199
16168	16071	16200
16169	16072	16201
16178	16073	16202
16179	16074	16203
16182	16075	16204
16183	16076	16205
16192	16077	16206

Table 5-1: Subcategorization of the EPA Landfills Database (continued)

Hazardous Subcategory Detailed Questionnaire ID Numbers	Non-Hazardous Subcategory Detailed Questionnaire ID Numbers	
16197	16078	16208
16210	16079	16211
16218	16083	16212
16235	16084	16215
16238	16085	16217
	16088	16219
	16090	16220
	16091	16221
	16092	16222
	16093	16223
	16097	16224
	16098	16225
	16099	16228
	16102	16230
	16103	16231
	16107	16232
	16109	16233
	16111	16234
	16113	16236
	16114	16239
	16115	16240
	16116	16241
	16117	16242
	16118	16243
	16119	16245

Table 5-1: Subcategorization of the EPA Landfills Database (continued)

Hazardous Subcategory Detailed Questionnaire ID Numbers	Non-Hazardous Subcategory Detailed Questionnaire ID Numbers	
	16120	16246
	16121	16248
	16122	16249
	16123	16250
	16124	16251
	16125	16252
	16127	16253

Table 5-2: Raw Wastewater Median Concentrations of Pollutants of Interest Common to Both the Hazardous and Non-Hazardous Landfill Subcategories

Non-Hazardous Pollutants of Interest	Hazardous Median Concentration	Non-Hazardous Median Concentration*
(mg/L)		
Ammonia	268	75 - 82
BOD	621	67 - 240
COD	1,309	994 - 1,100
Nitrate/Nitrite	1.6	0.65 - 0.95
TDS	15,958	2,894 - 4,850
TOC	441	236 - 377
Total Phenols	25	0.25 - 0.57
TSS	151	21 - 137
(ug/L)		
1,4-Dioxane	466	11
2-Butanone	1,048	1,082
2-Propanone	2,889	992
4-Methyl-2-Pentanone	500	101
Alpha Terpineol	96	123
Benzoic Acid	2,482	100
Hexanoic Acid	2,703	5,818
Methylene Chloride	118	37
O-Cresol	79	15
Phenol	4,400	102
P-Cresol	144	75
Toluene	104	108
Tripropyleneglycol Methyl Ether	853	197
Chromium	36	28
Strontium	3,044	1,671 - 4,615

Table 5-2: Raw Wastewater Median Concentrations of Pollutants of Interest Common to Both the Hazardous and Non-Hazardous Landfill Subcategories (continued)

Non-Hazardous Pollutants of Interest	Hazardous Median Concentration	Non-Hazardous Median Concentration*
Titanium	33	64
Zinc	100	100

* Non-Hazardous subcategory median concentrations are presented as a range because raw wastewater data was calculated separately for municipal solid waste and non-municipal solid waste facilities.

Table 5-3: Comparison of Subtitle D Non-Municipal and Municipal Raw Wastewater Pollutant Concentrations (ug/L)

Pollutant	C & D Study		EPA Characterization Studies - Data Range			Subtitle D Municipal Raw Wastewater Median Concentration		
			1990	1987				
Metals	Mean [1]	Facilities Det/Total[2]	Ash Monofills	Co-Disposal	Monofills	Median	Mean	Max
Arsenic	12.3	12/16	ND(50) - 400	8 - 46	10 - 218	32.4	50.4	179
Barium	661	13/13	ND(2) - 9,220	270 - 890	NA	483	720	3,500
Boron	NA	NP	NA	NA	NA	3,910	3,874	16,250
Chromium	NA	NP	ND(7) - 32	ND(10) - 13	5 - 914	28	46	240
Hexavalent Chromium	NA	NP	NA	NA	NA	30	77	247
Molybdenum	NA	NP	NA	NA	NA	10	27	69
Silicon	NA	NP	470 - 15,300	NA	NA	15,759	28,817	159,000
Strontium	NA	NP	NA	NA	NA	1,671	1,569	2,146
Titanium	NA	NP	NA	NA	NA	64	66	157
Zinc	658	15/15	5.2 - 370	9 - 1,210	48 - 3,300	100	1,476	31,813
Organics								
1,4-Dioxane	49	1/5	NA	NA	NA	11	118	323
2-Butanone	NA	NP	NA	NA	ND(50)	1,082	5,119	36,544
2-Propanone	NA	NP	NA	NA	ND(50)	991	2,407	8,614
4-Methyl-2-Pentanone	130	2/8	NA	NA	ND(50)	101	3,789	46,161
Alpha Terpineol	NA	NP	NA	NA	ND(50)	123	334	1,061
Benzoic Acid	15,457	4/9	ND(50) - 73	NA	ND(50)	100	7,220	33,335
Dichloroprop	NA	NP	NA	NA	ND(50)	6	10	29
Disulfoton	3.3	2/4	NA	NA	NA	6	9	20
Hexanoic acid	NA	NP	NA	NA	ND(50)	5,818	13,148	37,256
MCPA	NA	NP	NA	NA	NA	403	816	4,370
MCPP	NA	NP	NA	NA	NA	233	432	1,900
Methylene Chloride	26.4	4/9	NA	NA	ND(50)	37	70	237
N,N-Dimethylformamide	NA	NP	NA	NA	ND(50)	10	214	1,008
O-Cresol	50	2/8	NA	NA	ND(50)	15	298	2,215
Phenol	384	3/6	ND(10) - 32	ND(50) - 2,100	ND(1.5)	102	287	1,425
P-Cresol	NA	NP	NA	NA	ND(50)	75	246	998
Toluene	61	7/9	NA	ND(50) - 120	ND(50)	108	166	598
Tripropyleneglycol Methyl Ether	NA	NP	NA	NA	ND(50)	197	568	1,235

Table 5-3: Comparison of Subtitle D Non-Municipal and Municipal Raw Wastewater Pollutant Concentrations (ug/L) (continued)

Pollutant	C & D Study		EPA Characterization Studies - Data Range			Subtitle D Municipal Raw Wastewater Median Concentration		
			1990		1987			
Conventional/Nonconventionals	Mean [1]	Facilities Det/Total[2]	Ash Monofills	Co-Disposal	Monofills	Median	Mean	Max
BOD	87,320	14/14	NA	NA	NA	240,000	1,228,534	7,609,318
COD	754,500	16/17	NA	1,300,000 -	5 - 1,200,000	994,000	2,024,932	11,881,700
Ammonia Nitrogen	20,420	16/78	4,380 - 77,400	3,900,000	1,200 - 36,000	81,717	238,163	2,900,000
TDS	2,263,100	17/18	924,000 - 41,000,000	160,000 - 410,000	NA	2,894,289	4,195,518	17,533,000
TSS	1,859,100	17/18	NA	NA	NA	137,000	735,308	14,470,000
Total Phenols	620	7/7	NA	1,930,000 -	NA	571	142,838	2,051,249
Nitrate/Nitrite	NA	NP	NA	7,970,000	NA	651	5,844	50,800
TOC	306,540	7/7	17 - 420,000	NA	59,100 - 636,000	376,521	661,477	3,446,084
				NA				
				438,000 - 1,310,000				
Dioxins/Furans								
1234678-HpCDD	NA	NP	ND(NV) - 0.222[2]	0.12 - 0.77[2]	0.009 - 172[2]	0.00014	0.0024	0.0071
OCDD	NA	NP	ND(NV) - 0.107	0.21 - 15	0.06 - 120	0.0018	0.030	0.0824

All units in ug/l unless otherwise noted
*: The number of sites that detected the parameter/the total number of sites that sampled the parameter
(1): Mean includes non-detects for metals and conventionals/nonconventionals and does not include non-detects for organics and dioxins/furans
(2): Total homolog concentration
NA: Not Analyzed
ND: Not Detected
NV: Not Available
NP: Not Applicable

Table 5-4: Summary of EPA Sampling Data for Subtitle D Monofills Average Raw Leachate Data for Selected Pollutants

Episode	Waste Type Landfilled	BOD_5	TSS	Ammonia	Zinc	Alpha Terpineol	Benzoic Acid	P-Cresol	Phenol
		(mg/L)							
4503	mill sludge (clay, lime, cellulose), fly ash, bark	120	104	53.2	0.028	ND	ND	ND	ND
4630	POTW sludge	85	292	118	0.086	ND	ND	ND	ND
4631	municipal resource recovery ash	12	11	75	0.033	ND	ND	ND	0.092
4638	C&D debris, state-regulated non-hazardous waste	67	22	0.67	0.102	ND	ND	ND	ND
4639	municipal resource recovery ash, WWTP residues	4	4	0.1	0.06	ND	ND	ND	ND
4644	C&D, yard waste, bricks, rubble, waste oil	13	4	0.85	0	ND	ND	ND	ND

ND: Non-Detect
NA: Data not provided.

Table 5-5: Average Contaminated Ground Water Pollutant Concentrations at Hazardous Landfills in the EPA Database (ug/L)

Hazardous Groundwater Pollutant of Interest	Cas #	MDL	QID 16018 Inf	QID 16031 Eff	QID 16032 Eff	QID 16034 Inf	QID 16036 Inf	QID 16094 Eff	QID 16095 Inf	QID 16095 Eff	QID 16136 Inf	QID 16141 Eff	QID 16144 Inf	QID 16144 Eff
1,1-Dichloroethane	75243	10		2		230	113		89	5 ND			121522	10
1,1,1-Trichloroethane	71556	10		5		180	185	1 ND	370	5 ND			37598	10
1,1,2,2-Tetrachloroethane	79345	10					0.5 ND	1 ND					218139	445
1,2,4-Trichlorobenzene	120821	10											265	19 ND
1,2-Dichlorobenzene	95501	10						1 ND					10491	19 ND
1,2-Dichloroethane	107062	10		2			4	1 ND					1376889	357
1,2,3-Trichloropropane	96184	10											1300084	138
1,3-Dichlorobenzene	541731	10											16628	19 ND
1,4-Dichlorobenzene	106467	10						1 ND					25655	19 ND
1,4-Dioxane	123911	10				46							6429	3738
2,4-Dichlorophenol	120832	10											101	109 ND
2378-TCDD	1746016	0.00001											0.00016	
2378-TCDF	51207319	0.00001											0.0066	
2,4,5-T	93765	0.2											5	
2,4,5-TP	93721	0.2											2	
2-Propanone	67641	50											25424	446
Ammonia as Nitrogen	7664417	10											27444	17760
Arsenic	7440382	10										50 ND	80	13
Benzene	71432	10	520	1							4606		37922	10
Benzoic Acid	65850	50											1330	1920
Benzyl Alcohol	100516	10											298	282
Bis(2-chloroethyl)ether	111444	10											16518	34716
Bis(2-ethylhexyl)phthalate	117817	10											1039	19 ND
BOD	C-002	2000			2700								86500	55230
Boron	7440428	100											846	770
Cadmium	7440439	5										3 ND	9	8
Chlorobenzene	108907	10	920	2				1 ND					12936	10
Chloroform	67663	10		2									132025	32
COD	C-004	5000			23600								6423889	2445850
Copper	7440508	25											53	521
Dalapon	75990	0.2											109	
Dicamba	1918009	0.2											34	
Dichlorvos	62737	5											236	

Table 5-5: Average Contaminated Ground Water Pollutant Concentrations at Hazardous Landfill in the EPA Database (ug/L) (continued)

Hazardous Groundwater Pollutant of Interest	Cas #	MDL	QID 16018 Inf	QID 16031 Eff	QID 16032 Eff	QID 16034 Inf	QID 16036 Inf	QID 16094 Eff	QID 16095 Inf	QID 16095 Eff	QID 16136 Inf	QID 16141 Eff	QID 16144 Inf	QID 16144 Eff
Dinoseb	88857	0.5											14	
Dioxathion	78342	5											270	
Ethyl Benzene	100414	10	372	2									14694	10
Hexane Extractable Material	C-036	5000											1700222	8750
Hexanoic Acid	142621	10											16368	28013
Lithium	7439932	100											305	219
Methylene Chloride	75092	10		2									123572	40
Molybdenum	7439987	10											13	13
Naphthalene	91203	10				54					4100		3766	19 ND
Nickel	7440020	40										10	136	1462
Nitrate/Nitrite	C-005	50										1000 ND	2136	1571
Pentachlorobenzene	608935	20											4333	38 ND
Phenol	108952	10											6029	1537
Silicon	7440213	100											6738	6602
Strontium	7440246	100											17156	12360
TOC	C-012	1000											2055028	730700
Toluene	108883	10	573	2					19	5 ND	2573		22080	10
Trans-1,2-Dichloroethene	156605	10		5				1 ND					84660	14
Trichloroethene	79016	10		5			5						272606	33
TSS	C-009	4000										37000	121639	26450
Zinc	7440666	20				120							576	3451

MDL: Method detection limit

QID: Questionnaire ID

E: Sampling episode

ND: Non-detect with respect to instrument detection limit (IDL)

*: IDL is greater than detected value

Table 5-6: Average Contaminated Ground Water Pollutant Concentrations at Non-Hazardous Landfills in the EPA Database (ug/L)

Non-Hazardous Groundwater			E4683	QID 16016	QID 16085		QID 16088		QID 16129		QID 16132	QID 16163
Pollutant of Interest	Cas #	MDL	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Eff	Eff
1,1-Dichloroethane	75243	10	10 ND	0.3 ND	5.5		8.6	1	22		0.35 ND	4 ND
1,1,1-Trichloroethane	71556	10	10 ND	0.5 ND	1.4 ND		2.1	1 ND	17		0.45 ND	5 ND
1,2-Dichloroethane	107062	10	10 ND	0.3 ND	1.4 ND		2.1 ND	1 ND	15		0.35 ND	8
2,4,5-T	93765	0.2	0.2 ND		0.2 ND		2		1 ND			
2,4,5-TP	93721	0.2	0.2 ND	2000 ND	0.2 ND		5		1.9 ND			
2-Propanone	67641	50	50 ND	10.5	50 ND		50 ND		742		1.3	
Ammonia as Nitrogen	7664417	10	1340		1284	256	1300	409	80551	563		
Arsenic	7440382	10	2 ND	16	4.3		3	2	13		11	25
Benzene	71432	10	10 ND	0.3 ND	1.4 ND	5.7	2.2	1 ND	13		0.35 ND	
Benzyl Alcohol	100516	10	10 ND		10 ND		10 ND		19			
BOD	C-002	2000	14000	1000	1000 ND	751	1000 ND		213655	1835		
Boron	7440428	100	173		362		97		1091			
Cadmium	7440439	5	4 ND	18	0.4	19	4 ND	15	5 ND		3.8	2
Chlorobenzene	108907	10	10 ND	0.5 ND	1.4 ND		2.1 ND	1.5 ND	12		0.35 ND	5 ND
Chloroform	67663	10	10 ND	0.5 ND	1.7		2.1 ND	1 ND	15			
COD	C-004	5000	28000	21637	51000		14000					33300
Copper	7440508	25	12	38	10 ND		10 ND		53	121	10	2.5
Dalapon	75990	0.2	0.2 ND		0.2 ND		6					
Dicamba	1918009	0.2	0.2 ND		0.2 ND		10					
Dinoseb	88857	0.5	0.5 ND		0.5 ND		3		50 ND			
Ethyl Benzene	100414	10	10 ND	0.3 ND	1.4 ND		2.1 ND	1 ND	15		0.35 ND	5 ND
Methylene Chloride	75092	10	10 ND	1	3.3 ND		2.1 ND	3.5 ND	49	0.6	0.45	
Naphthalene	91203	10	10 ND	36 ND	10 ND		10 ND		12			
Nickel	7440020	40	14 ND	30	59		14 ND	27	45	21	16	40
Nitrate/Nitrite	C-005	50	2660		1300		1340					10000 ND
Phenol	108952	10	10 ND	54.5 ND	5718 ND		10 ND		145			
Silicon	7440213	100	3530		3880		3270					
Strontium	7440246	100	201		657		200					
TOC	C-012	1000	10000 ND		40000		10000 ND				3996	
Toluene	108883	10	10 ND	0.3 ND	1.4 ND		2.1 ND	1 ND	47		0.35 ND	5 ND
Trans-1,2-Dichloroethene	156605	10	10 ND	0.3 ND	2.8	5.7	3.6	1 ND	38	0.5 ND	0.35 ND	5 ND
Trichloroethene	79016	10	10 ND	0.35	10 ND		2.1 ND	1 ND	19	0.5	0.45	1
TSS	C-009	4000	4000 ND		24000	5593	4000 ND		43848	2651		
Zinc	7440666	20	15.2	35	70		16		82	24		

MDL: Method detection limit
QID: Questionnaire ID
E: Sampling episode
ND: Non-detect with respect to instrument detection limit (IDL)
*: IDL is greater than detected value

Table 5-7: Age of Landfills in EPA Sampling Database

Episode	RCRA Classification	Number of Cells	Year Landfill Began Accepting Waste	Year Landfill Stopped Accepting Waste	Projected Closure
4491	Subtitle D Lined (varies)	25	1970	1994	1999
4503	Subtitle D Unlined	1	1974	1990	1992-3
4626	Subtitle D Lined (comp)	1	1986	1993	2000
4630	Subtitle D Lined (clay)	5	1988	1994	2003
4631	Subtitle D Lined (comp)	5	1987	-	-
	Subtitle C Lined (clay)	-	1972	1982	1991
	Subtitle C Lined (clay)	10	1972	1982	1991
4638	Subtitle D Lined (dbl comp)	5	1990	-	-
4639	Subtitle D Lined (comp)	2	1988	-	-
4644	Subtitle D Lined (clay)	2	1989	-	-
4659	Subtitle C Unlined	-	1958	1981	1981
	Subtitle C Lined (clay)	-	1981	1988	-
4667	Subtitle D Lined (varies)	4	1974	1993	1997
	Subtitle D Unlined	1	1962	1974	1991
4683	Subtitle D - GW Lined (varies)	7	1981	-	2017

Table 5-7: Age of Landfills in EPA Sampling Database (continued)

Episode	RCRA Classification	Number of Cells	Year Landfill Began Accepting Waste	Year Landfill Stopped Accepting Waste	Projected Closure
4687	Subtitle D Lined (comp)	1	1994	-	-
4690	Subtitle C Unlined	9	1952	1973	1976
	Subtitle C Lined (comp)	2	1980	1993	2008
	Subtitle C Unlined	8	1968	1979	1980
	Subtitle D Unlined	1	1992	1993	1998
	Subtitle C Lined (clay)	1	1982	1985	1986
	Subtitle D Unlined	2	1991	1993	1998
4738	Subtitle D Lined (clay)	4	1984	1994	1998
4721	Subtitle C Lined (clay)	2	1980	1993	1997
4759	Subtitle C Lined (varies)	39	1975	1993	2000

(comp): composite liner (synthetic and clay)
(varies): cells lined with either synthetic, asphalt, clay, composite or double lined composite

Table 5-8: Median Raw Wastewater Characteristics at Non-Hazardous Landfills of Varying Age

Pollutant	Landfill Age Group (Year in which Landfill Facility Began Accepting Waste)		
	Pre-1980 Median Conc.	1980-1990 Median Conc.	1991-Present Median Conc.
Ammonia	140 mg/L (15)	95 mg/L (10)	48 mg/L (3)
BOD_5	210 mg/L (18)	125 mg/L (13)	344 mg/L (4)
COD	596 mg/L (17)	930 mg/L (11)	3,038 mg/L (4)
TOC	445 mg/L (15)	377 mg/L (8)	150 mg/L (3)
TSS	202 mg/L (17)	49 mg/L (9)	100 mg/L (4)
Alpha Terpineol	746 ug/L (2)	123 ug/L (1)	-
Benzoic Acid	75 ug/L (4)	9,308 ug/L (1)	-
P-Cresol	25 ug/L (5)	117 ug/L (2)	-
Phenol	17 ug/L (8)	242 ug/L (4)	820 ug/L (1)
Chromium	27 ug/L (16)	31 ug/L (9)	10 ug/L (3)
Zinc	145 ug/L (16)	93 ug/L (12)	139 ug/L (4)

( ): Parentheses denote number of observations (number of landfills with data).

6.0 WASTEWATER GENERATION AND CHARACTERIZATION

In 1994, under the authority of Section 308 of the Clean Water Act (CWA), the Environmental Protection Agency (EPA) distributed a questionnaire entitled "Waste Treatment Industry Questionnaire Phase II: Landfills" to 252 facilities that EPA had tentatively identified as possible generators of landfill wastewater. Some of the facilities employed on-site wastewater treatment, while others did not. EPA selected these facilities for survey purposes to represent a total of 1,024 potential generators of landfill wastewater. A total of 220 questionnaire respondents generated landfill leachate in 1992. This section presents information on wastewater generation at these facilities based on the questionnaire responses. In addition, this section also summarizes the information on wastewater characteristics for landfill facilities that EPA sampled and for those facilities that provided self-monitoring data.

6.1 Wastewater Generation and Sources of Wastewater

Landfill facilities do not generate "process wastewater" as EPA has traditionally defined it. At 40 CFR Part 122.2, EPA defines process wastewater as "any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, by-product, intermediate product, finished product or waste product". EPA typically uses this definition of process wastewater for manufacturing or processing operations. Since landfill operations do not include or result in "manufacturing processes" or "products", EPA refers to the wastewater treated at landfill facilities as landfill generated wastewater.

In general, the types of wastewater generated by activities associated with landfills and collected for treatment, discharge, or reuse are the following: leachate, landfill gas condensate, truck/equipment washwater, drained free liquids, laboratory derived wastewater, floor washings, recovering pumping wells, contaminated ground water, and storm water runoff. For the purposes of the Landfill industry study, EPA considers all of these wastewater sources "in-scope" except for contaminated ground water, recovering pumping wells, and non-contaminated storm water.

In 1992, landfill facilities in the U.S. generated approximately 22.7 billion gallons of wastewater. For the purposes of this guideline, EPA considers approximately 7.3 billion gallons of this wastewater "in-scope". The remaining 15.4 billion gallons of wastewater generated at landfills consist of contaminated ground water, wastewater recovered from pump wells, and non-contaminated storm water. The primary sources of wastewater at landfills are defined below.

Landfill leachate as defined at 40 CFR Part 258.2, is liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste. Over time, the seepage of water through the landfill as a result of precipitation may increase the mobility of pollutants and, thereby, increase the potential for their movement into the wider environment. As water passes through the layers of waste, it may "leach" pollutants from the disposed waste, moving them deeper into the soil. This mobility may present a potential hazard to public health and the environment through ground water contamination and other means. One measure used to prevent the movement of toxic and hazardous waste constituents from a landfill is a landfill liner operated in conjunction with a leachate collection system. Leachate is typically collected from a liner system placed at the bottom of the landfill. Leachate also may be collected through the use of slurry walls, trenches, or other containment systems. The leachate generated varies from site to site based on a number of factors including the types of waste accepted, operating practices (including shedding, daily cover, and capping), the depth of fill, compaction of wastes, annual precipitation, and landfill age. Landfill leachate accounts for over 97 percent of the total volume of in-scope wastewater.

Landfill gas condensate is a liquid which has condensed in the landfill gas collection system during the extraction of gas from within the landfill. Gases such as methane and carbon dioxide are generated due to microbial activity within the landfill and must be removed to avoid hazardous and explosive conditions. In gas collection systems, gases containing high concentrations of water vapor condense in traps staged throughout the gas collection network. The gas condensate contains volatile compounds and accounts for a relatively small percentage of flow from a landfill.

Drained free liquids are aqueous wastes drained from waste containers (e.g., drums, trucks, etc.) or wastewater resulting from waste stabilization prior to landfilling. Landfills that accept containerized waste may generate this type of wastewater. Wastewater generated from these waste processing activities is collected and usually combined with other landfill generated wastewater for treatment at the wastewater treatment plant.

Truck/equipment washwater is generated during either truck or equipment washes at landfills. During routine maintenance or repair operations, trucks and/or equipment used within the landfill (e.g., loaders, compactors, or dump trucks) are washed and the resultant wastewater is collected for treatment. In addition, it is common practice for many facilities to wash the wheels, body, and undercarriage of trucks used to deliver the waste to the open landfill face upon leaving the landfill. On-site wastewater treatment equipment and storage tanks are also periodically cleaned and their associated washwaters are collected. Floor washings generated during routine cleaning and maintenance of the facility also are collected for treatment.

Laboratory-derived wastewater is generated from on-site laboratories which characterize incoming waste streams and monitor on-site treatment performance. Landfill facilities usually combine the very small amounts of wastewater from this source with leachate and other wastewater for treatment at the wastewater treatment plant.

Contaminated storm water is storm water which comes in direct contact with landfill wastes, the waste handling and treatment areas, or wastewater that is subject to the limitations and standards. Some specific areas of a landfill that may produce contaminated storm water include (but are not limited to) the following: the open face of an active landfill with exposed waste (no cover added); the areas around wastewater treatment operations; trucks, equipment or machinery that has been in direct contact with the waste; and waste dumping areas. Storm water that does not come into contact with these areas was not considered to be within the scope of this study.

Landfill operations also generate and discharge wastewater that is not covered by this regulation. These sources include non-contaminated storm water, contaminated ground water, and wastewater from recovering pumping wells. Chapter 2: "Scope of the Regulation" discusses the exclusion of these flows. A brief description of this wastewater is presented below.

Non-contaminated (non-contact) storm water is storm water that does not come in direct contact with landfill wastes, the waste handling and treatment areas, or wastewater that is subject to the limitations and standards. Non-contaminated storm water includes storm water which flows off the cap, cover, intermediate cover, daily cover, and/or final cover of the landfill.

Contaminated ground water is water below the land surface in the zone of saturation which has been contaminated by landfill leachate. Contaminated ground water occurs at landfills without liners or at facilities that have released contaminants from a liner system into the surrounding ground water. Ground water can also infiltrate the landfill or the leachate collection system if the water table is high enough to penetrate the landfill area.

Recovering pumping wells generate wastewater as a result of the various ancillary operations associated with ground water pumping operations. These operations include construction and development, well maintenance, and well sampling (i.e. purge water). The wastewater will have very similar characteristics to contaminated ground water.

6.2 Wastewater Flow and Discharge

Tables 6-1 through 6-4 present national estimates of the flows for primary wastwater sources found at landfills reported in "Section A" of the "Waste Treatment Industry Questionnaire Phase II: Landfills". Chapter 3, Section 3.2.1 discusses how EPA calculated national estimates. The Agency based the national estimates presented in Tables 6-1 through 6-4 on 167 of the 220 facilities that generate and treat landfill leachate. EPA excluded the remaining 53 facilities from this guideline as discussed in Chapter 2. EPA

considers these 167 landfill facilities as "in-scope" facilities, or within the scope of the regulation. The tables report the flows by subcategory, as follows: Non-Hazardous subcategory (broken down into Subtitle D municipal solid waste and non-municipal solid waste facilities) and Hazardous subcategory. The tables also show the amount of wastewater flow from landfills by discharge status, as follows: direct, indirect, and zero.

Direct discharge facilities are those that discharge their wastewater directly into a receiving stream or body of water. Based on national estimates, there were no direct discharging hazardous landfills identified in the Landfills industry study. Indirect discharging facilities discharge their wastewater indirectly to a publicly-owned treatment works (POTW). Zero or alternative discharge facilities use treatment and disposal practices that result in no discharge of wastewater to surface waters or POTWs. Alternative disposal options for landfill generated wastewater include off-site treatment at another landfill wastewater treatment system or a Centralized Waste Treatment facility, deep well injection, incineration, evaporation, land application, and recirculation back to the landfill.

Tables 6-1, 6-2, and 6-3 present wastewater flows by subcategory (Hazardous and Non-Hazardous, which is divided into Municipal and Non-Municipal) and discharge type for the different types of wastewater generated by landfills in 1992. Total flows are reported for wastewater treated on site and off site, discharged untreated to a POTW or surface water, and recycled flows that are put back into the landfill. Wastewater flows identified as "Other" treatment include evaporation, incineration, or deep well injection.

Table 6-4 combines the in-scope wastewater flows from Tables 6-1, 6-2, and 6-3. Table 6-4 does not include out-of-scope flows from contaminated ground water, recovering pumping wells, or storm water. The table presents the national estimates of facilities subject to this guideline and the estimated wastewater flows from these facilities.

6.2.1 Wastewater Flow and Discharge at Subtitle D Non-Hazardous Landfills

Landfill facilities generated approximately 7 billion gallons of in-scope wastewater at non-hazardous landfills

in 1992. Flows collected from leachate collection systems are the primary source of wastewater, accounting for over 98 percent of the in-scope wastewater generated at non-hazardous landfills.

Landfill facilities subject to this guideline have several options for the discharge of their wastewater. EPA estimates that there are 143 Subtitle D non-hazardous facilities discharging wastewater directly into a receiving stream or body of water, accounting for 1.1 billion gallons per year. In addition, there are 756 facilities discharging wastewater indirectly to a POTW, accounting for 4.7 billion gallons per year.

Also, there are a number of facilities which use treatment and disposal practices that result in no discharge of wastewater to surface waters. The Agency estimates that there are 338 of these zero or alternative discharge facilities. Several zero or alternative discharge facilities in the Non-Hazardous subcategory recycle wastewater flows back into the landfill. The recirculation of leachate is generally believed to encourage the biological activity occurring in the landfill and accelerates the stabilization of the waste. The recirculation of landfill leachate is not prohibited by federal regulations, although many states have prohibited the practice. EPA estimates that 348 million gallons of landfill wastewater are recirculated back to Subtitle D non-hazardous landfill units each year.

6.2.2 Wastewater Flow and Discharge at Subtitle C Hazardous Landfills

Hazardous landfill facilities generated approximately 342 million gallons of in-scope wastewater in 1992. Flows collected from leachate collection systems are the primary source of wastewater, accounting for approximately 72 percent of the in-scope wastewater generated at hazardous landfills, and routine maintenance activities such as truck/equipment washing and floor washing account for 26 percent of the flows.

Landfill facilities have several options for the discharge of their wastewater. EPA's survey of the Landfills industry did not identify any hazardous landfills subject to the guideline that discharge in-scope wastewater

directly to surface waters. EPA estimates that there are 6 facilities discharging wastewater indirectly to POTWs, accounting for 40 million gallons per year.

The Agency estimates that 139 hazardous landfill facilities use zero or alternative discharge disposal options which account for over 302 million gallons per year. EPA estimates that 102 facilities ship wastewater off site for treatment, often to a treatment plant located at another landfill or to a Centralized Waste Treatment facility. Shipping off site accounts for 9 million gallons per year of wastewater. Another 36 facilities use underground injection for disposal of their wastewater, accounting for 312 million gallons per year, while 1 facility solidifies less than 0.1 million gallons per year of landfill wastewater.

6.3 Wastewater Characterization

The Agency collected the information reported in this section through its sampling program and data supplied by the Landfills industry via technical questionnaires. EPA sampling programs consisted of five-day events at landfills with selected BAT treatment systems (EPA sampled both raw leachate and treated effluent at these facilities) as well as one-day events to characterize raw leachate quality at landfill facilities. The Agency also used industry-provided data, as supplied in the Detailed Questionnaire and in the Detailed Monitoring Questionnaire responses, to characterize landfill generated wastewater. In addition, for the proposal, EPA used data collected as part of the Centralized Waste Treatment Industry study (see reference 31) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) ground water study (see reference 25) in the characterization of the wastewater from hazardous landfill facilities. However, after proposal, EPA decided not to include CERCLA data in characterizing hazardous landfill leachate because CERCLA discharges consisted primarily of ground water, which is not a wastewater flow covered by this regulation. Chapter 4 discusses these data sources in detail as well as the QA/QC procedures and editing rules used to evaluate these data. EPA characterized the raw wastewater for each subcategory by taking the median influent concentration from all data sources for each pollutant detected in that subcategory. This pollutant concentration is referred to as the Median Raw Wastewater Concentration File.

This section presents background information on the types of wastewater generated at landfill facilities and the factors that affect the wastewater characteristics. It also discusses the pollutant parameters analyzed and detected at EPA sampling episodes and the methodology for developing the Median Raw Wastewater Concentration File. This section also presents available literature data on the wastewater characteristics of Non-Hazardous subcategory landfill generated wastewater.

6.3.1 Background Information

Landfill generated wastewater is comprised of several wastewater sources that EPA discussed in Section 6.1. Wastewater that is subject to the landfill regulation includes landfill leachate, landfill gas condensate, truck/equipment washwater, drained free liquids, laboratory-derived wastewater, floor washings, and contaminated storm water runoff. Wastewater sources at landfills which are not subject to the landfill regulation include contaminated ground water, wastewater from recovering pumping wells, and non-contaminated storm water. The following section discusses the primary sources of in-scope landfill generated wastewater.

6.3.1.1 Landfill Leachate

Leachate is the liquid which passes through or emerges from solid waste, and contains soluble, suspended, or miscible materials removed from such waste. Several factors affect leachate quality, including the following:

- types of waste accepted/deposited
- operating practices (shredding, cover, and capping)
- amount of infiltration
- depth of fill
- compaction
- age

Waste types received for disposal are the most representative characteristic of a landfill and, therefore, of the wastewater generated, since the main contaminants in the wastewater are derived from the materials deposited into the fill (see Chapter 5: Industry Subcategorization). The amount of infiltration and the age of a landfill primarily affect the concentration of contaminants in the leachate. The remaining factors mainly influence the rate of infiltration.

EPA considered the following two factors when characterizing landfill leachate: the concentration of contaminants in the leachate and the volume of leachate generated. On a relative basis, the highest concentrations of contaminants are typically present in leachate of new or very young landfills. However, the overall loads (i.e., the mass) of pollutants are generally not very large because new landfills typically generate low volumes of leachate. As the volume of waste approaches the capacity of the landfill and the production of leachate increases, both the pollutant loadings (flow x concentration) and the concentrations of certain contaminants (mainly organic pollutants) increase. The increase of pollutant concentration is attributed to the onset of decomposition activities within the landfill and to the leachate traversing the entire depth of refuse. Therefore, large pollutant loadings from a typical landfill occur during a period of high leachate production and high contaminant levels (see reference 13). The exact periods of varying leachate production cannot be quantified readily but are site specific and dependent on each of the above variables.

Over a period of time (as the landfill ages and leaching continues), the concentration of contaminants in the leachate decreases (see reference 13). The landfill may continue to generate substantial quantities of leachate; however, pollutant loadings are lower due to the lower concentrations of soluble, suspended, or miscible contaminants remaining in the landfill. As decomposition of the landfill continues, the landfill attains a stabilized state of equilibrium where further leaching produces leachate with lower loadings than during the period of peak leachate production. This stabilized state is presumably the result of decomposition of landfill waste by indigenous microorganisms, which will remove many of the contaminants usually susceptible to further leaching.

Biological decomposition of landfill municipal refuse is often modeled after the anaerobic breakdown of other organic wastes. The following discussion of the decomposition process has been adapted from a report on the characteristics of landfill leachate prepared by the Wisconsin Department of Natural Resources (see reference 13).

Biological activity occurs in a landfill shortly after deposition of organic material. At first, wastes high in moisture content decompose rapidly under aerobic conditions, creating large amounts of heat. As oxygen is depleted, the intermediate anaerobic stage of decomposition begins. This change from aerobic to anaerobic conditions occurs unevenly through the landfill and depends upon the rate of oxygen diffusion in the fill layers. In the first stage of anaerobic decomposition, extra-cellular enzymes convert complex organic wastes to soluble organic molecules. Once the organic wastes are solubilized, the second stage of anaerobic decomposition converts them to simple organic molecules, such as acetic, propionic, and butyric acids, and other organic acids. These soluble organic acids enter the leachate percolating through a landfill, resulting in decreased pH of the leachate and increasing oxygen demand. Anaerobic activity in the landfill can also lower the reduction oxidation (redox) potential of the wastes which, under low pH conditions, can cause an increase in inorganic contaminants. Eventually, bacteria within the landfill begin converting the organic acids to methane. The absence of organic acids in the landfill increases the pH of the leachate which can lead to a decrease in the solubility of inorganic contaminants, lowering inorganic concentrations in the leachate (see reference 13).

The age or degree of decomposition of a landfill may, in certain circumstances, be ascertained by observing the concentration of various leachate indicator parameters, such as BOD_5, TDS, or the organic nitrogen concentration (see reference 13). The concentrations of these leachate indicator parameters can vary over the decomposition life of a landfill. Typically, older landfills have lower concentrations of BOD_5, COD, and most organic pollutants, indicating a smaller amount of degradable compounds from the aged waste. In addition, aged leachates can contain high levels of chemically reduced compounds, such as ammonia, and high chlorides because of the anaerobic environment of the landfill. However, using these indicator

parameters alone does not take into account any refuse-filling variables, such as processing of wastes prior to disposal and fill depth. To compensate for these additional variables, researchers examined ratios of leachate parameters over time (see reference 13). One such ratio is the ratio of BOD_5 to COD in the leachate. Leachates from younger landfills typically exhibit BOD_5 to COD ratios of approximately 0.8, while older landfills exhibit a ratio as low as 0.1. The decline in the BOD_5 to COD ratio with age is due primarily to the readily decomposable material (phenols, alcohols) degrading faster than the more recalcitrant compounds (heavy molecular weight organic compounds). As a result, as the landfill ages the BOD_5 of the leachate will decrease faster than the COD. Other ratios examined that reportedly decrease over time include the following: volatile solids to fixed solids, volatile acids to TOC, and sulfate to chloride (see reference 13).

It is common to find that the sum of individual organic contaminants does not always match the measured TOC and/or COD value. Compounds that comprise this difference are not always readily identified due to the complex nature of leachate and due to the presence of other organic compounds found in leachate. Myriad organic compounds exist in decomposing refuse and most of the organics in leachate are soluble. Reportedly, free volatile acids constitute the main organic fraction in leachate (see reference 13). However, other organic compounds have been identified in landfill leachates including carbohydrates, proteins, and humic and fulvic-like substances. Gaps in mass balance results are typically attributed to these compounds.

Responses to EPA's Detailed Questionnaire indicate that 1,625 in-scope landfills collect leachate at a median daily flow of 6,000 gallons per day. In 1992, in-scope landfills in the U.S. generated approximately 7.2 billion gallons of landfill leachate. Of this, approximately 1.6 billion gallons were treated on site, 719 million gallons were treated off site, 3.7 billion gallons were sent untreated to POTWs, 417 million gallons were sent untreated to a surface water, 348 million gallons were recycled back to the landfill, and 358 million gallons were treated or disposed by other methods, such as off-site treatment at another landfill wastewater treatment system or a Centralized Waste Treatment facility, deep well injection, incineration, evaporation, or land application.

6.3.1.1.1 Additional Sources of Non-Hazardous Leachate Characterization Data

Most of the existing literature regarding non-hazardous landfill leachate characteristics resulted from studies taken at an isolated range of municipal landfills in the 1970s and 1980s. Data presented in these reports on pollutant concentrations found in leachate are typically expressed in ranges due to the variability of leachate from various landfills. The range of pollutant concentration values, as well as the lack of specific information on factors affecting leachate results (e.g., sampling methods, analytical methods, landfill waste types, etc.) limit the usefulness of these data. However, these data are mentioned as additional background information in support of EPA's characterization activities. Table 6-5 presents a summary of available municipal leachate characteristic data from the following sources:

- Five published papers: George, 1972; Chian and DeWalle, 1977; Metry and Cross, 1977; Cameron, 1978; and Shams-Korzani and Henson, 1993.
- McGinley, Paul M. and Kmet, P. "Formation, Characteristics, Treatment and Disposal of Leachate from Municipal Solid Waste Landfills." Wisconsin Department of Natural Resources Special Report, August 1984, and
- Sobotka & Co., Inc. Case history data compiled and reported to U.S. EPA's Economic Analysis Branch, Office of Solid Waste, July 1986.

The variability and high pollutant concentrations in older landfill leachate characterization data can be attributed to landfills that accepted waste prior to the enactment of the Resource Conservation and Recovery Act (RCRA) in 1980. Landfills in operation prior to this date may have disposed of a multitude of different industrial and/or toxic wastes in addition to municipal solid waste. The disposal of these high-strength wastes could account for the large variability observed in leachate characteristics data collected from municipal landfills in this period. After the promulgation of RCRA, EPA established controls that specified the type and characteristics of wastes that may be received by either a hazardous (Subtitle C) or non-hazardous (Subtitle D) facility (see Chapter 3: Section 3.1 for the discussion on regulatory history). EPA has also mandated other control measures, such as leachate collection systems, under RCRA for both types of landfills. By instituting the acceptance criteria and leachate control standards under RCRA, the

characteristics of the leachate from both hazardous and non-hazardous landfills do not vary as greatly as observed in landfills prior to 1980. EPA's data shows that RCRA regulations have resulted in smaller concentration ranges for pollutants from landfills. EPA did observe pollutant variability in the data it collected; however, the variability was not as great as found in the data from older literature sources.

6.3.1.2 Landfill Gas Condensate

Landfill gas condensate forms in the collection lines used to extract and vent landfill gas. Condensate collects at low points in the gas collection lines and landfill facilities usually pump it to the on-site wastewater holding tank or treatment system. Responses to EPA's Detailed Questionnaire indicate that 158 in-scope landfills collect landfill gas condensate at a median daily flow of 343 gallons per day. In 1992, in-scope landfills in the U.S. generated approximately 23 million gallons of landfill gas condensate. Of this, approximately 20 million gallons were treated on site, 1.7 million gallons were treated off site, and 0.8 million gallons were sent untreated to POTWs. Of the 155 facilities collecting gas condensate, 66 commingle condensate with leachate for treatment on site, 79 facilities do not treat the condensate on site, and 10 facilities treat landfill gas condensate separately from other landfill generated wastewater.

Landfill gas condensate represents a small amount of the total wastewater flow for the industry. Hazardous waste landfills produce 9 million gallons/year of gas condensate, or about 4 percent of the leachate flow volume. Municipal solid waste landfills produce 14 million gallons/year of gas condensate, or about 0.2 percent of the leachate flow volume.

Of the 37 respondents to the Detailed Questionnaire that collect landfill gas condensate, five facilities treat the condensate separately from leachate. These facilities treated landfill gas condensate with one or more of the following technologies: equalization, neutralization, oil-water separation, granular activated carbon, and air stripping. All five facilities discharged the treated waste stream indirectly to a POTW. Table 6-6 presents landfill gas condensate monitoring data provided in the Detailed Questionnaire from two facilities that collect and treat landfill gas condensate separately from other landfill generated wastewater. Facility

16012 presented landfill gas condensate monitoring data after treatment by hydrocarbon/aqueous phase separation and caustic neutralization, and facility 16015 presented monitoring data after treatment by equalization, caustic neutralization, and carbon adsorption.

6.3.1.3 Drained Free Liquids

Drained free liquids are liquids drained from containerized waste prior to landfilling. Wastewater characteristics and volume of drained free liquids vary greatly depending upon the contents and origin of the waste. However, they will have similar characteristics to the containerized waste and, therefore, similar characteristics to landfill leachate. Drained free liquids include other wastewater generated by waste processing activities, such as waste stabilization. Waste stabilization includes the chemical fixation or solidification of the solid waste. Wastewater generated from these activities includes decant from the waste treated and any associated rinse waters. This waste processing wastewater is collected separately and then combined with leachate and other landfill operation wastewater for treatment at the wastewater treatment facility.

Responses to EPA's Detailed Questionnaire indicate that 25 in-scope landfills collect drained free liquids at a median daily flow of 3 gallons per day. In 1992, in-scope landfills in the U.S. generated approximately 0.5 million gallons of drained free liquids. Of this, approximately 715 gallons were treated on site and 47,000 gallons were treated or disposed by other methods such as treatment by a CWT or deep well injection.

6.3.1.4 Truck and Equipment Washwater

Landfill facilities generate truck and equipment washwater during either truck or equipment washes at the landfill. Depending on the type and usage of the vehicle/equipment cleaned and the type of landfill, the washwater volume and characteristics can vary greatly. For hazardous and non-hazardous landfill facilities, washwater will typically be more dilute in strength in comparison to typical leachate characteristics and contain mostly solids. Insoluble solids, consisting of mostly inorganics, metals, and low concentrations of

organic compounds are the primary source of contaminants in the washwater. Since truck and equipment washwater tends to contain the same constituents as the waste being landfilled and are similar in characteristic to the landfill leachate, they are typically combined for treatment with leachate and other landfill generated wastewater.

Responses to EPA's Detailed Questionnaire indicate that 356 in-scope landfills collect truck and equipment washwater at a median daily flow of 141 gallons per day. In 1992, in-scope landfills in the U.S. generated approximately 101 million gallons of truck and equipment washwater. Of this, approximately 38 million gallons were treated on site, 9 million gallons were sent untreated to POTWs, 1.3 million gallons were either treated off site, recycled back to the landfill, or sent untreated to a surface water, and 53 million gallons were treated or disposed by other methods, such as off-site treatment at another landfill wastewater treatment system or a Centralized Waste Treatment facility, deep well injection, incineration, evaporation, or land application.

Floor washings are also generated during routine cleaning and maintenance of landfill facilities. Responses to EPA's Detailed Questionnaire indicate that 68 in-scope landfills collect floor washings at a median daily flow of 985 gallons per day. In 1992, in-scope landfills in the U.S. generated approximately 45 million gallons of floor washings. Of this, approximately 6.4 million gallons were treated on site, 3.3 million gallons were sent untreated to POTWs, and 35 million gallons were treated or disposed by other methods, as discussed above.

6.3.2 Pollutant Parameters Analyzed at EPA Sampling Episodes

EPA conducted 19 sampling episodes at 18 landfill facilities. The Agency conducted five episodes at hazardous landfill facilities and 13 at non-hazardous facilities. EPA conducted one-day sampling episodes for the purpose of collecting raw wastewater samples to characterize landfill generated wastewater. Samples collected during the week-long sampling episodes included raw wastewater samples as well as

intermediate and effluent samples to evaluate the entire wastewater treatment system. Chapter 4 discusses these data collection activities in further detail.

Table 6-7 presents the pollutants analyzed at the one-day and week-long sampling episodes. EPA analyzed for a total of 470 pollutants in the raw wastewater, intermediate, and treated effluent waste stream samples, including 232 toxic and nonconventional organic compounds, 69 toxic and nonconventional metals, 4 conventional pollutants, and 165 toxic and nonconventional pollutants including pesticides, herbicides, dioxins, and furans. The list of pollutants analyzed are included under the following analytical methods: method 1613 for dioxins/furans, method 1620 for metals, method 1624 for volatile organics, method 1625 for semivolatile organics, and methods 1656, 1657, and 1658 for pesticides/herbicides, as well as classical wet chemistry methods.

Table 6-8 presents the list of pollutants analyzed at EPA sampling episodes by subcategory and episode number and whether EPA detected the pollutant in the facility's raw wastewater. If EPA did not detect a pollutant at a facility, Table 6-8 lists an ND (non-detect) in the appropriate row. If EPA did detect a pollutant at a facility, Table 6-8 lists a blank, and in cases where EPA did not sample for a pollutant at a facility, Table 6-8 lists a dash.

EPA collected composite samples at the week-long sampling events at episodes 4626, 4667, 4687, 4690, 4721, and 4759, while EPA collected grab samples at the remaining 12 one-day sampling events. The Agency developed a preliminary list of pollutants of interest by eliminating those pollutants that EPA never detected at any facility in a subcategory from the initial list of 470 pollutants. For the Non-Hazardous subcategory, EPA sampling never detected 316 pollutants in the raw wastewater at Subtitle D municipal facilities and 324 pollutants in the raw wastewater at Subtitle D non-municipal facilities. For the Hazardous subcategory, EPA sampling never detected 250 pollutants in the raw wastewater. Therefore, out of the 470 pollutants initially analyzed for, EPA detected 154 pollutants at least once at Subtitle D municipal facilities and 146 pollutants at least once at Subtitle D non-municipal facilities. For the Hazardous

subcategory, EPA detected 220 pollutants at least once at hazardous facilities. Using the editing criteria presented in Chapter 7, the Agency reduced this preliminary list of pollutants of interest to the final list of 32 pollutants of interest for the Non-Hazardous subcategory (32 pollutants of interest for Subtitle D municipal facilities and 9 pollutants of interest for Subtitle D non-municipal facilities) and 63 pollutants of interest for the Hazardous subcategory. Tables 6-9 and 6-10 present the median concentration for the pollutants of interest for both subcategories.

6.3.3 Raw Wastewater Characterization Data

In order to characterize wastewater from the Landfills industry, EPA compiled raw wastewater data from EPA sampling, the Detailed Questionnaire, the Detailed Monitoring Questionnaire, and the Centralized Waste Treatment Industry (CWT) database.

EPA reviewed each data source to determine if the data was representative of landfill generated wastewater. First, EPA selected only those sample points corresponding to raw wastewater. Second, EPA used several criteria to eliminate sampling data not considered representative of raw landfill wastewater. In characterizing landfill raw wastewater, EPA included only sampled wastewater containing at least 85 percent leachate and/or gas condensate. Therefore, EPA eliminated raw wastewater data that consisted mainly of wastewater that is not subject to this rule (e.g., storm water, ground water, or sanitary wastewater). Also, EPA eliminated wastewater data containing industrial process wastewater. This eliminated the possibility of finding pollutants that may not have originated in a landfill.

Next, EPA grouped all data points according to the classification of the landfill, e.g. municipal solid waste, hazardous waste, or Subtitle D non-municipal solid waste. Many facilities provided data from both technical questionnaires (the Detailed Questionnaire and the Detailed Monitoring Questionnaire), and in several instances, EPA conducted sampling at a facility that also provided data in the technical questionnaires. In these cases, EPA combined all data from the facility to obtain a facility average concentration for each pollutant. For each subcategory, EPA gathered the facility averages for all pollutants

into a file called the Raw Wastewater Source File. EPA then calculated the median of the facility average concentrations in the Source File to determine the median raw wastewater concentration for each pollutant in the subcategory. Tables 6-9 and 6-10 present the median values for the Non-Hazardous and Hazardous subcategories, respectively. EPA refers to this file as the Median Raw Wastewater Concentration File. Tables 6-11 through 6-13 present, by subcategory, the minimum and maximum of the facility average concentrations in the Raw Wastewater Source File, along with the number of observations and number of non-detect values. Note that although EPA included CERCLA data in the characterization of hazardous landfill leachate for the proposal, EPA did not include CERCLA data for raw wastewater characterization for the final rule. The CERCLA data consists primarily of contaminated ground water and, since contaminated ground water is not subject to the regulations, EPA determined that CERCLA data should not be used for hazardous landfill wastewater characterization. Therefore, the raw wastewater characterization data for the Hazardous subcategory presented in Tables 6-11 through 6-13 do not include CERCLA data.

6.3.4 Conventional, Toxic, and Selected Nonconventional Pollutant Parameters

The Clean Water Act defines different types of pollutant parameters used to characterize raw wastewater. These parameters include conventional, nonconventional, and toxic pollutants. Conventional pollutants found in landfill generated wastewater include the following:

- Total Suspended Solids (TSS)
- 5-day Biochemical Oxygen Demand (BOD_5)
- pH
- Oil and Grease (measured as Hexane Extractable Material)

Total solids in wastewater are defined as the residue remaining upon evaporation of the liquid at just above its boiling point. TSS is the portion of the total solids that can be filtered out of solution using a 1 micron filter. Raw wastewater TSS in leachate is a function of the type and form of wastes accepted for disposal

at landfill facilities. Landfill design and operational parameters such as depth of fill, compaction, and capping also influence the concentration of TSS. BOD_5 is one of the most important gauges of pollution potential of a wastewater and varies with the amount of biodegradable matter that can be assimilated by biological organisms under aerobic conditions. The nature of the chemicals contained in landfill generated wastewater affects the BOD_5 due to the differences in susceptibility of different molecular structures to microbiological degradation. Landfill generated wastewater containing compounds with lower susceptibility to decomposition by microorganisms tends to exhibit lower BOD_5 values, even though the total organic loading may be much higher when compared to wastewater exhibiting substantially higher BOD_5 values. For example, a landfill generated wastewater may have a low BOD_5 value while, at the same time, exhibiting a high TOC or COD concentration. Raw wastewater BOD_5 values can vary depending on the waste deposited in the landfill and the landfill age, as noted previously in Section 6.3.1.1.

The pH of a solution is a unitless measurement which represents the acidity or alkalinity of a wastewater stream (or aqueous solution) based on the disassociation of the acid or base in the solution into hydrogen (H^+) or hydroxide (OH^-) ions, respectively. Raw wastewater pH can be a function of the waste deposited in a landfill but can vary depending on the conditions within the landfill, as noted previously in Section 6.3.1.1. Fluctuations in pH are controlled readily by equalization followed by neutralization. Control of pH is necessary to achieve proper removal of pollutants in treatment systems such as metals precipitation and biological treatment systems.

Oil and grease also may be present in selected landfill generated wastewater. Proper control of oil and grease is important because it can interfere with the operation of certain wastewater treatment system processes such as chemical precipitation and the settling operations in biological systems. If it is not removed prior to discharge, excessive levels of oil and grease can interfere with the operation of POTWs and can create a film along surface waters, disrupting the biological activities in those waterways.

Table 6-11 presents the minimum and maximum facility average concentration data for TSS, BOD_5, and oil and grease for each landfill subcategory and the minimum and maximum facility average values for pH. EPA obtained the minimum and maximum values presented for each pollutant in the table from the Raw Wastewater Source File for both subcategories. The Source File contains many pollutants which EPA detected at least once in a subcategory but were not necessarily selected as pollutants of interest. EPA discusses the selection of pollutants of interest in Chapter 7.

EPA also used certain classical nonconventional pollutants for the purposes of raw wastewater characterization. These pollutant parameters include the following: ammonia as nitrogen, nitrate/nitrite, total dissolved solids, total organic carbon, total phenols, chemical oxygen demand, amenable cyanide, and total phosphorus. All of these pollutants are pollutants of interest for either the Non-Hazardous or Hazardous subcategory, with the exception of total phosphorus. For the purposes of presenting raw wastewater characterization data, EPA included these nonconventional pollutants with the conventional pollutants for each landfill subcategory in Table 6-11.

6.3.5 Toxic Pollutants and Remaining Nonconventional Pollutants

Table 6-12 presents the minimum and maximum facility-average concentration data for metals and toxic pollutants for the Non-Hazardous and Hazardous subcategories. EPA obtained the minimum and maximum values presented for each pollutant in the table from the Raw Wastewater Source File for both subcategories. Most of the pollutants included in Table 6-12 are pollutants of interest for either the Non-Hazardous or Hazardous subcategory. EPA detected a wide range of metals in raw wastewater from landfill facilities in both subcategories including both toxic pollutant and nonconventional pollutant metals.

Table 6-13 presents the minimum and maximum facility average concentration data for organic toxic and nonconventional pollutants for the two subcategories. EPA obtained the minimum and maximum values presented for each pollutant in the table from the Raw Wastewater Source File for both subcategories. All pollutants included in Table 6-13 are pollutants of interest for either the Non-Hazardous or Hazardous

subcategory. EPA detected a wide range of organic pollutants in raw wastewater at landfill facilities in both subcategories. Many of these are common organic pollutants found in municipal or commercial waste.

6.3.6 Raw Wastewater at Subtitle D Non-Hazardous Landfills

6.3.6.1 Raw Wastewater at Subtitle D Municipal Landfills

Raw wastewater generated at Subtitle D municipal landfills contained a range of conventional, toxic, and nonconventional pollutants. This wastewater also contained significant concentrations of common nonconventional metals such as iron, magnesium, and manganese. These metals are naturally occurring elements found in raw water, and the presence of these metals in landfill raw wastewater can be attributed to background levels in the water source used at the facility. Generally, toxic heavy metals were found at relatively low concentrations. EPA did not find toxic metals such as arsenic, cadmium, mercury, and lead at treatable levels in any of EPA's sampling episodes. Typical organic pollutants found in leachate included 2-butanone (methyl ethyl ketone) and 2-propanone (acetone), which are common solvents used in household products (such as paints and nail polish), and common industrial solvents such 4-methyl-2-pentanone and 1,4-dioxane. EPA detected only trace concentrations of only two pesticides (dichloroprop and disulfoton) in wastewater from municipal landfills. Additionally, EPA's data showed high loads of organic acids such as benzoic acid and hexanoic acid resulting from anaerobic decomposition of solid waste.

EPA identified 32 pollutants of interest for Subtitle D municipal landfills, including the following: eight conventional/nonconventional pollutants, six metals, 16 organics and pesticides/herbicides, and two dioxins/furans. In the Agency's sampling episodes, EPA never detected 316 pollutants, while approximately 122 pollutants were detected but were not present above the minimum level.

6.3.6.2 Raw Wastewater at Subtitle D Non-Municipal Landfills

A subset of the Subtitle D Non-Hazardous landfill subcategory is the Subtitle D non-municipal landfill.

These types of landfills do not accept municipal solid waste or household refuse. Rather, these facilities accept a number of different types of non-hazardous, non-municipal solid wastes. Waste types accepted at Subtitle D non-municipal facilities include, but are not limited to, municipal incinerator ash, industrial non-hazardous wastes and sludges, wastewater treatment plant sludge, yard waste, and construction and demolition wastes.

EPA identified 9 pollutants of interest for Subtitle D non-municipal landfills, including the following: eight conventional/nonconventional pollutants and one metal. In the Agency's sampling episodes, EPA never detected 324 pollutants, while 136 pollutants were detected but were not present above the minimum level.

Many Subtitle D non-municipal facilities accept two or more of the non-municipal waste types discussed above. Certain facilities accept only one type of waste and are referred to as "monofills". EPA performed an analysis to determine if significant differences existed in raw wastewater characteristics from Subtitle D municipal landfills and these monofill facilities. As discussed in Chapter 5, Section 5.3.1, EPA analyzed characterization data collected at municipal solid waste landfills and monofills as part of EPA's sampling program and analyzed data from several published reports, including prior EPA studies, analyzing construction and demolition monofills, ash monofills, and co-disposal sites. EPA evaluated these data to identify any pollutants found at significant concentrations in monofills that were not found in Subtitle D municipal landfills.

Based on a review of these data sources, EPA observed that the pollutants present in raw wastewater from monofills were not significantly different from those found in Subtitle D municipal landfills, and, in fact, pollutants present in monofills were a subset of those pollutants found at municipal solid waste landfills. In addition, concentrations of virtually all pollutants found in ash, sludge, and construction and demolition waste monofills were significantly lower than those found in raw wastewater from Subtitle D municipal landfills (see Chapter 5, Tables 5-3 and 5-4). EPA acknowledges that there were no organic pollutants of interest detected at Subtitle D non-municipal landfills, and that some monofills, such as ash monofills, may

have a low organic content and, therefore, may not be able to use the selected BPT/BAT treatment technology (biological treatment) to treat the wastewater. However, EPA concluded that these Subtitle D non-municipal facilities can meet the BPT/BAT limitations using available technologies. These treatment systems may be installed at costs comparable to those for biological treatment. As discussed in Chapter 11, EPA established equivalent effluent limitations for all Subtitle D non-hazardous landfills.

6.3.6.3 Dioxins and Furans in Raw Wastewater at Subtitle D Non-Hazardous Landfills

There are 210 isomers of chlorinated dibenzo-p-dioxins (CDD) and chlorinated dibenzofurans (CDF). EPA is primarily concerned with the 2,3,7,8-substituted congeners, of which EPA considers 2,3,7,8-TCDD to be the most toxic and is the only one that is a toxic pollutant. EPA considers non- 2,3,7,8-substituted congeners to be less toxic, in part, because they are not readily absorbed by living organisms. Dioxins and furans may be formed as by-products in certain industrial unit operations related to petroleum refining, pesticide and herbicide production, paper bleaching, and production of materials involving chlorinated compounds. Dioxins and furans are not water-soluble and are not expected to leach out of non-hazardous landfills in significant quantities.

As part of EPA sampling episodes at 13 non-hazardous landfills, EPA analyzed raw wastewater samples for 17 congeners of dioxins and furans. Table 6-14 presents the results of the data analyses. EPA also used additional raw leachate data from ash monofills from previous EPA studies, as discussed in Chapter 5, Section 5.3.1. EPA found low levels of OCDD, HpCDD, and HxCDD in raw wastewater at several landfills. The Agency did not detect the most toxic dioxin congener, 2,3,7,8-TCDD, in raw wastewater at a Subtitle D landfills. All concentrations of dioxins and furans in raw, untreated wastewater were well below the Universal Treatment Standards for F039 wastes (multi-source leachate) in 40 CFR 268.48, which establish minimum concentration standards based on based on the Best Demonstrated Available Treatment Technology (BDAT)[1]. At the concentrations found in raw landfill wastewater, EPA expects

[1] EPA bases UTS on the BDAT for each listed hazardous waste. BDAT represents the treatment technology that EPA concludes is the most effective for treating a particular waste that is also readily available to generators and treaters.

dioxins and furans to partition to the biological sludge as part of the BPT/BAT treatment technologies. EPA included the partitioning of dioxins and furans to the sludge in the evaluation of treatment benefits and water quality impacts. EPA sampling data and calculations conclude that the concentrations of dioxins and furans present in the wastewater would not prevent the sludge from being redeposited in a non-hazardous landfill.

6.3.7 Raw Wastewater at Subtitle C Hazardous Landfills

The Agency used data from EPA sampling episodes and industry supplied data obtained through the technical questionnaires to characterize raw wastewater from Subtitle C hazardous landfills. Wastewater generated at Subtitle C landfills contained a wide range of conventional, toxic, and nonconventional pollutants at treatable levels. There were a significantly greater number of pollutants found in hazardous landfill raw wastewater in comparison to non-hazardous landfills. Pollutants which were common to both untreated non-hazardous and hazardous wastewater were generally an order of magnitude higher in concentration in hazardous landfill wastewater. The list of pollutants of interest for the Hazardous subcategory (presented in Table 6-10), which includes 63 parameters, reflects the more toxic nature of hazardous landfill wastewater and the wide range of industrial waste sources. Chapter 7 discusses the methodology for determining pollutants of interest. For further discussion on the differences between hazardous and non-hazardous landfill leachate, see Chapter 5, Section 5.3.1.

Pollutants typical of raw leachate from hazardous facilities and found at higher median concentrations than at Subtitle D facilities included arsenic, chromium, copper, nickel, and zinc. EPA did not detect cadmium, lead, and mercury at treatable concentrations in the raw wastewater for any of the hazardous landfills sampled during EPA sampling episodes.

EPA identified a total of 63 pollutants of interest for Subtitle C hazardous landfills, including the following: 11 conventional/nonconventional pollutants, 11 metals, 37 organics and pesticides/herbicides, and 4 dioxins/furans. EPA sampling episodes never detected 250 pollutants, while approximately 157 pollutants were detected but were not present above the minimum level.

6.3.7.1 Dioxins and Furans in Raw Wastewater at Subtitle C Hazardous Landfills

As part of EPA sampling episodes at two in-scope Subtitle C landfills and two in-scope pre-1980 industrial landfills, EPA analyzed raw leachate samples for 17 congeners of dioxins and furans. Table 6-15 presents the results of these analyses. As in the Non-Hazardous subcategory, EPA did not detect the most toxic dioxin congener, 2,3,7,8-TCDD, at any in-scope hazardous/industrial landfill. EPA found low levels of several congeners in raw wastewater at many of the sampled landfills. Low levels of OCDD, OCDF, HpCDD, and HpCDF were detected in over half of the landfills sampled. However, all concentrations of dioxins and furans in raw, untreated wastewater were well below the Universal Treatment Standards (UTS) for F039 wastes (multi-source leachate) in 40 CFR 268.48, which establish minimum concentration standards based on BDAT. At the concentrations found in raw landfill wastewater, EPA expects dioxins and furans to partition to the biological sludge as part of the BPT/BAT treatment technologies.

Table 6-1: Wastewater Generated in 1992: Hazardous Subcategory (gallons)

Discharge Type	Wastewater Type	Treated On-Site	Treated Off-Site	Untreated to POTW	Untreated to Surface Water	Recycled Flow	Other
Indirect	Leachate	37,600,000	0	0	0	0	0
	Gas Condensate	772,000	0	0	0	0	0
	Truck/Equipment Washwater	1,220,000	0	101,000	0	0	0
	Floor Washings	706,000	0	0	0	0	0
	Storm Water	0	0	4,740,000	294,000,000	0	0
	Total Indirect	40,298,000	0	4,841,000	294,000,000	0	0
Zero	Leachate	18,100,000	20,600,000	0	0	0	169,000,000
	Gas Condensate	8,390,000	0	0	0	0	0
	Drained Free Liquids	0	0	0	0	0	47,000
	Truck/Equipment Washwater	28,400	513,000	0	0	0	50,300,000
	Floor Washings	0	0	0	0	0	35,000,000
	Contaminated Ground Water	28,700,000	0	0	0	0	0
	Storm Water	0	2,300,000	30,700,000	662,000,000	0	0
	Total Zero	55,218,400	23,413,000	30,700,000	662,000,000	0	254,347,000
Subcategory Total		95,516,400	23,413,000	35,541,000	956,000,000	0	254,347,000

Table 6-2: Wastewater Generated in 1992: Non-Hazardous Subcategory Municipal Facilities (gallons)

Discharge Type	Wastewater Type	Treated On-Site	Treated Off-Site	Untreated to POTW	Untreated to Surface Water	Recycled Flow	Other
Direct	Leachate	565,000,000	782,000	804,000	167,000,000	49,000	94,400,000
	Gas Condensate	1,570,000	0	0	0	0	0
	Drained Free Liquids	715	0	0	0	0	0
	Truck/Equipment Washwater	15,300,000	0	0	0	0	0
	Floor Washings	4,890,000	0	0	0	0	0
	Contaminated Ground Water	163,000,000	0	0	0	0	0
	Storm Water	348,000,000	0	0	3,430,000,000	0	0
	Total Direct	1,097,760,715	782,000	804,000	3,597,000,000	49,000	94,400,000
Indirect	Leachate	777,000,000	7,640,000	3,640,000,000	0	29,800,000	5,870,000
	Gas Condensate	9,700,000	65,900	793,000	0	0	19,700
	Truck/Equipment Washwater	20,700,000	0	9,060,000	594,000	0	0
	Floor Washings	794,000	0	3,320,000	0	0	0
	Contaminated Ground Water	226,000,000	0	0	0	0	0
	Storm Water	3,710,000,000	0	677,000,000	3,890,000,000	85,400,000	1,060,000,000

Table 6-2: Wastewater Generated in 1992: Non-Hazardous Subcategory Municipal Facilities (gallons) (cont'd)

Discharge Type	Wastewater Type	Treated On-Site	Treated Off-Site	Untreated to POTW	Untreated to Surface Water	Recycled Flow	Other
Indirect	Total Indirect	4,744,194,000	7,705,900	4,330,173,000	3,890,594,000	115,200,000	1,065,889,700
Zero	Leachate	170,000,000	561,000,000	0	0	233,000,000	88,600,000
	Gas Condensate	0	1,610,000	0	0	0	0
	Truck/Equipment Washwater	425,000	0	0	0	177,000	2,990,000
	Contaminated Ground Water	296,000,000	0	0	0	0	0
	Storm Water	3,930,000	0	0	137,000,000	212,000,000	24,700,000
	Total Zero	470,355,000	562,610,000	0	137,000,000	445,177,000	116,290,000
Subcategory Total		6,312,309,715	571,097,900	4,330,977,000	7,624,594,000	560,426,000	1,276,579,700

Table 6-3: Wastewater Generated in 1992: Non-Hazardous Subcategory Non-Municipal Facilities (gallons)

Discharge Type	Wastewater Type	Treated On-Site	Treated Off-Site	Untreated to POTW	Untreated to Surface Water	Recycled Flow	Other
Direct	Leachate	0	0	0	250,000,000	0	0
	Storm Water	0	0	0	4,900,000	0	0
	Total Direct	0	0	0	254,900,000	0	0
Indirect	Leachate	47,400,000	0	57,000,000	0	85,100,000	0
	Contaminated Ground Water	0	0	4,120,000	0	0	0
	Storm Water	19,800,000	0	0	0	0	43,100,000
	Total Indirect	67,200,000	0	61,120,000	0	85,100,000	43,100,000
Zero	Leachate	56,700	129,000,000	0	0	0	0
	Truck/Equipment Washwater	2,000	0	0	0	0	0
	Total Zero	58,700	129,000,000	0	0	0	0
Subcategory Total		67,258,700	129,000,000	61,120,000	254,900,000	85,100,000	43,100,000

Table 6-4: Quantity of In-Scope Wastewater Generated in 1992 (gallons)

Discharge Status	Subcategory					Total Wastewater Generated	Total Number of Facilities
	Non-Hazardous			Hazardous			
	Subtitle D Municipal	Subtitle D Non-Municipal	Subtitle D Facilities	Subtitle C	Subtitle C Facilities		
Direct	849,679,000	249,659,000	143	0	0	1,099,338,000	143
Indirect	4,509,255,000	189,511,000	756	40,361,000	6	4,739,127,000	762
Zero	1,058,156,000	128,633,000	338	302,112,000	139	1,488,901,000	477
Total	6,417,090,000	567,803,000	1,237	342,473,000	145	7,327,366,000	1,382

Table 6-5: Contaminant Concentration Ranges in Municipal Leachate as Reported in Literature Sources

Pollutant Parameter	George (1972)	Chain/DeWalle (1977)	Metry/Cross (1977)	Cameron (1978)	Wisconsin Report (20 Sites)	Sobotka Report (44 Sites)
Conventional						
BOD	9 - 54,610	81 - 33,360	2,200 - 720,000	9 - 55,000	ND - 195,000	7 - 21,600
pH	3.7 - 8.5	3.7 - 8.5	3.7 - 8.5	3.7 - 8.5	5 - 8.9	5.4 - 8.0
TSS	6 - 2,685	10 - 700	13 - 26,500		2 - 140,900	28 - 2,835
Non-Conventional						
Alkalinity	0 - 20,850	0 - 20,850	310 - 9,500	0 - 20,900	ND - 15,050	0 - 7,375
Bicarbonate			3,260 - 5,730			
Chlorides	34 - 2,800	4.7 - 2,467	47 - 2,350	34 - 2,800	2 - 11,375	120 - 5,475
COD	0 - 89,520	40 - 89,520	800 - 750,000	0 - 9,000	6.6 - 97,900	440 - 50,450
Fluorides				0 - 2.13	0 - 0.74	0.12 - 0.790
Hardness	0 - 22,800	0 - 22,800	35 - 8,700	0 - 22,800	52 - 225,000	0.8 - 9,380
NH3-Nitrogen	0 - 1,106	0 - 1,106	0.2 - 845	0 - 1,106		11.3 - 1,200
NO3-Nitrogen	0 - 1,300	0.2 - 1,0.29	4.5 - 18			0 - 5,0.95
Organic Nitrogen			2.4 - 550			4.5 - 78.2
Ortho-Phosphorus		6.5 - 85	0.3 - 136	0 - 154		
Sulfates	1 - 1,826	1 - 1,558	20 - 1,370	0 - 1,826	ND - 1,850	8 - 500
Sulfide				0 - 0.13		
TOC		256 - 28,000			ND - 30,500	5 - 6,884
TDS	0 - 42,276	584 - 44,900	100 - 51,000	0 - 42,300	584 - 50,430	1,400 - 16,120
Total-K-Nitrogen	0 - 1,416				2 - 3,320	47.3 - 938
Total Phosphorus	1 - 154	0 - 130			ND - 234	
Total Solids		0 - 59,200				1,900 - 25,873
Metals						
Aluminum				0 - 122	ND - 85	0.010 - 5.07
Arsenic				0 - 11.6	ND - 70.2	0 - 0.08
Barium				0 - 5.4	ND - 12.5	0.01 - 10
Beryllium				0 - 0.3	ND - 0.36	0.001 - 0.01
Boron				0.3 - 73	0.867 - 13	
Cadmium		0.03 - 17		0 - 0.19	ND - 0.04	0 - 0.1
Calcium	5 - 4,080	60 - 7,200	240 - 2,570	5 - 4,000	200 - 2,500	95.5 - 2,100
Total Chromium				0 - 33.4	ND - 5.6	0.001 - 1.0
Copper	0 - 9.9	0 - 9.9		0 - 10	ND - 4.06	0.003 - 0.32
Cyanide				0 - 0.11	ND - 6	0 - 4.0
Iron	0.2 - 5,500	0 - 2,820	0.12 - 1,700	0.2 - 5,500	ND - 1,500	0.22 - 1,400
Lead	0 - 0.5	<0.10 - 2.0		0 - 5.0	0 - 14.2	0.001 - 1.11
Magnesium	16.5 - 15,600	17 - 15,600	64 - 547	16.5 - 15,600	ND - 780	76 - 927
Manganese	0.06 - 1,400	0.09 - 125	13	0.06 - 1,400	ND - 31.1	0.03 - 43
Mercury				0 - 0.064	ND - 0.01	0 - 0.02
Molybendum				0 - 0.52	0.01 - 1.43	
Nickel				0.01 - 0.8	ND - 7.5	0.01 - 1.25
Potassium	2.8 - 3,770	28 - 3,770	28 - 3,800	2.8 - 3,770	ND - 2,800	30 - 1,375
Sodium	0 - 7,700	0 - 7,700	85 - 3,800	0 - 7,700	12 - 6,010	
Titanium				0 - 5.0	<0.01	
Vanadium				0 - 1.4	0.01	
Zinc	0 - 1,000	0 - 370	0.03 - 135	0 - 1,000	ND - 731	0.01 - 67

All concentrations in mg/L, except pH (std units).
ND = Non-detect

Table 6-6: Landfill Gas Condensate (from Detailed Questionnaire)

QID	Pollutant	# Obs	# ND	Avg. Conc.	Unit
16012	**Conventional**				
	Oil & Grease	1	0	422	mg/L
	Metals				
	Arsenic	1	0	570	ug/L
16015	**Organics**				
	1,2-Benzenedicarboxylic Acid, Diethyl Ester	3	1	2.0	mg/L
	1,3-Butadiene, 1,1,2,3,4,4-Hexachloro-	3	1	2.2	mg/L
	1,3-Dichlorobenzene	3	1	1.2	mg/L
	1,4-Dichlorobenzene	3	1	2.0	mg/L
	2,4,6-Trichlorophenol	3	2	15.0	mg/L
	2,4-Dichlorophenol	3	2	15.0	mg/L
	2,4-Dimethylphenol	3	2	17.3	mg/L
	2,6-Dinitrotoluene	3	2	5.83	mg/L
	2-Methyl-4,6-Dinitrophenol	3	0	100	mg/L
	2-Nitrophenol	3	2	17.5	mg/L
	3,4-Benzopyrene	3	2	2.0	mg/L
	3-Methyl-4-Chlorophenol	3	1	20.0	mg/L
	Benz(E)Acephenenthrylene	3	2	2.33	mg/L
	Benzenamine, 4-Nitro-	3	1	2.2	mg/L
	Benzene, Nitro-	3	2	4.3	mg/L
	Benzene Hexachloride	3	1	2.3	mg/L
	Benzene, Ethyl-	3	2	3.4	mg/L
	Benzene, Methyl-	3	2	2.6	mg/L
	Benzo(Def)Phenanthrene	3	1	2.2	mg/L
	Bis(2-Chloroethoxy)Methane	3	2	2.8	mg/L
	Chloroform	3	2	3.9	mg/L
	Di-n-propyl Nitrosamine	3	0	3.3	mg/L
	Ethene, Trichloro	3	2	2.5	mg/L
	Ethene, Tetrachloro-	3	1	10.6	mg/L
	O-Chlorophenol	3	2	8.7	mg/L
	Residue, Non-flammable	3	0	27.2	mg/L
	Metals				
	Gold	3	1	0.04	mg/L
	Lead	3	2	0.13	mg/L
	Zinc	3	0	0.14	mg/L

16012: Treated effluent after hydrocarbon/aqueous phase separation and caustic neutralization.
16015: Treated effluent after equalization, caustic neutralization, and carbon adsorption.
QID: Questionnaire ID number
Obs: Number of observations
ND: Number of non-detects

Table 6-7: EPA Sampling Episode Pollutants Analyzed

POLLUTANT	CAS NUM
CLASSSICAL WET CHEMISTRY	
AMENABLE CYANIDE	C-025
AMMONIA NITROGEN	7664-41-7
BOD	C-002
CHLORIDE	16887-00-6
COD	C-004
FLUORIDE	16984-48-8
HEXANE EXTRACTABLE MATERIAL	C-036
HEXAVALENT CHROMIUM	18540-29-9
NITRATE/NITRITE	C-005
PH	C-006
RECOVERABLE OIL AND GREASE	C-007
TDS	C-010
TOC	C-012
TOTAL CYANIDE	57-12-5
TOTAL PHENOLS	C-020
TOTAL PHOSPHORUS	14265-44-2
TOTAL SOLIDS	C-008
TOTAL SULFIDE	18496-25-8
TSS	C-009
1613: DIOXINS/FURANS	
2378-TCDD	1746-01-6
2378-TCDF	51207-31-9
12378-PECDD	40321-76-4
12378-PECDF	57117-41-6
23478-PECDF	57117-31-4
123478-HXCDD	39227-28-6
123678-HXCDD	57653-85-7
123789-HXCDD	19408-74-3
123478-HXCDF	70648-26-9
123678-HXCDF	57117-44-9
123789-HXCDF	72918-21-9
234678-HXCDF	60851-34-5
1234678-HPCDD	35822-46-9
1234678-HPCDF	67562-39-4
1234789-HPCDF	55673-89-7
OCDD	3268-87-9
OCDF	39001-02-0
1657: PESTICIDES/HERBICIDES	
AZINPHOS ETHYL	2642-71-9
AZINPHOS METHYL	86-50-0
CHLORFEVINPHOS	470-90-6
CHLORPYRIFOS	2921-88-2
COUMAPHOS	56-72-4
CROTOXYPHOS	7700-17-6
DEF	78-48-8
DEMETON A	8065-48-3A
DEMETON B	8065-48-3B
DIAZINON	333-41-5
DICHLORFENTHION	97-17-6
DICHLORVOS	62-73-7
DICROTOPHOS	141-66-2
DIMETHOATE	60-51-5
DIOXATHION	78-34-2
DISULFOTON	298-04-4
EPN	2104-64-5
ETHION	563-12-2
ETHOPROP	13194-48-8
FAMPHUR	52-85-7
FENSULFOTHION	115-90-2
FENTHION	55-38-9
HEXAMETHYLPHOSPHORAMIDE	680-31-9
LEPTOPHOS	21609-90-5
MALATHION	121-75-5
MERPHOS	150-50-5

POLLUTANT	CAS NUM
1657: PESTICIDES/HERBICIDES	
METHAMIDOPHOS	10265-92-6
METHYL CHLORPYRIFOS	5598-13-0
METHYL PARATHION	298-00-0
METHYL TRITHION	953-17-3
MEVINPHOS	7786-34-7
MONOCROTOPHOS	6923-22-4
NALED	300-76-5
PARATHION (ETHYL)	56-38-2
PHORATE	298-02-2
PHOSMET	732-11-6
PHOSPHAMIDONE	297-99-4
PHOSPHAMIDON Z	23783-98-4
RONNEL	299-84-3
SULFOTEPP	3689-24-5
SULPROFOS	35400-43-2
TEPP	107-49-3
TERBUFOS	13071-79-9
TETRACHLORVINPHOS	22248-79-9
TOKUTHION	34643-46-4
TRICHLORFON	52-68-6
TRICHLORONATE	327-98-0
TRICRESYLPHOSPHATE	78-30-8
TRIMETHYLPHOSPHATE	512-56-1
1656: PESTICIDES/HERBICIDES	
ACEPHATE	30560-19-1
ACIFLUORFEN	50594-66-6
ALACHLOR	15972-60-8
ALDRIN	309-00-2
ATRAZINE	1912-24-9
BENFLURALIN	1861-40-1
ALPHA-BHC	319-84-6
BETA-BHC	319-85-7
GAMMA-BHC	58-89-9
DELTA-BHC	319-86-8
BROMACIL	314-40-9
BROMOXYNIL OCTANOATE	1689-99-2
BUTACHLOR	23184-66-9
CAPTAFOL	2425-06-1
CAPTAN	133-06-2
CARBOPHENOTHION	786-19-6
ALPHA-CHLORDANE	5103-71-9
GAMMA-CHLORDANE	5103-74-2
CHLOROBENZILATE	510-15-6
CHLORONEB	2675-77-6
CHLOROPROPYLATE	5836-10-2
CHLOROTHALONIL	1897-45-6
DIBROMOCHLOROPROPANE	96-12-8
DACTHAL (DCPA)	1861-32-1
4,4'-DDD	72-54-8
4,4'-DDE	72-55-9
4,4'-DDT	50-29-3
DIALLATE A	2303-16-4A
DIALLATE B	2303-16-4B
DICHLONE	117-80-6
DICOFOL	115-32-2
DIELDRIN	60-57-1
ENDOSULFAN I	959-98-8
ENDOSULFAN II	33213-65-9
ENDOSULFAN SULFATE	1031-07-8
ENDRIN	72-20-8
ENDRIN ALDEHYDE	7421-93-4
ENDRIN KETONE	53494-70-5
ETHALFLURALIN	55283-68-6
ETRADIAZOLE	2593-15-9

Table 6-7: EPA Sampling Episode Pollutants Analyzed (continued)

POLLUTANT	CAS NUM
1656: PESTICIDES/HERBICIDES	
FENARIMOL	60168-88-9
HEPTACHLOR	76-44-8
HEPTACHLOR EPOXIDE	1024-57-3
ISODRIN	465-73-6
ISOPROPALIN	33820-53-0
KEPONE	143-50-0
METHOXYCHLOR	72-43-5
METRIBUZIN	21087-64-9
MIREX	2385-85-5
NITROFEN	1836-75-5
NORFLUORAZON	27314-13-2
PCB-1016	12674-11-2
PCB-1221	11104-28-2
PCB-1232	11141-16-5
PCB-1242	53469-21-9
PCB-1248	12672-29-6
PCB-1254	11097-69-1
PCB-1260	11096-82-5
PENTACHLORONITROBENZENE	82-68-8
PENDAMETHALIN	40487-42-1
CIS-PERMETHRIN	61949-76-6
TRANS-PERMETHRIN	61949-77-7
PERTHANE	72-56-0
PROPACHLOR	1918-16-7
PROPANIL	709-98-8
PROPAZINE	139-40-2
SIMAZINE	122-34-9
STROBANE	8001-50-1
TERBACIL	5902-51-2
TERBUTHYLAZINE	5915-41-3
TOXAPHENE	8001-35-2
TRIADIMEFON	43121-43-3
TRIFLURALIN	1582-09-8
1658: PESTICIDES/HERBICIDES	
DALAPON	75-99-0
DICAMBA	1918-00-9
DICHLOROPROP	120-36-5
DINOSEB	88-85-7
MCPA	94-74-6
MCPP	7085-19-0
PICLORAM	1918-02-1
2,4-D	94-75-7
2,4-DB	94-82-6
2,4,5-T	93-76-5
2,4,5-TP	93-72-1
1620: METALS	
ALUMINUM	7429-90-5
ANTIMONY	7440-36-0
ARSENIC	7440-38-2
BARIUM	7440-39-3
BERYLLIUM	7440-41-7
BISMUTH	7440-69-9
BORON	7440-42-8
CADMIUM	7440-43-9
CALCIUM	7440-70-2
CERIUM	7440-45-1
CHROMIUM	7440-47-3
COBALT	7440-48-4
COPPER	7440-50-8
DYSPROSIUM	7429-91-6
ERBIUM	7440-52-0
EUROPIUM	7440-53-1
GADOLINIUM	7440-54-2
GALLIUM	7440-55-3

POLLUTANT	CAS NUM
1620: METALS	
GERMANIUM	7440-56-4
GOLD	7440-57-5
HAFNIUM	7440-58-6
HOLMIUM	7440-60-0
INDIUM	7440-74-6
IODINE	7553-56-2
IRIDIUM	7439-88-5
IRON	7439-89-6
LANTHANUM	7439-91-0
LEAD	7439-92-1
LITHIUM	7439-93-2
LUTETIUM	7439-94-3
MAGNESIUM	7439-95-4
MANGANESE	7439-96-5
MERCURY	7439-97-6
MOLYBDENUM	7439-98-7
NEODYMIUM	7440-00-8
NICKEL	7440-02-0
NIOBIUM	7440-03-1
OSMIUM	7440-04-2
PALLADIUM	7440-05-3
PHOSPHORUS	7723-14-0
PLATINUM	7440-06-4
POTASSIUM	7440-09-7
PRASEODYMIUM	7440-10-0
RHENIUM	7440-15-5
RHODIUM	7440-16-6
RUTHENIUM	7440-18-8
SAMARIUM	7440-19-9
SCANDIUM	7440-20-2
SELENIUM	7782-49-2
SILICON	7440-21-3
SILVER	7440-22-4
SODIUM	7440-23-5
STRONTIUM	7440-24-6
SULFUR	7704-34-9
TANTALUM	7440-25-7
TELLURIUM	13494-80-9
TERBIUM	7440-27-9
THALLIUM	7440-28-0
THORIUM	7440-29-1
THULIUM	7440-30-4
TIN	7440-31-5
TITANIUM	7440-32-6
TUNGSTEN	7440-33-7
URANIUM	7440-61-1
VANADIUM	7440-62-2
YTTERBIUM	7440-64-4
YTTRIUM	7440-65-5
ZINC	7440-66-6
ZIRCONIUM	7440-67-7
1624: VOLATILE ORGANICS	
1,1-DICHLOROETHANE	75-34-3
1,1-DICHLOROETHENE	75-35-4
1,1,1-TRICHLOROETHANE	71-55-6
1,1,1,2-TETRACHLOROETHANE	630-20-6
1,1,2-TRICHLOROETHANE	79-00-5
1,1,2,2-TETRACHLOROETHANE	79-34-5
1,2-DIBROMOETHANE	106-93-4
1,2-DICHLOROETHANE	107-06-2
1,2-DICHLOROPROPANE	78-87-5
1,2,3-TRICHLOROPROPANE	96-18-4
1,3-DICHLOROPROPANE	142-28-9
1,4-DIOXANE	123-91-1

Table 6-7: EPA Sampling Episode Pollutants Analyzed (continued)

POLLUTANT	CAS NUM
1624: VOLATILE ORGANICS	
2-BUTANONE (MEK)	78-93-3
2-CHLORO-1,3-BUTADIENE	126-99-8
2-CHLOROETHYLVINYL ETHER	110-75-8
2-HEXANONE	591-78-6
2-METHYL-2-PROPENENITRILE	126-98-7
2-PROPANONE (ACETONE)	67-64-1
2-PROPENAL (ACROLEIN)	107-02-8
2-PROPEN-1-OL (ALLYL ALCOHOL)	107-18-6
3-CHLOROPROPENE	107-05-1
4-METHYL-2-PENTANONE	108-10-1
ACRYLONITRILE	107-13-1
BENZENE	71-43-2
BROMODICHLOROMETHANE	75-27-4
BROMOFORM	75-25-2
BROMOMETHANE	74-83-9
CARBON DISULFIDE	75-15-0
CHLOROACETONITRILE	107-14-2
CHLOROBENZENE	108-90-7
CHLOROETHANE	75-00-3
CHLOROFORM	67-66-3
CHLOROMETHANE	74-87-3
CIS-1,3-DICHLOROPROPENE	10061-01-5
CROTONALDEHYDE	4170-30-3
DIBROMOCHLOROMETHANE	124-48-1
DIBROMOMETHANE	74-95-3
DIETHYL ETHER	60-29-7
ETHYL BENZENE	100-41-4
ETHYL CYANIDE	107-12-0
ETHYL METHACRYLATE	97-63-2
IODOMETHANE	74-88-4
ISOBUTYL ALCOHOL	78-83-1
METHYLENE CHLORIDE	75-09-2
M-XYLENE	108-38-3
O+P XYLENE	136777-61-2
TETRACHLOROETHENE	127-18-4
TETRACHLOROMETHANE	56-23-5
TOLUENE	108-88-3
TRANS-1,2-DICHLOROETHENE	156-60-5
TRANS-1,3-DICHLOROPROPENE	10061-02-6
TRANS-1,4-DICHLORO-2-BUTENE	110-57-6
TRICHLOROETHENE	79-01-6
TRICHLOROFLUOROMETHANE	75-69-4
VINYL ACETATE	108-05-4
VINYL CHLORIDE	75-01-4
1625: SEMIVOLATILE ORGANICS	
1-METHYLFLUORENE	1730-37-6
1-METHYLPHENANTHRENE	832-69-9
1-PHENYLNAPHTHALENE	605-02-7
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8
1,2-DICHLOROBENZENE	95-50-1
1,2-DIPHENYLHYDRAZINE	122-66-7
1,2,3-TRICHLOROBENZENE	87-61-6
1,2,3-TRIMETHOXYBENZENE	634-36-6
1,2,4-TRICHLOROBENZENE	120-82-1
1,2,4,5-TETRACHLOROBENZENE	95-94-3
1,2:3,4-DIEPOXYBUTANE	1464-53-5
1,3-BENZENEDIOL (RESORCINOL)	108-46-3
1,3-DICHLORO-2-PROPANOL	96-23-1
1,3-DICHLOROBENZENE	541-73-1
1,3,5-TRITHIANE	291-21-4
1,4-DICHLOROBENZENE	106-46-7
1,4-DINITROBENZENE	100-25-4
1,4-NAPHTHOQUINONE	130-15-4
1,5-NAPHTHALENEDIAMINE	2243-62-1

POLLUTANT	CAS NUM
1625: SEMIVOLATILE ORGANICS	
2-BROMOCHLOROBENZENE	694-80-4
2-CHLORONAPHTHALENE	91-58-7
2-CHLOROPHENOL	95-57-8
2-ISOPROPYLNAPHTHALENE	2027-17-0
2-METHYL-4,6-DINITROPHENOL	534-52-1
2-METHYLBENZOTHIOAZOLE	120-75-2
2-METHYLNAPHTHALENE	91-57-6
2-NITROANILINE	88-74-4
2-NITROPHENOL	88-75-5
2-PHENYLNAPHTHALENE	612-94-2
2-PICOLINE	109-06-8
2-(METHYLTHIO)BENZOTHIAZOLE	615-22-5
2,3-BENZOFLUORENE	243-17-4
2,3-DICHLOROANILINE	608-27-5
2,3-DICHLORONITROBENZENE	3209-22-1
2,3,4,6-TETRACHLOROPHENOL	58-90-2
2,3,6-TRICHLOROPHENOL	933-75-5
2,4-DIAMINOTOLUENE	95-80-7
2,4-DICHLOROPHENOL	120-83-2
2,4-DIMETHYLPHENOL	105-67-9
2,4-DINITROPHENOL	51-28-5
2,4-DINITROTOLUENE	121-14-2
2,4,5-TRICHLOROPHENOL	95-95-4
2,4,5-TRIMETHYLANILINE	137-17-7
2,4,6-TRICHLOROPHENOL	88-06-2
2,6-DICHLORO-4-NITROANILINE	99-30-9
2,6-DICHLOROPHENOL	87-65-0
2,6-DINITROTOLUENE	606-20-2
2,6-DI-TERT-BUTYL-P-BENZOQUINONE	719-22-2
3-BROMOCHLOROBENZENE	108-37-2
3-CHLORONITROBENZENE	121-73-3
3-METHYLCHOLANTHRENE	56-49-5
3-NITROANILINE	99-09-2
3,3-DICHLOROBENZIDINE	91-94-1
3,3'-DIMETHOXYBENZIDINE	119-90-4
3,5-DIBROMO-4-HYDROXYBENZONITRILE	1689-84-5
3,6-DIMETHYLPHENANTHRENE	1576-67-6
4-AMINOBIPHENYL	92-67-1
4-BROMOPHENYL PHENYL ETHER	101-55-3
4-CHLORO-2-NITROANILINE	89-63-4
4-CHLORO-3-METHYLPHENOL	59-50-7
4-CHLOROANILINE	106-47-8
4-CHLOROPHENYL PHENYL ETHER	7005-72-3
4-NITROANILINE	100-01-6
4-NITROBIPHENYL	92-93-3
4-NITROPHENOL	100-02-7
4,4-METHYLENE-BIS(2-CHLOROANILINE)	101-14-4
4,5-METHYLENE-PHENANTHRENE	203-64-5
5-CHLORO-O-TOLUIDINE	95-79-4
5-NITRO-O-TOLUIDINE	99-55-8
7,12-DIMETHYLBENZ(A)ANTHRACENE	57-97-6
ACENAPHTHENE	83-32-9
ACENAPHTHYLENE	208-96-8
ACETOPHENONE	98-86-2
ALPHA-NAPHTHYLAMINE	134-32-7
ALPHA-TERPINEOL	98-55-5
ANILINE	62-53-3
ANTHRACENE	120-12-7
ARAMITE	140-57-8
BENZANTHRONE	82-05-3
BENZENETHIOL	108-98-5
BENZIDINE	92-87-5
BENZOIC ACID	65-85-0
BENZO(A)ANTHRACENE	56-55-3

Table 6-7: EPA Sampling Episode Pollutants Analyzed (continued)

POLLUTANT	CAS NUM	POLLUTANT	CAS NUM
1625: SEMIVOLATILE ORGANICS		**1625: SEMIVOLATILE ORGANICS**	
BENZO(A)PYRENE	50-32-8	N-NITROSOMORPHOLINE	59-89-2
BENZO(B)FLUORANTHENE	205-99-2	N-NITROSOPIPERIDINE	100-75-4
BENZO(GHI)PERYLENE	191-24-2	N,N-DIMETHYLFORMAMIDE	68-12-2
BENZO(K)FLUORANTHENE	207-08-9	O-ANISIDINE	90-04-0
BENZYL ALCOHOL	100-51-6	O-CRESOL	95-48-7
BETA-NAPHTHYLAMINE	91-59-8	O-TOLUIDINE	95-53-4
BIPHENYL	92-52-4	P-CRESOL	106-44-5
BIS(2-CHLOROETHOXY)METHANE	111-91-1	P-CYMENE	99-87-6
BIS(2-CHLOROETHYL)ETHER	111-44-4	P-DIMETHYLAMINO-AZOBENZENE	60-11-7
BIS(2-CHLOROISOPROPYL)ETHER	108-60-1	PENTACHLOROBENZENE	608-93-5
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	PENTACHLOROETHANE	76-01-7
BUTYL BENZYL PHTHALATE	85-68-7	PENTACHLOROPHENOL	87-86-5
CARBAZOLE	86-74-8	PENTAMETHYLBENZENE	700-12-9
CHRYSENE	218-01-9	PERYLENE	198-55-0
CROTOXYPHOS	7700-17-6	PHENACETIN	62-44-2
DIBENZOFURAN	132-64-9	PHENANTHRENE	85-01-8
DIBENZOTHIOPHENE	132-65-0	PHENOL	108-95-2
DIBENZO(A,H)ANTHRACENE	53-70-3	PHENOTHIAZINE	92-84-2
DIETHYL PHTHALATE	84-66-2	PRONAMIDE	23950-58-5
DIMETHYL PHTHALATE	131-11-3	PYRENE	129-00-0
DIMETHYL SULFONE	67-71-0	PYRIDINE	110-86-1
DI-N-BUTYL PHTHALATE	84-74-2	SAFROLE	94-59-7
DI-N-OCTYL PHTHALATE	117-84-0	SQUALENE	7683-64-9
DIPHENYL ETHER	101-84-8	STYRENE	100-42-5
DIPHENYLAMINE	122-39-4	THIANAPHTHENE (2,3-BENZOTHIOPHENE)	95-15-8
DIPHENYLDISULFIDE	882-33-7	THIOACETAMIDE	62-55-5
ETHYL METHANESULFONATE	62-50-0	THIOXANTHONE	492-22-8
ETHYLENETHIOUREA	96-45-7	TRIPHENYLENE	217-59-4
ETHYNYLESTRADIOL-3-METHYL ETHER	72-33-3	TRIPROPYLENEGLYCOLMETHYL ETHER	20324-33-8
FLUORANTHENE	206-44-0		
FLUORENE	86-73-7		
HEXACHLOROBENZENE	118-74-1		
HEXACHLOROBUTADIENE	87-68-3		
HEXACHLOROCYCLOPENTADIENE	77-47-4		
HEXACHLOROETHANE	67-72-1		
HEXACHLOROPROPENE	1888-71-7		
HEXANOIC ACID	142-62-1		
INDENO(1,2,3-CD)PYRENE	193-39-5		
ISOPHORONE	78-59-1		
ISOSAFROLE	120-58-1		
LONGIFOLENE	475-20-7		
MALACHITE GREEN	569-64-2		
METHAPYRILENE	91-80-5		
METHYL METHANESULFONATE	66-27-3		
NAPHTHALENE	91-20-3		
N-C10 (N-DECANE)	124-18-5		
N-C12 (N-DODECANE)	112-40-3		
N-C14 (N-TETRADECANE)	629-59-4		
N-C16 (N-HEXADECANE)	544-76-3		
N-C18 (N-OCTADECANE)	593-45-3		
N-C20 (N-EICOSANE)	112-95-8		
N-C22 (N-DOCOSANE)	629-97-0		
N-C24 (N-TETRACOSANE)	646-31-1		
N-C26 (N-HEXACOSANE)	630-01-3		
N-C28 (N-OCTACOSANE)	630-02-4		
N-C30 (N-TRIACONTANE)	638-68-6		
NITROBENZENE	98-95-3		
N-NITROSODIETHYLAMINE	55-18-5		
N-NITROSODIMETHYLAMINE	62-75-9		
N-NITROSODI-N-BUTYLAMINE	924-16-3		
N-NITROSODI-N-PROPYLAMINE	621-64-7		
N-NITROSODIPHENYLAMINE	86-30-6		
N-NITROSOMETHYL-ETHYLAMINE	10595-95-6		
N-NITROSOMETHYL-PHENYLAMINE	614-00-6		

Table 6-8: EPA Sampling Episode List of Analytes Never Detected

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
1613: DIOXINS/FURANS																					
2378-TCDD	1746-01-6	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2378-TCDF	51207-31-9	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
12378-PECDD	40321-76-4	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12378-PECDF	57117-41-6	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
23478-PECDF	57117-31-4	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
123478-HXCDD	39227-28-6	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
123678-HXCDD	57653-85-7	ND	-	-	ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND	ND	ND	ND
123789-HXCDD	19408-74-3	ND	-	-	ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND	ND	ND	ND
123478-HXCDF	70648-26-9	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
123678-HXCDF	57117-44-9	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
123789-HXCDF	72918-21-9	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
234678-HXCDF	60851-34-5	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND
1234678-HPCDD	35822-46-9		-	-	ND		ND		ND	ND	ND	ND	ND		ND		ND	ND			ND
1234678-HPCDF	67562-39-4	ND	-	-	ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND			ND
1234789-HPCDF	55673-89-7	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
OCDD	3268-87-9		-	-	ND		ND		ND	ND	ND	ND	ND				ND	ND			ND
OCDF	39001-02-0	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND			ND
1620: METALS																					
ALUMINUM	7429-90-5									ND	ND	ND	ND				ND				
ANTIMONY	7440-36-0				ND	ND	ND	ND	ND			ND		ND		ND	ND				
ARSENIC	7440-38-2								ND		ND		ND								
BARIUM	7440-39-3																				
BERYLLIUM	7440-41-7	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BISMUTH	7440-69-9	ND		ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BORON	7440-42-8			ND																	
CADMIUM	7440-43-9						ND	ND	ND	ND			ND		ND	ND	ND		ND	ND	
CALCIUM	7440-70-2																				
CERIUM	7440-45-1	ND		ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND
CHROMIUM	7440-47-3				ND		ND	ND	ND		ND	ND	ND				ND		ND		
COBALT	7440-48-4		ND		ND				ND	ND	ND	ND	ND		ND						
COPPER	7440-50-8				ND		ND					ND			ND	ND	ND				
DYSPROSIUM	7429-91-6	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERBIUM	7440-52-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	
EUROPIUM	7440-53-1	ND			ND	ND	ND	ND	ND				ND	ND	ND	ND	ND	ND	ND	ND	
GADOLINIUM	7440-54-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
GALLIUM	7440-55-3	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GERMANIUM	7440-56-4	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GOLD	7440-57-5	ND		ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HAFNIUM	7440-58-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
HOLMIUM	7440-60-0	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
INDIUM	7440-74-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
IODINE	7553-56-2	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
IRIDIUM	7439-88-5	ND	ND		ND	ND	ND	ND	ND				ND	ND	ND	ND	ND		ND	ND	ND
IRON	7439-89-6																				
LANTHANUM	7439-91-0	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
LEAD	7439-92-1	ND	ND				ND	ND	ND			ND	ND		ND	ND	ND		ND	ND	
LITHIUM	7439-93-2	ND			ND	ND		ND		ND	ND		ND								
LUTETIUM	7439-94-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
MAGNESIUM	7439-95-4																				
MANGANESE	7439-96-5																				
MERCURY	7439-97-6				ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND		
MOLYBDENUM	7439-98-7				ND	ND	ND	ND		ND			ND		ND	ND					
NEODYMIUM	7440-00-8	ND	ND	ND	ND		ND	ND	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	
NICKEL	7440-02-0									ND	ND	ND	ND								
NIOBIUM	7440-03-1	ND			ND	ND	ND	ND	ND				ND	ND	ND	ND		ND	ND	ND	ND
OSMIUM	7440-04-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PALLADIUM	7440-05-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
PHOSPHORUS	7723-14-0	ND			ND						ND	ND	ND				ND				
PLATINUM	7440-06-4	ND	ND		ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND
POTASSIUM	7440-09-7	ND										ND									
PRASEODYMIUM	7440-10-0	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
RHENIUM	7440-15-5	ND	ND		ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	
RHODIUM	7440-16-6	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	
RUTHENIUM	7440-18-8	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
SAMARIUM	7440-19-9	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	
SCANDIUM	7440-20-2	ND			ND	ND	ND	ND	ND				ND	ND	ND	ND	ND	ND	ND	ND	
SELENIUM	7782-49-2	ND			ND	ND	ND	ND			ND	ND	ND	ND	ND		ND				
SILICON	7440-21-3	ND																			
SILVER	7440-22-4	ND	ND		ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SODIUM	7440-23-5																				
STRONTIUM	7440-24-6	ND																			
SULFUR	7704-34-9	ND										ND									
TANTALUM	7440-25-7	ND			ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	
TELLURIUM	13494-80-9	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERBIUM	7440-27-9	ND	ND		ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
THALLIUM	7440-28-0	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND
THORIUM	7440-29-1	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THULIUM	7440-30-4	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
TIN	7440-31-5	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND			ND	

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
TITANIUM	7440-32-6				ND						ND	ND	ND				ND		ND		
TUNGSTEN	7440-33-7	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
URANIUM	7440-61-1	ND	ND		ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
VANADIUM	7440-62-2				ND		ND		ND	ND	ND	ND	ND				ND				
YTTERBIUM	7440-64-4	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
YTTRIUM	7440-65-5			ND			ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
ZINC	7440-66-6											ND									
ZIRCONIUM	7440-67-7	ND	ND		ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND	ND	ND	ND	
1624: VOLATILE ORGANICS																					
1,1-DICHLOROETHANE	75-34-3			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				
1,1-DICHLOROETHENE	75-35-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,1,1-TRICHLOROETHANE	71-55-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND
1,1,1,2-TETRACHLOROETHANE	630-20-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,1,2-TRICHLOROETHANE	79-00-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,1,2,2-TETRACHLOROETHANE	79-34-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,2-DIBROMOETHANE	106-93-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	107-06-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND				
1,2-DICHLOROPROPANE	78-87-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
1,2,3-TRICHLOROPROPANE	96-18-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,3-DICHLOROPROPANE	142-28-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DIOXANE	123-91-1	ND				ND	ND	ND	ND		ND	ND	ND		ND		ND			ND	
2-BUTANONE (MEK)	78-93-3						ND	ND	ND	ND	ND	ND	ND				ND				
2-CHLORO-1,3-BUTADIENE	126-99-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
2-CHLOROETHYLVINYL ETHER	110-75-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-HEXANONE	591-78-6	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND				ND
2-METHYL-2-PROPENENITRILE	126-98-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
2-PROPANONE (ACETONE)	67-64-1							ND		ND	ND	ND	ND								
2-PROPENAL (ACROLEIN)	107-02-8	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-PROPEN-1-OL (ALLYL ALCOHOL)	107-18-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND
3-CHLOROPROPENE	107-05-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-2-PENTANONE	108-10-1	ND				ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				
ACRYLONITRILE	107-13-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZENE	71-43-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				
BROMODICHLOROMETHANE	75-27-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BROMOFORM	75-25-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BROMOMETHANE	74-83-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	75-15-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	
CHLOROACETONITRILE	107-14-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
CHLOROBENZENE	108-90-7	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND			ND
CHLOROETHANE	75-00-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND		ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
CHLOROFORM	67-66-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
CHLOROMETHANE	74-87-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,3-DICHLOROPROPENE	10061-01-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
CROTONALDEHYDE	4170-30-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBROMOCHLOROMETHANE	124-48-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBROMOMETHANE	74-95-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIETHYL ETHER	60-29-7	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		ND
ETHYL BENZENE	100-41-4						ND	ND	ND	ND	ND	ND	ND	ND			ND				
ETHYL CYANIDE	107-12-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYL METHACRYLATE	97-63-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IODOMETHANE	74-88-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOBUTYL ALCOHOL	78-83-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	
METHYLENE CHLORIDE	75-09-2				ND		ND	ND	ND	ND	ND	ND	ND		ND		ND				
M-XYLENE	108-38-3				ND		ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		
O+P XYLENE	136777-61-2				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		ND
TETRACHLOROETHENE	127-18-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND
TETRACHLOROMETHANE	56-23-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND
TOLUENE	108-88-3								ND	ND	ND	ND	ND	ND			ND				
TRANS-1,2-DICHLOROETHENE	156-60-5	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND
TRANS-1,3-DICHLOROPROPENE	10061-02-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	79-01-6	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND				ND
TRICHLOROFLUOROMETHANE	75-69-4	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VINYL ACETATE	108-05-4	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VINYL CHLORIDE	75-01-4	ND				ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND
1625: SEMIVOLATILE ORGANICS																					
1-METHYLFLUORENE	1730-37-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYLPHENANTHRENE	832-69-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-PHENYLNAPHTHALENE	605-02-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROBENZENE	95-50-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND
1,2-DIPHENYLHYDRAZINE	122-66-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
1,2,3-TRICHLOROBENZENE	87-61-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3-TRIMETHOXYBENZENE	634-36-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	120-82-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4,5-TETRACHLOROBENZENE	95-94-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2:3,4-DIEPOXYBUTANE	1464-53-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-BENZENEDIOL (RESORCINOL)	108-46-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DICHLORO-2-PROPANOL	96-23-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DICHLOROBENZENE	541-73-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
1,3,5-TRITHIANE	291-21-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND
1,4-DICHLOROBENZENE	106-46-7		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND
1,4-DINITROBENZENE	100-25-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-NAPHTHOQUINONE	130-15-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,5-NAPHTHALENEDIAMINE	2243-62-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-BROMOCHLOROBENZENE	694-80-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-CHLORONAPHTHALENE	91-58-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-CHLOROPHENOL	95-57-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-ISOPROPYLNAPHTHALENE	2027-17-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-4,6-DINITROPHENOL	534-52-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
2-METHYLBENZOTHIOAZOLE	120-75-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLNAPHTHALENE	91-57-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
2-NITROANILINE	88-74-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-NITROPHENOL	88-75-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
2-PHENYLNAPHTHALENE	612-94-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-PICOLINE	109-06-8			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
2-(METHYLTHIO)BENZOTHIAZOLE	615-22-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
2,3-BENZOFLUORENE	243-17-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DICHLOROANILINE	608-27-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DICHLORONITROBENZENE	3209-22-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4,6-TETRACHLOROPHENOL	58-90-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,6-TRICHLOROPHENOL	933-75-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIAMINOTOLUENE	95-80-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DICHLOROPHENOL	120-83-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLPHENOL	105-67-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		
2,4-DINITROPHENOL	51-28-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
2,4-DINITROTOLUENE	121-14-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-TRICHLOROPHENOL	95-95-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-TRIMETHYLANILINE	137-17-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-TRICHLOROPHENOL	88-06-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DICHLORO-4-NITROANILINE	99-30-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DICHLOROPHENOL	87-65-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DINITROTOLUENE	606-20-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
2,6-DI-TERT-BUTYL-P-BENZOQUINONE	719-22-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-BROMOCHLOROBENZENE	108-37-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-CHLORONITROBENZENE	121-73-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLCHOLANTHRENE	56-49-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-NITROANILINE	99-09-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DICHLOROBENZIDINE	91-94-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-DIMETHOXYBENZIDINE	119-90-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
3,5-DIBROMO-4-HYDROXYBENZONITRILE	1689-84-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,6-DIMETHYLPHENANTHRENE	1576-67-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-AMINOBIPHENYL	92-67-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-BROMOPHENYL PHENYL ETHER	101-55-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-CHLORO-2-NITROANILINE	89-63-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-CHLORO-3-METHYLPHENOL	59-50-7	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
4-CHLOROANILINE	106-47-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-NITROANILINE	100-01-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-NITROBIPHENYL	92-93-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-NITROPHENOL	100-02-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
4,4-METHYLENE-BIS(2-CHLOROANILINE)	101-14-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,5-METHYLENE-PHENANTHRENE	203-64-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-CHLORO-O-TOLUIDINE	95-79-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-NITRO-O-TOLUIDINE	99-55-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7,12-DIMETHYLBENZ(A)ANTHRACENE	57-97-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	83-32-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
ACENAPHTHYLENE	208-96-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACETOPHENONE	98-86-2	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND		ND	ND
ALPHA-NAPHTHYLAMINE	134-32-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
ALPHA-TERPINEOL	98-55-5					ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND		ND
ANILINE	62-53-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		
ANTHRACENE	120-12-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARAMITE	140-57-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZANTHRONE	82-05-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZENETHIOL	108-98-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZIDINE	92-87-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZOIC ACID	65-85-0	ND				ND	ND	ND	ND	ND	ND	ND	ND		ND						
BENZO(A)ANTHRACENE	56-55-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(A)PYRENE	50-32-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	205-99-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(GHI)PERYLENE	191-24-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(K)FLUORANTHENE	207-08-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZYL ALCOHOL	100-51-6	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
BETA-NAPHTHYLAMINE	91-59-8		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
BIPHENYL	92-52-4	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-CHLOROETHOXY) METHANE	111-91-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-CHLOROETHYL) ETHER	111-44-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
BIS(2-CHLOROISOPROPYL) ETHER	108-60-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
BUTYL BENZYL PHTHALATE	85-68-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBAZOLE	86-74-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHRYSENE	218-01-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CROTOXYPHOS	7700-17-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBENZOFURAN	132-64-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
DIBENZOTHIOPHENE	132-65-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBENZO(A,H)ANTHRACENE	53-70-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIETHYL PHTHALATE	84-66-2	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIMETHYL PHTHALATE	131-11-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIMETHYL SULFONE	67-71-0	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-BUTYL PHTHALATE	84-74-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-OCTYL PHTHALATE	117-84-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIPHENYL ETHER	101-84-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
DIPHENYLAMINE	122-39-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIPHENYLDISULFIDE	882-33-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYL METHANESULFONATE	62-50-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLENETHIOUREA	96-45-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYNYLESTRADIOL-3-METHYL ETHER	72-33-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORANTHENE	206-44-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
FLUORENE	86-73-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
HEXACHLOROBENZENE	118-74-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	87-68-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOPENTADIENE	77-47-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROETHANE	67-72-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROPROPENE	1888-71-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXANOIC ACID	142-62-1	ND					ND		ND	ND	ND	ND	ND		ND				ND		
INDENO(1,2,3-CD)PYRENE	193-39-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOPHORONE	78-59-1			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOSAFROLE	120-58-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LONGIFOLENE	475-20-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MALACHITE GREEN	569-64-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHAPYRILENE	91-80-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL METHANESULFONATE	66-27-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	91-20-3		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		
N-C10 (N-DECANE)	124-18-5		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C12 (N-DODECANE)	112-40-3	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C14 (N-TETRADECANE)	629-59-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
N-C16 (N-HEXADECANE)	544-76-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C18 (N-OCTADECANE)	593-45-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C20 (N-EICOSANE)	112-95-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
N-C22 (N-DOCOSANE)	629-97-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C24 (N-TETRACOSANE)	646-31-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C26 (N-HEXACOSANE)	630-01-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C28 (N-OCTACOSANE)	630-02-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C30 (N-TRIACONTANE)	638-68-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NITROBENZENE	98-95-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODIETHYLAMINE	55-18-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODIMETHYLAMINE	62-75-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODI-N-BUTYLAMINE	924-16-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODI-N-PROPYLAMINE	621-64-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODIPHENYLAMINE	86-30-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSOMETHYL -ETHYLAMINE	10595-95-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSOMETHYL-PHENYLAMINE	614-00-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSOMORPHOLINE	59-89-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSOPIPERIDINE	100-75-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N,N-DIMETHYLFORMAMIDE	68-12-2	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
O-ANISIDINE	90-04-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
O-CRESOL	95-48-7	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND			
O-TOLUIDINE	95-53-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P-CRESOL	106-44-5	ND		ND			ND	ND	ND	ND	ND	ND	ND				ND		ND		
P-CYMENE	99-87-6	ND			ND	ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND		ND
P-DIMETHYLAMINO-AZOBENZENE	60-11-7	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLOROBENZENE	608-93-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLOROETHANE	76-01-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLOROPHENOL	87-86-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTAMETHYLBENZENE	700-12-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERYLENE	198-55-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHENACETIN	62-44-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHENANTHRENE	85-01-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
PHENOL	108-95-2					ND	ND	ND		ND	ND	ND	ND								
PHENOTHIAZINE	92-84-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PRONAMIDE	23950-58-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PYRENE	129-00-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
PYRIDINE	110-86-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
SAFROLE	94-59-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SQUALENE	7683-64-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
STYRENE	100-42-5	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THIANAPHTHENE (2,3-BENZOTHIOPHENE)	95-15-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THIOACETAMIDE	62-55-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THIOXANTHONE	492-22-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
TRIPHENYLENE	217-59-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPROPYLENEGLYCOLMETHYL ETHER	20324-33-8	ND		ND			ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND		
1656: PESTICIDES/HERBICIDES																					
ACEPHATE	30560-19-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACIFLUORFEN	50594-66-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
ALACHLOR	15972-60-8	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
ALDRIN	309-00-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ATRAZINE	1912-24-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND			
BENFLURALIN	1861-40-1	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
ALPHA-BHC	319-84-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND	
BETA-BHC	319-85-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
GAMMA-BHC	58-89-9		ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
DELTA-BHC	319-86-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		
BROMACIL	314-40-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
BROMOXYNIL OCTANOATE	1689-99-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
BUTACHLOR	23184-66-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
CAPTAFOL	2425-06-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CAPTAN	133-06-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBOPHENOTHION	786-19-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ALPHA-CHLORDANE	5103-71-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
GAMMA-CHLORDANE	5103-74-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZILATE	510-15-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
CHLORONEB	2675-77-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROPROPYLATE	5836-10-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
CHLOROTHALONIL	1897-45-6	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	
DIBROMOCHLOROPROPANE (DBCP)	96-12-8	ND		ND		ND	ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND	
DACTHAL (DCPA)	1861-32-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
4,4'-DDD	72-54-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	72-55-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
4,4'-DDT	50-29-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND		
DIALLATE A	2303-16-4A	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
DIALLATE B	2303-16-4B	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		
DICHLONE	117-80-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DICOFOL	115-32-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIELDRIN	60-57-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
ENDOSULFAN I	959-98-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
ENDOSULFAN II	33213-65-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ENDOSULFAN SULFATE	1031-07-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND
ENDRIN	72-20-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
ENDRIN ALDEHYDE	7421-93-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
ENDRIN KETONE	53494-70-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
ETHALFLURALIN	55283-68-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	
ETRADIAZOLE	2593-15-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
FENARIMOL	60168-88-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTACHLOR	76-44-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
HEPTACHLOR EPOXIDE	1024-57-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
ISODRIN	465-73-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
ISOPROPALIN	33820-53-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
KEPONE	143-50-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHOXYCHLOR	72-43-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
METRIBUZIN	21087-64-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
MIREX	2385-85-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NITROFEN	1836-75-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
NORFLUORAZON	27314-13-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1016	12674-11-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1221	11104-28-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1232	11141-16-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1242	53469-21-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1248	12672-29-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1254	11097-69-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1260	11096-82-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLORONITROBENZENE (PCNB)	82-68-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
PENDAMETHALIN	40487-42-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
CIS-PERMETHRIN	61949-76-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-PERMETHRIN	61949-77-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERTHANE	72-56-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
PROPACHLOR	1918-16-7	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	
PROPANIL	709-98-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PROPAZINE	139-40-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		
SIMAZINE	122-34-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND			
STROBANE	8001-50-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERBACIL	5902-51-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERBUTHYLAZINE	5915-41-3	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				
TOXAPHENE	8001-35-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIADIMEFON	43121-43-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIFLURALIN	1582-09-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	
1657: PESTICIDES/HERBICIDES																					
AZINPHOS ETHYL	2642-71-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AZINPHOS METHYL	86-50-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORFEVINPHOS	470-90-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
CHLORPYRIFOS	2921-88-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
COUMAPHOS	56-72-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CROTOXYPHOS	7700-17-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEF	78-48-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEMETON A	8065-48-3A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
DEMETON B	8065-48-3B	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIAZINON	333-41-5		ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
DICHLORFENTHION	97-17-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
DICHLORVOS	62-73-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
DICROTOPHOS	141-66-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
DIMETHOATE	60-51-5	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIOXATHION	78-34-2	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DISULFOTON	298-04-4	ND	ND				ND	ND	ND		ND		ND	ND	ND	ND	ND		ND	ND	ND
EPN	2104-64-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHION	563-12-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHOPROP	13194-48-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FAMPHUR	52-85-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FENSULFOTHION	115-90-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FENTHION	55-38-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXAMETHYLPHOSPHORAMIDE	680-31-9	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
LEPTOPHOS	21609-90-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MALATHION	121-75-5		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
MERPHOS	150-50-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
METHAMIDOPHOS	10265-92-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
METHYL CHLORPYRIFOS	5598-13-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL PARATHION	298-00-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
METHYL TRITHION	953-17-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MEVINPHOS	7786-34-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MONOCROTOPHOS	6923-22-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NALED	300-76-5	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
PARATHION (ETHYL)	56-38-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHORATE	298-02-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHOSMET	732-11-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHOSPHAMIDON E	297-99-4	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
PHOSPHAMIDON Z	23783-98-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RONNEL	299-84-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SULFOTEPP	3689-24-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SULPROFOS	35400-43-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TEPP	107-49-3		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
TERBUFOS	13071-79-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6-8: EPA Sampling Episode List of Analytes Never Detected (continued)

		Non-Hazardous Subcategory														Hazardous Subcategory					
		Subtitle D Municipal					**Subtitle D Non-Municipal**														
POLLUTANT	**CAS NUM**	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
TETRACHLORVINPHOS	22248-79-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOKUTHION	34643-46-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
TRICHLORFON	52-68-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLORONATE	327-98-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICRESYLPHOSPHATE	78-30-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIMETHYLPHOSPHATE	512-56-1		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
1658: PESTICIDES/HERBICIDES																					
DALAPON	75-99-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND	ND
DICAMBA	1918-00-9		ND					ND	ND	ND	ND	ND	ND								
DICHLOROPROP	120-36-5	ND	ND					ND	ND	ND	ND	ND	ND								
DINOSEB	88-85-7	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND		ND		ND	ND			
MCPA	94-74-6							ND	ND		ND		ND								
MCPP	7085-19-0					ND	ND	ND	ND		ND		ND			ND			ND		
PICLORAM	1918-02-1	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND		ND	ND	ND			ND	
2,4-D	94-75-7		ND			ND		ND	ND	ND	ND	ND	ND				ND				
2,4-DB	94-82-6		ND	ND		ND		ND	ND	ND	ND	ND	ND		ND						
2,4,5-T	93-76-5	ND	ND					ND	ND	ND	ND	ND	ND			ND	ND				
2,4,5-TP	93-72-1		ND			ND		ND	ND	ND	ND		ND								
CLASSSICAL WET CHEMISTRY																					
AMENABLE CYANIDE	C-025	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
AMMONIA NITROGEN	7664-41-7										ND										
BOD	C-002													ND							
CHLORIDE	16887-00-6	ND																			
COD	C-004																				
FLUORIDE	16984-48-8																				
HEXANE EXTRACTABLE MATERIAL	C-036	-					-		ND	ND	ND	ND	ND				ND				
HEXAVALENT CHROMIUM	18540-29-9					ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		
NITRATE/NITRITE	C-005																				
PH	C-006																				
RECOVERABLE OIL AND GREASE	C-007		-	-	-	-		-	-	-	-	ND	-	-	-	-	ND	-	-	-	-
TDS	C-010																				
TOC	C-012										ND	ND	ND				ND				
TOTAL CYANIDE	57-12-5			ND	ND	ND	ND				ND	ND	ND	ND					ND		
TOTAL PHENOLS	C-020							ND					ND								
TOTAL PHOSPHORUS	14265-44-2								ND	ND	ND		ND				ND				
TOTAL SOLIDS	C-008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-
TOTAL SULFIDE	18496-25-8		-										ND	ND							
TSS	C-009										ND	ND	ND								

Table 6-9: Subtitle D Non-Hazardous Subcategory Median Raw Wastewater Concentration File

Subtitle D Non-Hazardous Pollutant of Interest	Subtitle D Municipal Median Concentration (ug/L)	Subtitle D Non-Municipal Median Concentration (ug/L)
Conventional		
BOD	240,000	67,000
TSS	137,000	20,500
Classical (Non-Conventional)		
Ammonia as Nitrogen	81,717	75,000
COD	994,000	1,100,000
Hexavalent Chromium	30	
Nitrate/Nitrite	651	950
TDS	2,894,289	4,850,000
TOC	376,521	236,000
Total Phenols	571	251
Organic (Toxic & Non-Conventional)		
1,4-Dioxane	10.8	
2-Butanone	1,082	
2-Propanone	992	
4-Methyl-2-Pentanone	101	
Alpha Terpineol	123	
Benzoic Acid	100	
Hexanoic Acid	5,818	
Methylene Chloride	36.8	
N,N-Dimethylformamide	10	
O-Cresol	15	
P-Cresol	75	
Phenol	102	
Toluene	108	
Tripropyleneglycol Methyl Ether	197	
Metals (Toxic & Non-Conventional)		
Barium	483	
Chromium	28	
Strontium	1,671	4,615
Titanium	63.8	
Zinc	100	
Pesticides/Herbicides (Non-Conventional)		
Dichloroprop	6.1	
Disulfoton	6.1	
Dioxins/Furans (Non-Conventional)		
1234678-HpCDD	0.00014	
OCDD	0.0018	

Table 6-10: Subtitle C Hazardous Subcategory Median Raw Wastewater Concentration File

Subtitle C Hazardous Pollutant of Interest	Median Conc. (ug/L)	Subtitle C Hazardous Pollutant of Interest	Median Conc. (ug/L)
Conventional		**Organics (cont.)**	
BOD	620,500	Toluene	104
Hexane Extractable Material	29,360	Trans-1,2-Dichloroethene	74.3
TSS	151,000	Trichloroethene	44.6
Classical (Non-Conventional)		Tripropyleneglycol Methyl Ether	853
Amenable Cyanide	1,638	Vinyl Chloride	42.7
Ammonia as Nitrogen	268,000	**Metals (Toxic & Non-Coventional)**	
COD	1,308,833	Arsenic	214
Nitrate/Nitrite	1,580	Chromium	47.8
TDS	15,958,333	Copper	36
TOC	440,902	Lithium	450
Total Phenols	25,004	Molybdenum	913
Organics (Toxic & Non-Conventional)		Nickel	240
1,1-Dichloroethane	45.7	Selenium	20
1,4-Dioxane	466	Strontium	3,044
2,4-Dimethylphenol	70	Tin	146
2-Butanone	1,048	Titanium	32.6
2-Propanone	2,889	Total Cyanide	82.5
4-Methyl-2-Pentanone	500	Zinc	100
Alpha Terpineol	95.7	**Pesticides/Herbicides (Non-Coventional)**	
Aniline	237	2,4,5-TP	4.1
Benzene	36.9	2,4-D	5
Benzoic Acid	2,482	2,4-DB	7.9
Benzyl Alcohol	43.6	Dicamba	4
Diethyl Ether	50	Dichloroprop	7.3
Ethylbenzene	44.8	MCPA	209
Hexanoic Acid	2,703	MCPP	870
Isobutyl Alcohol	39.7	Picloram	2
Methylene Chloride	118	Terbuthylazine	14.5
M-Xylene	29.4	**Dioxins/Furans (Non-Conventional)**	
Naphthalene	48.9	1234678-HpCDD	0.00018
O+P Xylene	17.1	1234678-HpCDF	0.00013
O-Cresol	78.8	OCDD	0.00035
Phenol	4,400	OCDF	0.0019
Pyridine	70		
P-Cresol	144		

Table 6-11: Range of Conventional and Selected Nonconventional Pollutants Raw Wastewater Average Concentrations (ug/L)

		Non-Hazardous Subcategory								Hazardous Subcategory			
		Subtitle D Municipal				Subtitle D Non-Municipal							
Pollutant	Cas No.	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND
Amenable Cyanide	C-025	-	-			-	-			0.01	29,895	4	2
Biochemical Oxygen Demand (BOD)	C-002	10,500	7,609,318	31	0	1,000	3,799,333	9	1	22,000	2,962,535	8	0
Total Suspended Solids (TSS)	C-009	6,500	14,470,000	26	0	4,000	16,500,000	8	2	31,667	568,233	9	0
pH	C-006	6.7	9.8	5	0	6.6	9.2	9	0	5.8	11	6	0
Hexane Extractable Material	C-036	5,000	26,000	4	0	5,000	64,000	9	4	5,000	64,800	5	1
Ammonia as Nitrogen	7664417	1,782	2,900,000	24	0	100	5,860,000	9	1	9,767	613,620	6	0
Chemical Oxygen Demand (COD)	C-004	35,000	11,881,700	28	0	80,000	16,700,000	9	0	270,000	6,872,579	8	0
Nitrate/Nitrite	C-005	20	50,800	17	3	50	36,000	9	1	380	192,516	6	0
Total Dissolved Solids (TDS)	C-010	752,000	17,533,000	22	0	936,000	33,900,000	9	0	4,594,917	31,000,000	6	0
Total Organic Carbon (TOC)	C-012	9,400	3,446,084	22	0	10,000	4,820,000	9	2	2,000	3,824,286	8	2
Total Phenols	C-020	50	2,051,249	15	1	50	39,200	9	1	280	192,367	5	0
Total Phosphorus	14265442	17	6,500	17	6	10	22,700	7	2	10	15,900	5	1

#Obs: Number of observations
#ND: Number of non-detects
(-): Not detected in any sample

Table 6-12: Range of Metals and Toxic Pollutants Raw Wastewater Average Concentrations (ug/L)

		Non-Hazardous Subcategory								Hazardous Subcategory			
		Subtitle D Municipal				Subtitle D Non-Municipal							
Pollutant	Cas No.	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND
Aluminum	7429905	60.5	111,100	7	0	21.5	712,000	8	3	-	-	-	-
Arsenic	7440382	-	-	-	-	2	18,300	10	3	17	1,370	9	1
Barium	7440393	43	3,500	19	1	140	3,570	10	0	-	-	-	-
Boron	7440428	36	5,704	7	0	76	16,250	8	0	511	8,175	7	0
Chromium	7440473	2	240	27	9	-	-	-	-	10	720	9	3
Chromium (Hexavalent)	18540299	2	247	9	3	-	-	-	-	-	-	-	-
Copper	7440508	-	-	-	-	-	-	-	-	9	610	9	4
Iron	7439896	2,494	1,667,600	27	0	556	100,000	9	0	3,585	36,758	7	0
Lithium	7439932	-	-	-	-	-	-	-	-	101	1,166	6	0
Magnesium	7439954	24,100	212,480	14	0	8,139	388,000	9	0	8,307	440,767	6	0
Manganese	7439965	149	78,820	20	0	471	7,151	9	0	81	9,045	6	0
Molybdenum	7439987	-	-	-	-	4.2	69	8	4	9	18,757	6	1
Nickel	7440020	-	-	-	-	-	-	-	-	60	2,871	9	0
Phosphorus	7723140	-	-	-	-	-	-	-	-	551	24,650	7	1
Selenium	7782492	-	-	-	-	-	-	-	-	14	173	9	3
Silicon	7440213	1,034	91,100	4	0	2,498	159,000	8	0	2,520	17,911	6	0
Strontium	7440246	787	2,146	4	0	277	30,100	8	0	369	30,839	6	0
Sulfur	7704349	3,969	107,999	4	0	13,700	386,573	7	0	10,360	786,857	6	0
Tin	7440315	-	-	-	-	-	-	-	-	30	1,118	6	1
Titanium	7440326	4	157	6	1	4.4	1,740	8	2	3	764	6	2
Total Cyanide	57125	-	-	-	-	-	-	-	-	10	13,317	10	1
Zinc	7440666	11.5	31,813	27	1	2	1,240	10	1	45.5	846	9	0

#Obs: Number of observations
#ND: Number of non-detects
(-): Not detected in any sample

Table 6-13: Range of Organic Pollutants Raw Wastewater Average Concentrations (ug/L)

		Non-Hazardous Subcategory								Hazardous Subcategory			
		Subtitle D Municipal				Subtitle D Non-Municipal							
Pollutant	Cas No.	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND
1,1-Dichloroethane	75343	-	-	-	-	-	-	-	-	0.5	250	10	4
1,4-Dioxane	123911	10	323	5	2	-	-	-	-	10	7,611	9	5
1234678-HpCDD	35822469	0.00005	0.007	3	1	-	-	-	-	0.00005	0.007	6	2
1234678-HpCDF	67562394	-	-	-	-	-	-	-	-	0.00005	0.001	6	2
2,4-D	94757	-	-	-	-	-	-	-	-	0.5	310	9	4
2,4-DB	94826	-	-	-	-	-	-	-	-	2.9	120	6	1
2,4-Dimethylphenol	105679	-	-	-	-	-	-	-	-	10	2,546	9	5
2,4,5-TP	93721	-	-	-	-	-	-	-	-	0.1	13.2	9	4
2-Butanone	78933	19.3	36,544	14	3	-	-	-	-	50	15,252	10	3
2-Propanone	67641	50	8,614	12	4	50	780	10	6	73	8,166	10	1
4-Methyl-2-Pentanone	108101	35	46,161	13	4	-	-	-	-	50	3,168	9	3
Alpha Terpineol	98555	10	1,061	5	1	-	-	-	-	10	654	6	3
Aniline	62533	-	-	-	-	-	-	-	-	10	2,500	9	5
Benzene	71432	-	-	-	-	-	-	-	-	0.3	229	10	5
Benzoic Acid	65850	0.55	33,335	7	3	-	-	-	-	50	306,194	6	1
Benzyl Alcohol	100516	-	-	-	-	-	-	-	-	10	5,690	6	4
Dicamba	1918009	-	-	-	-	-	-	-	-	0.49	31	6	0
Dichloroprop	120365	1	29	5	2	-	-	-	-	2.2	44	6	1
Diethyl Ether	60297	-	-	-	-	-	-	-	-	10	159	9	5
Disulfoton	298044	2.3	20	5	2	-	-	-	-	-	-	-	-
Ethyl Benzene	100414	-	-	-	-	-	-	-	-	0.5	1,072	10	4
Hexanoic Acid	142621	10	37,256	5	1	-	-	-	-	13	31,086	6	1
Isobutyl Alcohol	78831	-	-	-	-	-	-	-	-	10	10,000	9	6
MCPA	94746	-	-	-	-	50	4370	8	2	15	7,071	6	1
MCPP	7085190	-	-	-	-	50	1900	8	4	13	12,887	6	3
Methylene Chloride	75092	1.6	237	20	6	-	-	-	-	1	19,112	10	4
M-Xylene	108383	-	-	-	-	-	-	-	-	10	650	6	2
Naphthalene	91203	-	-	-	-	-	-	-	-	10	7,799	9	5
N,N-Dimethylformamide	68122	10	1,008	5	3	-	-	-	-	-	-	-	-
OCDD	3268879	0.0001	0.082	3	1	0.0001	0.0176	8	5	0.0001	0.062	6	2
OCDF	39001020	-	-	-	-	-	-	-	-	0.0001	0.012	6	2
O-Cresol	95487	1	2,215	8	6	-	-	-	-	10	626	9	2
O+P Xylene	136777612	-	-	-	-	-	-	-	-	10	230	6	2
P-Cresol	106445	1	998	9	3	-	-	-	-	10	17,396	7	2
Phenol	108952	2	1,425	14	5	-	-	-	-	10	99,947	9	1
Picloram	1918021	-	-	-	-	-	-	-	-	0.5	7.3	5	2
Pyridine	110861	-	-	-	-	-	-	-	-	10	10,000	9	6
Terbuthylazine	5915413	-	-	-	-	-	-	-	-	5	97	5	2
Toluene	108883	3	598	23	5	-	-	-	-	5	2,541	10	3
Trans-1,2-Dichloroethene	156605	-	-	-	-	-	-	-	-	0.4	6,237	10	4
Trichloroethene	79016	-	-	-	-	-	-	-	-	0.5	27,083	10	4
Tripropyleneglycol Methyl Ether	20324338	99	1,235	5	2	-	-	-	-	99	3,182	6	3
Vinyl Chloride	75014	-	-	-	-	-	-	-	-	0.2	1,429	10	5

#Obs: Number of observations
#ND: Number of non-detects
(-): Not detected in any sample

Table 6-14: Dioxins and Furans at Non-Hazardous EPA Sampling Episodes by Episode and Sample Point

Subtitle D Episode/SP	Sample Type	1234678-HpCDD	1234678-HpCDF	OCDD	OCDF	123478-HxCDD	123478-HxCDF	1234789-HpCDF	123678-HxCDD	123678-HxCDF	12378-PeCDD	12378-PeCDF	123789-HxCDD	123789-HxCDF	234678-HxCDF	23478-PeCDF	2378-TCDD	2378-TCDF
Municipal																		
4491 sp01 - inf	grab	140 pg/L	ND	1800 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4626 sp01 - inf	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4626 sp02 - inf	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4626 sp03 - inf	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4626 sp08 - eff	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4626 sp09 - FC	grab	32.9 ng/kg	ND	803 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4626 sp09 - FC	grab	41.2 ng/kg	ND	1100 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp01 - inf	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4667 sp06 - eff	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4667 sp07 - FC	grab	29 ng/kg	ND	279 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp07 - FC	grab	32 ng/kg	ND	271 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp07 - FC	grab	44 ng/kg	ND	308 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp07 - FC	grab	43 ng/kg	ND	338 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp07 - FC	grab	39 ng/kg	ND	290 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4687 sp01 - inf	comp	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4687 sp03 - eff	comp	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4738 sp01 - inf	grab	240 pg/L	56 pg/L	11,000 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4738 sp02 - inf	grab	480 pg/L	ND	5,300 ng/kg	ND	ND	ND	ND	6 ng/kg	ND	ND	ND	16 ng/kg	ND	ND	ND	ND	ND
Non-Municipal																		
4503 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4630 sp01 - inf	grab	103 pg/L	ND	5380 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4631 sp03 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4638 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4639 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4644 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp04 - inf	grab	ND	ND	503 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: Only filter cake was analyzed for dioxins and furans in Municipal episodes 4626 and 4667

sp: sample point	comp: composite sample	NS: Not sampled	mg/L = 1000 ug/L
inf: influent	grab: grab sample	ND: Non-detect	ug/L = 1000 ng/L
eff: effluent		FC: Filter cake	ng/L = 1000 pg/L

Table 6-15: Dioxins and Furans at Hazardous EPA Sampling Episodes by Episode and Sample Point

Episode Sample Point	Sample Type	1234678-HpCDD	1234678-HpCDF	OCDD	OCDF	123478-HxCDD	123478-HxCDF	1234789-HpCDF	123678-HxCDD	123678-HxCDF	12378-PeCDD	12378-PeCDF	123789-HxCDD	123789-HxCDF	234678-HxCDF	23478-PeCDF	2378-TCDD	2378-TCDF
4631 sp01 - inf	grab	13,600 pg/L	1,180 pg/L	116,000 pg/L	6,600 pg/L	ND	95.4 pg/L	162 pg/L	798 pg/L	202 pg/L	ND	79.1 pg/L	196 pg/L	ND	ND	ND	ND	31.1 pg/L
4631 sp02 - inf	grab	479 pg/L	88 pg/L	7,920 pg/L	573 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4659 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4682 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4682 sp02 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 spD01 - inf	comp	446 pg/L	ND	4,160 pg/L	135 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp01 - inf	comp	752 pg/L	86 pg/L	9,070 pg/L	357 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp01 - inf	comp	593 pg/L	55 pg/L	6,290 pg/L	243 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp01 - inf	comp	576 pg/L	ND	5,040 pg/L	136 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp01 - inf	comp	496 pg/L	62 pg/L	4,630 pg/L	212 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp02 - eff	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4721 sp03 - inf	grab	551 pg/L	70 pg/L	5,080 pg/L	162 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp05 - inf	grab	698 pg/L	ND	5,080 pg/L	290 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp06 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4759 sp01 - inf	comp	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4759 sp03 - eff	comp	ND	ND	100 pg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

sp: sample point
inf: influent
eff: effluent

comp: composite sample
grab: grab sample

D: Duplicate
ND: Non-detect
NS: Not sampled

mg/L = 1000 ug/L
ug/L = 1000 ng/L
ng/L = 1000 pg/L

7.0 POLLUTANT PARAMETER SELECTION

7.1 Introduction

EPA reviewed wastewater characterization data presented in Chapter 6 to identify which pollutant parameters present in landfills wastewater should be considered for regulation. EPA classifies pollutants into the following three categories: conventional, nonconventional, and toxic pollutants. Conventional pollutants include BOD_5, TSS, oil and grease, and pH. Toxic pollutants -- EPA also refers to them as priority pollutants -- include selected metals, pesticides and herbicides, and over 100 organic parameters that represent a comprehensive list of volatile and semi-volatile compounds. Nonconventional pollutants are any pollutants that do not fall within the specific conventional and toxic pollutant lists and include, for example, TOC, COD, chloride, fluoride, ammonia-nitrogen, nitrate/nitrite, total phenol, and total phosphorous.

This chapter presents the criteria used for the selection of pollutant parameters EPA evaluated for regulation and the selection of pollutants for which EPA has established effluent limitations and standards.

7.2 Pollutants Considered for Regulation

To characterize landfill wastewater and to determine the pollutants that it should evaluate for potential limitations and standards, EPA collected wastewater characterization samples at 15 landfill facilities, in addition to influent data collected at six, week-long sampling episodes. EPA analyzed wastewater samples for 470 conventional, toxic, and nonconventional pollutants including metals, organics, pesticides, herbicides, and dioxins and furans. Chapter 6 presents this wastewater characterization data.

From the original list of 470 analytes, EPA developed a list of "pollutants of interest" for each subcategory that it would further evaluate for possible regulation. This list reflects the types of pollutants typically found in landfill wastewater. From this list of pollutants, EPA calculated the current pollutant mass loadings for

the industry and estimated the pollutant loading associated with compliance with the final limitations and standards. The list of pollutants of interest also served as the basis for selecting pollutants for regulation.

7.3 Selection of Pollutants of Interest

EPA determined pollutants of interest for each subcategory using the raw wastewater data collected during the EPA sampling program. Chapter 6 presents the landfill facilities sampled in each subcategory in Table 6-8 and whether EPA detected the pollutants analyzed in the facility's raw wastewater. EPA only included the sampled facilities that were within the scope of the rule to determine the pollutants of interest. Therefore, EPA did not include sampling data from captive exempt facilities nor contaminated ground water data in the analysis. Figure 7-1 presents a diagram of the procedures used to select pollutants of interest.

EPA applied the following criteria to develop a list of pollutants for further evaluation for each subcategory:

1. EPA determined any pollutant detected three or more times in the influent at a concentration at or above 5 times the minimum level at more than one facility to be a pollutant of interest.

2. For dioxins/furans, EPA determined any dioxin or furan detected three or more times in the influent at a concentration above the minimum level at more than one facility to be a pollutant of interest.

3. EPA excluded pollutants that are naturally occurring compounds in soil or ground water at landfill facilities or pollutants that are used as treatment chemicals in this industry from the pollutants of interest list. These compounds include aluminum, boron, calcium, chloride, fluoride, iron, manganese, magnesium, potassium, silicon, sodium, sulfur, total phosphorus, and total sulfide.

Tables 7-1 and 7-2 list the final pollutants of interest for the Non-Hazardous and Hazardous subcategories that EPA has selected for further evaluation after applying these criteria. As shown in Table 7-1, EPA identified separate lists of pollutants of interest for Subtitle D municipal solid waste landfills and Subtitle D non-municipal solid waste landfills. However, EPA combined these two lists for the entire Non-Hazardous landfill subcategory. At proposal, one Non-Hazardous subcategory pollutant of interest, MCPA, was present at non-municipal solid waste landfills and was not present at municipal solid waste landfills. However, after proposal, EPA re-evaluated the status of several facilities in the landfills database

and now classifies an additional nine facilities as captive landfills not included within the scope of this guideline. With the removal of pollutants associated with these facilities from the analysis, EPA determined that, after application of the criteria, MCPA was no longer a pollutant of interest for non-municipal facilities because it was detected only twice in the influent at a concentration at or above 5 times the minimum level at two non-captive facilities. Therefore, EPA did not include MCPA as a pollutant of interest for the Non-Hazardous subcategory for the final rule. Pollutants of interest in both subcategories include conventional, nonconventional, and toxic pollutants and include metals, organics, pesticides, herbicides, and dioxins and furans.

7.4 Development of Pollutant Discharge Loadings

EPA estimated mass loadings of pollutant discharges for the pollutants of interest on a facility-by-facility basis. The Agency calculated pollutant loadings for current discharges and estimated projected discharges based on each of the regulatory options using the procedures described below.

7.4.1 Development of Current Discharge Concentrations

The current discharge concentration database contains the discharge concentration for each pollutant of interest at each facility in each subcategory. The Agency determined mass loadings by multiplying the pollutant concentration by the facility-specific regulated wastewater flow. EPA used all available data including Detailed Questionnaire and Detailed Monitoring Questionnaire data and EPA sampling data to determine mass loadings.

In the Detailed Questionnaire and Detailed Monitoring Questionnaires, EPA requested facilities to provide information on wastewater treatment-in-place and to provide concentration data on treated wastewater effluent. The Agency compiled all effluent wastewater data for each facility after screening the data using the conventions discussed in Chapter 4 for raw wastewater. For facilities with multiple effluent sample points, EPA determined the final effluent concentration by taking a flow weighted average of the samples. From the effluent wastewater data from each facility, the Agency created a data file that contained one

average concentration value for each pollutant of interest at each facility. The amount of data in the file varied significantly from facility to facility. EPA based several of the current discharge concentrations on hundreds of sampling data points obtained through the Detailed Monitoring Questionnaire, while it based others on as few as one sampling data point. The Detailed Monitoring Questionnaire data reflect up to three years of data and are unique to each facility in terms of numbers of parameters analyzed and monitoring frequency. Additionally, monitoring may have been performed weekly, monthly, or quarterly. For facilities sampled by EPA, there was information available for all 470 analytes, and sampling typically reflected the daily performance of a system over a five-day period.

For facilities with wastewater treatment-in-place, but with either no available effluent data or incomplete effluent data, EPA generated a treated effluent average concentration. To develop the treated effluent average concentration, EPA grouped facilities by subcategory and then placed them in treatment-in-place groups, depending on the type of treatment employed on site. Within a treatment-in-place group, the Agency calculated the treated effluent average concentration for a pollutant of interest by taking the median of all weighted source averages for all facilities within the treatment-in-place group. If there were no data for a particular pollutant within a treatment-in-place group, EPA calculated the treated effluent average concentration for a pollutant of interest in a subcategory by taking the median of all weighted source averages for all facilities within the entire subcategory.

For facilities with no treatment-in-place, the Agency used raw wastewater concentrations to represent current effluent discharge values. EPA calculated facility averages using all available data sources and using the procedures outlined above. For facilities with no treatment-in-place and with either no influent data or incomplete influent data, the Agency used the subcategory median raw wastewater concentration (see Section 6.3.3 for details on developing the Median Raw Wastewater Concentration File) to represent the current discharge for each pollutant of interest.

For the Hazardous subcategory and for Subtitle D non-municipal solid waste facilities in the Non-Hazardous subcategory, there were insufficient effluent data to calculate a representative treatment-in-place or subcategory treated effluent average concentration result for several pollutants of interest. The alternate methodologies developed to calculate representative current discharge concentration values for both the Hazardous subcategory and for Subtitle D non-municipal facilities in the Non-Hazardous subcategory are discussed below.

7.4.1.1 Alternate Methodology for Non-Hazardous Subcategory: Subtitle D Non-Municipal

For Subtitle D non-municipal solid waste facilities in the Non-Hazardous subcategory, EPA used the effluent data from municipal solid waste landfills to supplement insufficient non-municipal data. EPA concluded this was appropriate in the circumstances because of the similarities in the median raw wastewater concentrations from Subtitle D municipal and non-municipal facilities. Table 6-7 in Chapter 6 presents the Subtitle D municipal and non-municipal median raw wastewater concentration data.

EPA employed the following procedure to calculate current discharge concentrations for Subtitle D non-municipal solid waste facilities. First, EPA used all available non-municipal landfill effluent data. Next, EPA placed non-municipal facilities in municipal facility treatment-in-place groups according to treatment employed on site. Then, EPA used municipal landfills treatment-in-place treated effluent average concentrations for each non-municipal facility with insufficient data.

7.4.1.2 Alternate Methodology for the Hazardous Subcategory

EPA estimated current discharge concentrations for the facilities in the Hazardous subcategory using the long-term averages developed for the subcategory (see Chapter 11: Development of Effluent Limitations and Standards). EPA's data collection efforts did not identify any direct discharging hazardous landfills, and EPA obtained detailed information from only three indirect discharging landfills. Therefore, the Agency modeled the current discharge concentrations on the small number of indirect discharging facilities in the

EPA database as a function of the expected discharge concentrations after treatment using the long-term averages. EPA used industry-provided effluent data whenever available.

The Agency developed an approach based upon the installed treatment system at the facility. EPA estimated the current discharge concentration as twice the long-term average (LTA) for a facility without any biological or chemical treatment-in-place. The modeling approach used to develop the current discharge concentration (CDC) for the indirect dischargers in the Hazardous subcategory is presented below.

QID	Treatment-In-Place	Modeling Scheme
16017	Separation and neutralization	2 x LTA^{med}
16041	Sequencing batch reactors	LTA
16087	Equalization, chemical precipitation, primary sedimentation, activated sludge, and secondary sedimentation	LTA

For facility 16017, the current discharge concentration value was based upon a function of the LTA^{med}. The LTA^{med} is the median of the long-term averages in the Hazardous subcategory. The long-term averages used in this subcategory are from BAT facilities 16041 and 16087. Therefore, the corresponding long-term averages were used for both of these BAT facilities.

7.4.2 Development of Pollutant Mass Loadings

Using the current discharge concentrations discussed above, EPA generated mass loading estimates for each pollutant of interest at each facility by multiplying the current discharge concentration value by the facility's average daily discharge flow rate. This resulted in mass loadings, reported in pounds per day, for each facility in the database. EPA calculated mass loadings to determine the amount of pollution discharged directly or indirectly to surface waters by landfill facilities and to estimate the amount of pollutant reduction after implementation of each regulatory technology option. Summaries of pollutant mass loadings for the selected regulatory options are presented in Chapter 11.

7.5 Assessment of Pollutants of Interest

As indicated above, EPA developed extensive lists of pollutants of interest for this industry. EPA used the full list of pollutants of interest to develop pollutant loadings and pollutant reductions as a result of treatment. However, the Agency only selected certain pollutants for regulation, since specific regulation of every pollutant is not always the most cost-effective approach to developing effluent limitations guidelines.

The treatment technologies evaluated as the basis of the regulation remove classes of compounds with similar treatability characteristics. Several of the pollutants of interest in the Landfills industry are similar in terms of their chemical structure and treatability. As a result, the regulation of a set of pollutants within a chemical class ensures that the treatment technologies will provide adequate control of other pollutants of interest within that class of compounds.

Based upon this analysis, EPA decided not to regulate certain pollutants of interest in the Non-Hazardous and Hazardous subcategories because their removals are represented adequately by another regulated pollutant, as discussed in the sections below. In addition, the Agency did not select several other pollutants of interest for regulation because EPA found these pollutants at concentrations below treatable levels in the Landfills industry. EPA also did not select pollutants for regulation if the Agency determined that these pollutants were found at only trace amounts in the industry, and therefore were not likely to cause toxic effects. The Agency also excluded several pollutants of interest from regulation because the selected BPT treatment technology would not remove these pollutants.

7.6 Selection of Pollutants To Be Regulated for Direct Dischargers

Based upon the data analyses outlined above, EPA developed a list of pollutants to be regulated for the Hazardous and Non-Hazardous subcategories. Figure 7-2 presents a diagram that illustrates the procedures used to select the regulated pollutants. EPA is not establishing effluent limitations and standards for all conventional, toxic, and nonconventional pollutants. There may be pollutants present in a specific landfill or type of landfill for which EPA did not establish limitations under this guideline but which may be

of concern to a receiving stream or POTW. Due to the specific nature of landfill waste at various sites, permit writers and local authorities may need to consider case-by-case limitations or standards for these pollutants. EPA's regulations require the permit writer or local authority to include technology-based limits for any toxic pollutant which is or may be discharged at a level greater than the level which can be achieved by treatment requirements appropriate to the permittee or which may pass through or interfere with POTW operations. (40 CFR § 122.44(e), 125.3. *See also* 40 CFR § 403.5(c) which requires the establishment of local limits in a POTW pretreatment program for any pollutant which may cause pass through or interference). The following sections discuss EPA's reasons for not establishing effluent limitations for selected pollutants.

7.6.1 Non-Hazardous Subcategory Pollutants to be Regulated for Direct Dischargers

EPA developed the list of pollutants to be regulated for the Non-Hazardous subcategory from the pollutants of interest list for the Non-Hazardous subcategory. The non-hazardous pollutants of interest list combines the pollutants of interest from Subtitle D municipal and non-municipal solid waste facilities for a total of 32 pollutants of interest. The BPT/BAT facilities selected by EPA demonstrate removal of the regulated pollutants. These facilities employed equalization, biological treatment, and for some, multimedia filtration. Initially, EPA considered regulating all 32 pollutants of interest. After a thorough analysis, EPA, however, chose not to set limitations for 24 pollutants of interest under BPT/BAT/NSPS for one of the following reasons:

- The pollutant (or pollutant parameter) is controlled through the regulation of other pollutants (or pollutant parameters).
- The pollutant (or pollutant parameter) is present in only trace amounts in the subcategory and/or is not likely to cause toxic effects.
- The pollutant (or pollutant parameter) is not controlled by the selected BPT technology.

The following seven Non-Hazardous subcategory pollutants of interest are pollutants that are controlled through the regulation of other pollutants**:**

Seven Pollutants Not Selected for Regulation in the Non-Hazardous Subcategory Because They Are Controlled Through the Regulation of Other Pollutants
COD TOC Total Phenols Hexanoic Acid O-Cresol Tripropyleneglycol Methyl Ether Titanium

COD is an alternative method of estimating the oxygen demand of the wastewater. However, EPA selected BOD_5 for regulation because it is more appropriately controlled by a biological treatment system. TOC measures all oxidizable organic material in a waste stream, including the organic chemicals not oxidized (and, therefore, not detected) in BOD_5 and COD tests. TOC is a rapid test for estimating the total organic carbon in a waste stream. For reasons similar to those used for not selecting COD for regulation, EPA did not select TOC for regulation. Total phenols is a general wet chemistry indicator measurement for phenolic compounds. Regulation of phenol will control other phenolic compounds. Similarly, hexanoic acid is relatively biodegradable and should be controlled by regulating benzoic acid. O-cresol is structurally similar to p-cresol and should be controlled by regulating p-cresol. Tripropyleneglycol methyl ether has treatability characteristics similar to alpha terpineol in a biological treatment system and should be controlled by regulating alpha terpineol. EPA determined that titanium will be removed incidentally by biological treatment in the same manner as zinc, through sorption into the biomass. Therefore, titanium should be controlled by regulating zinc.

In the proposal, EPA chose not to regulate 2-butanone, 2-propanone, and 4-methyl-2-pentanone because they were controlled through the regulation of toluene. After proposal EPA decided not to regulate toluene. The reasons these pollutants were not selected for regulation in the final rule are discussed below.

The following thirteen Non-Hazardous subcategory pollutants of interest are present in only trace amounts and/or are not likely to cause toxic effects:

Thirteen Pollutants Not Selected for Regulation in the Non-Hazardous Subcategory Because They Are Present in Only Trace Amounts and/or Are Not Likely to Cause Toxic Effects
Nitrate/Nitrite TDS 1,4-Dioxane 4-Methyl-2-Pentanone Methylene Chloride N,N-Dimethylformamide Toluene Barium Chromium Dichloroprop Disulfoton 1,2,3,4,6,7,8-HpCDD OCDD

EPA presents the Non-Hazardous subcategory median raw wastewater concentration data for the pollutants of interest in Chapter 6, Table 6-9, and the minimum and maximum concentrations for conventional and nonconventional pollutants, metals, organic pollutants, and dioxins/furans in Tables 6-11 through 6-14.

For this industry, nitrate/nitrite is used primarily as a measure of the extent of nitrification that occurs during the biodegradation process. Typically, levels of nitrate/nitrite found in landfill wastewater do not require removal. Removal of nitrate/nitrite can be obtained by specially designed biological treatment systems (such as nitrification/denitrification systems) that are able to complete the conversion of nitrate/nitrite to nitrogen gas. Often, removal of nitrate/nitrite is required to address specific water quality concerns for an individual receiving water (i.e., nutrient problems in the Great Lakes). EPA has determined that the levels of nitrate/nitrite in landfill wastewater do not justify regulation on a national level and individual permit writers can address specific water quality considerations.

TDS is used primarily as a water quality measurement and not as a pollutant that can be controlled through biological treatment. It often is used as a measurement of the salinity of an ambient water or a wastewater and often indicates the presence of naturally occurring salts of metals such as sodium, iron, and magnesium. While it can inhibit biological treatment processes at levels above 10,000 mg/L, acclimated biological treatment systems can operate successfully with influent TDS concentrations as high as 76,000 mg/L (reference 55). The median concentration of total dissolved solids in the Non-Hazardous subcategory was only 4,850 mg/L for non-municipal solid waste landfills and 2,890 mg/L for municipal solid waste landfills. Therefore, EPA has determined that concentrations of total dissolved solids found in landfills in the Non-Hazardous subcategory do not justify regulation. EPA's sampling data showed levels of n,n-dimethylformamide in landfill wastewater generally near the analytical detection limit (median concentration for non-hazardous municipal solid waste landfills was 10 ug/L) and, because of this low concentration throughout the subcategory, regulation was not warranted.

EPA classifies four pollutants, 1,4-dioxane, 4-methyl-2-pentanone, methylene chloride, and toluene as "volatile organics" under analytical test method 1624. In the proposed rule, EPA established direct discharge limitations for toluene for landfills in the Non-Hazardous subcategory. However, after proposal, EPA decided not to regulate toluene because it is not treated by the biological treatment technology selected as the basis for the landfills effluent limitations. Furthermore, based on the concentration of toluene in untreated municipal leachate (108 ug/L), the Agency concluded that the loading of toluene to the atmosphere will not cause toxic effects.

While EPA acknowledges that a small portion of the removal of these pollutants is due to biological degradation, these pollutants are highly volatile and the primary mechanism for their removal from wastewater is through volatilization to the atmosphere. EPA based these final regulations on the performance of an aerated biological system. Wastewater aeration may increase the volatilization of certain organic compounds, a potential environmental concern. While EPA does not recognize the transfer of pollutants from one media to another as effective treatment, based on the concentrations of these pollutants

in untreated wastewater (below treatable levels (10 times the method detection limit)), indications are that the potential increase in air emissions due to this regulation will be minimal.

Volatile organic compound (VOC) levels in historic landfill leachate (from both hazardous and non-hazardous waste landfills dating from the 1930s to the mid-1990s) are also at levels which are low enough as not to call into question EPA's determination to base these rules on the performance of aerated biological systems. Tables 6-9, 6-10, and 6-13 show the concentrations of VOCs found in landfill wastewater.

Furthermore, EPA's Office of Air and Radiation is currently evaluating the air emissions from wastewater generated at municipal solid waste landfills, and intends to take the landfills effluent limitations guidelines into account in determining whether further controls under Section 112 of the Clean Air Act (which requires technology-based standards for hazardous air pollutants emitted by major sources of emissions of those pollutants) are justified. (Preliminary indications are that hazardous air pollutant emissions from aeration would be a minor fraction of those from other landfill emission sources such as landfill gas emissions.)

EPA's sampling detected two metals, barium and chromium, below treatable levels at non-hazardous landfills in the EPA database. The median raw wastewater concentrations of barium and chromium found at municipal landfills is 0.48 mg/L and 0.03 mg/L, respectively, less than 5 times the method detection limit. EPA is excluding these two metals from regulation because, at the concentrations found at non-hazardous landfills, these pollutants are not likely to cause toxic effects.

EPA found low levels of dichloroprop, disulfoton, 1,2,3,4,6,7,8-HpCDD, and OCDD in raw wastewater at several Non-Hazardous subcategory landfills. At the concentrations found, EPA expects these pollutants to partition to the biological sludge created as a result of the use of the BPT/BAT treatment technologies. EPA sampling data and calculations conclude that the concentrations of these pollutants present in the wastewater will not prevent the sludge from being redeposited in a non-hazardous landfill.

The following four pollutants were not selected for regulation in the Non-Hazardous subcategory because they are not controlled by the selected BPT/BAT technology:

Four Pollutants Not Selected for Regulation in the Non-Hazardous Subcategory Because They Are Not Controlled by the Selected BPT/BAT Technology
2-Butanone 2-Propanone Hexavalent Chromium Strontium

EPA classifies 2-butanone and 2-propanone as "volatile organics" under analytical test method 1624. Because the selected BPT/BAT technology for the Non-Hazardous subcategory is aerated equalization followed by biological treatment and then multimedia filtration, EPA determined that the majority of the removal of volatile organic compounds is due to volatilization to the atmosphere in either the aerated equalization tanks or in the activated sludge aeration basin. Therefore, EPA did not regulate volatile organic pollutants because the BPT/BAT technology does not provide controls for the removal of these pollutants.

EPA detected hexavalent chromium and strontium in wastewater at the facilities selected as the basis for BPT/BAT/NSPS, but EPA did not have adequate removal data at the BPT/BAT/NSPS facilities employing biological treatment and, therefore, these pollutants could not be regulated. For both pollutants, EPA had removal data from one BPT/BAT facility. In both cases, the BPT facilities demonstrated negative percent removals of these pollutants. In addition to the lack of adequate data, EPA determined that for this subcategory, these metals are not present in concentrations that are likely to cause toxic effects. Therefore, these two metals were excluded from regulation in the Non-Hazardous subcategory.

In conclusion, the following eight pollutants of interest are regulated under BPT/BAT/NSPS in the Non-Hazardous subcategory:

Eight Pollutants Selected for Regulation in the Non-Hazardous Subcategory
Ammonia as Nitrogen BOD_5 TSS Alpha Terpineol Benzoic Acid P-Cresol Phenol Zinc

The Agency wishes to note that zinc was selected for regulation in spite of the fact that exclusion criteria used to eliminate other pollutants of interest apply, at least partially. Zinc has been selected for regulation in spite of its relatively low untreated wastewater concentration. The median concentration of zinc found in raw wastewater at municipal solid waste landfills and at non-municipal solid waste landfills is 0.10 mg/L and 0.09 mg/L, respectively. EPA selected zinc for regulation because EPA observed incidental removals ranging from 58 percent to 90 percent at the treatment systems selected for BPT. Additionally, EPA's sampling did not find raw wastewater concentrations of zinc at levels that would inhibit biological treatment systems (see Chapter 11, Section 11.2.1).

Chapter 11 describes in detail the development of the effluent limitations for each of these pollutants.

7.6.2 Hazardous Subcategory Pollutants to be Regulated for Direct Dischargers

EPA developed the list of pollutants to be regulated for the Hazardous subcategory from the Hazardous subcategory pollutants of interest list. The two BPT/BAT facilities selected by EPA demonstrate removal of the regulated pollutants through the use of chemical precipitation and biological treatment. Initially, EPA considered regulating all 63 pollutants of interest; EPA chose, however, not to set limitations for 50 pollutants of interest under BPT/BAT/NSPS for one of the following reasons:

- The pollutant (or pollutant parameter) is controlled through the regulation of other pollutants (or pollutant parameters).

- The pollutant (or pollutant parameter) is present in only trace amounts in the subcategory and/or is not likely to cause toxic effects.

- The pollutant (or pollutant parameter) is not controlled by the selected BPT technology.

As discussed in Chapter 6, after proposal, EPA analyzed the raw wastewater characterization data for hazardous landfills without CERCLA ground water data. As a result, raw wastewater concentrations for several pollutants of interest have changed since proposal and, therefore, in some cases, EPA's reasons for not selecting these pollutants for regulation also have changed.

EPA did not select the following thirteen Hazardous subcategory pollutants of interest for regulation because they are controlled through the regulation of other pollutants:

Thirteen Pollutants Not Selected for Regulation in the Hazardous Subcategory Because They Are Controlled Through the Regulation of Other Pollutants
COD TOC Total Phenols 2,4-Dimethylphenol Benzyl Alcohol Diethyl Ether Isobutyl Alcohol Hexanoic Acid O-Cresol Tripropyleneglycol Methyl Ether Molybdenum Nickel Strontium

COD is an alternative method of estimating the oxygen demand of the wastewater. EPA, however, selected BOD_5 for regulation because it is more appropriately controlled by a biological treatment system. TOC measures all oxidizable organic material in a waste stream, including the organic chemicals not oxidized (and, therefore, not detected) in BOD_5 and COD tests. TOC is a rapid test for estimating the total

organic carbon in a waste stream. For similar reasons to the rationale for not selecting COD for regulation, EPA did not select TOC for regulation.

While present in treatable concentrations, EPA did not have adequate removal data for molybdenum, nickel, and strontium at the Hazardous subcategory BPT/BAT facilities. However, these metals should be controlled adequately through the regulation of both chromium and zinc. Total phenols is a general, wet chemistry indicator measurement for phenolic compounds and should be controlled by regulating phenol. Similarly, 2,4-dimethylphenol has chemical and treatability characteristics similar to phenol and, therefore, should also be controlled through the regulation of phenol. Hexanoic acid, benzyl alcohol, and isobutyl alcohol are relatively biodegradable and should be controlled by regulating benzoic acid. O-cresol is structurally similar to p-cresol and should be controlled by regulating p-cresol. Tripropyleneglycol methyl ether and diethyl ether have treatability characteristics similar to alpha terpineol in a biological treatment system and should be controlled by regulating alpha terpineol.

In the proposal, EPA chose not to regulate 2-butanone, 2-propanone, 4-methyl-2-pentanone, ethylbenzene, m-xylene, and o+p xylene because they were controlled through the regulation of toluene. After proposal EPA decided not to regulate toluene. The reasons these pollutants were not selected for regulation in the final rule are discussed below.

EPA did not select the following sixteen pollutants of interest for regulation in the Hazardous subcategory because they are present in only trace amounts and/or are not likely to cause toxic effects:

Sixteen Pollutants Not Selected for Regulation in the Hazardous Subcategory Because They Are Present in Only Trace Amounts and/or Are Not Likely to Cause Toxic Effects
Hexane Extractable Material Nitrate/Nitrite TDS 2,4-D 2,4-DB

2,4,5-TP
Dicamba
Dichloroprop
MCPA
MCPP
Picloram
Terbutylazine
1,2,3,4,6,7,8-HpCDD
1,2,3,4,6,7,8-HpCDF
OCDD
OCDF

EPA presents the Hazardous subcategory median raw wastewater concentration data for the pollutants of interest in Chapter 6, Table 6-10, and the minimum and maximum concentrations for conventional and nonconventional pollutants, metals, organic pollutants, and dioxins/furans in Tables 6-11 through 6-13, and Table 6-15.

For this industry, nitrate/nitrite is used primarily as a measure of the extent of nitrification that occurs during the biodegradation process. Typically, levels of nitrate/nitrite found in landfill wastewater do not require removal. Removal of nitrate/nitrite can be obtained by specially designed biological treatment systems (such as nitrification/denitrification systems) that are able to complete the conversion of nitrate/nitrite to nitrogen gas. Often, removal of nitrate/nitrite is required to address specific water quality concerns for an individual receiving water (i.e., nutrient problems in the Great Lakes). EPA has, however, determined that the levels of nitrate/nitrite in landfill wastewater do not justify regulation on a national level and individual permit writers can address specific water quality considerations.

TDS is used primarily as a water quality measurement and not as a pollutant that can be controlled through biological treatment. It often is used as a measurement of the salinity of an ambient water or a wastewater and often indicates the presence of naturally occurring salts of metals such as sodium, iron, and magnesium. While it can inhibit biological treatment processes at levels above 10,000 mg/L, acclimated biological

treatment systems can operate successfully with influent TDS concentrations as high as 76,000 mg/L (reference 55). The median concentration of total dissolved solids was 16,000 mg/L for landfills in the Hazardous subcategory. Therefore, EPA has determined that concentrations of total dissolved solids found in landfills in the Hazardous subcategory do not justify regulation. Similarly, hexane extractable material is a general, wet chemistry indicator measurement for oil and grease compounds that generally can be controlled through source reduction and good housekeeping. Therefore, EPA did not select hexane extractable material for regulation.

EPA detected low levels of 2,4-D, 2,4-DB, 2,4,5-TP, dicamba, dichloroprop, MCPA, MCPP, picloram, terbutylazine, 1,2,3,4,6,7,8-HpCDD, 1,2,3,4,6,7,8-HpCDF, OCDD, and OCDF in three out of five of the Hazardous subcategory landfills sampled during EPA's sampling program. At the concentrations found in raw landfill wastewater, EPA expects these pollutants to partition to the biological sludge created as a result of the use of the BPT/BAT treatment technologies. EPA sampling data and calculations conclude that the concentrations of these pollutants present in the untreated wastewater will not prevent the sludge from being redeposited in a hazardous landfill.

EPA did not select the following twenty-one pollutants for regulation in the Hazardous subcategory because they are not controlled by the selected BPT/BAT technology:

Twenty-One Pollutants Not Selected for Regulation in the Hazardous Subcategory Because They Are Not Controlled by the Selected BPT/BAT Technology
Amenable Cyanide
Total Cyanide
1,1-Dichloroethane
1,4-Dioxane
2-Butanone
2-Propanone
4-Methyl-2-Pentanone
Benzene
Ethylbenzene

M-Xylene
Methylene Chloride
O+P Xylene
Toluene
Trans-1,2-Dichloroethene
Trichloroethene
Vinyl Chloride
Copper
Lithium
Selenium
Tin
Titanium

EPA classifies 1,1-dichloroethane, 1,4-dioxane, 2-butanone, 2-propanone, 4-methyl-2-pentanone, benzene, ethylbenzene, m-xylene, methylene chloride, o+p xylene, toluene, trans-1,2-dichloroethene, trichloroethene, and vinyl chloride as "volatile organics" under analytical test method 1624. Because the selected BPT/BAT technology for the Hazardous subcategory is aerated equalization followed by chemical precipitation, biological treatment, and multimedia filtration, EPA determined that the majority of the removal of volatile organic compounds is due to volatilization to the atmosphere in either the aerated equalization tanks or in the activated sludge aeration basin. Therefore, EPA did not regulate volatile organic pollutants because the BPT/BAT technology does not provide controls for removal of these pollutants.

While EPA does not recognize the transfer of pollutants from one media to another as effective treatment, based on the concentrations of these pollutants in untreated wastewater (below treatable levels (10 times the method detection limit)), indications are that the potential increase in air emissions due to this regulation will be minimal.

Volatile organic compounds (VOCs) in hazardous waste landfill leachate are being steadily minimized due to the Resource Conservation and Recovery Act (RCRA) land disposal restriction rules, which typically require aggressive destructive treatment of organics in hazardous wastes before the waste can be landfilled

(see 40 CFR 268.40 and 268.48).[1] VOC levels in historic landfill leachate (from both hazardous and non-hazardous waste landfills dating from the 1930s to the mid-1990s) are also at levels which are low enough as not to call into question EPA's determination to base these rules on the performance of aerated biological systems. Tables 6-9, 6-10, and 6-13 show the concentrations of VOCs found in landfill wastewater.

For the proposed rule, EPA established direct discharge limitations for benzene and toluene for landfills in the Hazardous subcategory. However, after proposal, EPA decided not to regulate benzene and toluene because they are not treated by the chemical or biological treatment technology selected as the basis for the landfills effluent limitations. Furthermore, based on the concentration of benzene (37 ug/L) and toluene (104 ug/L) in untreated leachate, the Agency concluded that the loading of benzene and toluene to the atmosphere will not cause toxic effects.

The Hazardous subcategory median untreated wastewater concentrations for copper, lithium, selenium, tin, and titanium were well below treatable concentrations (10 times the method detection limit). Median untreated wastewater concentrations ranged from 0.02 mg/L to 0.03 mg/L for selenium, copper, and titanium, 0.15 mg/L for tin, and 0.45 mg/L for lithium. While the metals are incidentally removed by the BPT/BAT technology, these concentrations are well below treatable concentrations for conventional metals precipitation technologies.

For total cyanide, the median untreated wastewater concentration for the Hazardous subcategory is 0.08 mg/L, which is well below treatable concentrations for conventional cyanide destruction technologies. While the median raw wastewater concentration of amenable cyanide at hazardous landfills is 1.6 mg/L, EPA concluded that the median untreated wastewater concentration data for total cyanide is more

[1] There are certain exceptions to these treatment requirements for hazardous wastewater which is disposed in surface impoundments. RCRA section 3005 (j) (11). However, if this wastewater contains VOCs above a designated concentration level, then the impoundments are subject to rules requiring control of the resulting air emissions. 40 CFR 264.1085 and 263.1086.

representative than amenable cyanide data of cyanide concentrations in hazardous landfill wastewater because the Agency collected data from ten facilities on total cyanide (one of which was non-detect) and only four facilities (two of which were non-detect) on amenable cyanide.

Based on these factors, the Agency concluded that the five metals plus amenable and total cyanide were present in untreated landfill wastewater at concentrations that were too low to be treated effectively by conventional metals and cyanide treatment technologies (chemical precipitation and chemical oxidation, respectively). Because EPA's BPT/BAT technology does not control these small concentrations of pollutants, the Agency has decided to exclude them from regulation.

In conclusion, the following 13 pollutants of interest will be regulated under BPT/BAT/NSPS in the Hazardous subcategory:

Thirteen Pollutants Selected for Regulation in the Hazardous Subcategory
Ammonia as Nitrogen
BOD_5
TSS
Alpha Terpineol
Aniline
Benzoic Acid
Naphthalene
P-Cresol
Phenol
Pyridine
Arsenic
Chromium
Zinc

Chapter 11 describes in detail the development of the effluent limitations for each of these pollutants.

7.7 Selection of Pollutants to be Regulated for Indirect Dischargers

Section 307(b) of the Clean Water Act (CWA) requires the Agency to promulgate pretreatment standards for existing sources (PSES) and new sources (PSNS). To establish pretreatment standards, EPA must first determine whether each BAT pollutant under consideration is not susceptible to treatment by a POTW, or interferes with the POTW's operation or sludge disposal practices.

7.7.1 Pass-Through Analysis for Indirect Dischargers

The Agency evaluated whether a pollutant is susceptible to treatment at a POTW by comparing removals between direct dischargers and well-operated POTWs for pollutants of interest for both subcategories, listed in Tables 7-1 and 7-2. In comparing removals, the Agency compares the percentage of a pollutant removed by POTWs with the percentage of the pollutant removed by direct discharging facilities applying BAT.

EPA compares removals for two reasons: 1) to ensure that wastewater treatment performance for indirect dischargers is equivalent to that for direct dischargers, and 2) to recognize and take into account the treatment capability and performance of the POTW in regulating the discharge of pollutants from indirect dischargers. Rather than compare the mass or concentration of pollutants discharged by the POTW with the mass or concentration of pollutants discharged by a BAT facility, EPA compares the percentage of the pollutants removed by the BAT treatment system with the POTW removal. EPA takes this approach because a comparison of mass or concentration of pollutants in a POTW effluent to pollutants in a BAT facility's effluent would not take into account the mass of pollutants discharged to the POTW from non-industrial sources, nor the dilution of the pollutants in the POTW effluent to lower concentrations from the addition of large amounts of non-industrial wastewater.

To establish the performance of well-operated POTWs, EPA used the information provided from “Fate of Priority Pollutants in Publicly Owned Treatment Works” (commonly referred to as the 50-POTW Study), supplemented by EPA's National Risk Management Research Laboratory's (NRMRL) treatability

database. EPA used NRMRL's database for those pollutants not found in the 50-POTW study. Chapter 4 discusses these studies in detail.

The 50-POTW Study presents data on 50 well-operated POTWs achieving secondary treatment. For this rulemaking, EPA edited the data in the 50-POTW Study and the data collected for this rule. Because the 50-POTW Study data included influent levels that were close to the detection limit, EPA eliminated these values, thereby minimizing the possibility that low POTW removals might simply reflect low influent concentrations instead of being a true measure of treatment effectiveness. EPA applied the following hierarchal data editing rules to the 50-POTW Study data:

1) Include only detected pollutants having at least three pairs (influent/effluent) of data points.

2) Eliminate average pollutant influent values less than 10 times the minimum analytical detection limit, along with the corresponding effluent values.

3) For analytes where no average influent concentrations were greater than 10 times the minimum level[2], eliminate all average influent values less than five times the minimum level, along with the corresponding effluent values;

4) For analytes where no average influent concentration was greater than five times the minimum level, eliminate all average influent concentrations less than 20 ug/L, along with the corresponding effluent values.

After editing the database, EPA then calculated POTW-specific percent removals for each pollutant based on its average influent and average effluent values. The POTW percent removal used for each pollutant in the pass-through test is the median value of all the POTW specific percent removals for that pollutant. EPA then compared the median POTW percent removal to the median percent removal for the BAT option treatment technology to determine pass through.

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[2] In applying the data editing rules for the 50-POTW Study for the final rule, the minimum level assigned to the non-detect values was the minimum level at the time of the 50-POTW Study (circa 1978-1980). For the proposal, the minimum level assigned to the non-detect values for 50-POTW removals was the Landfills study minimum levels (circa 1994).

The 50-POTW Study did not contain data for all pollutants for which the pass-through analysis was required. Therefore, EPA obtained additional data from EPA's NRMRL Treatability Database . The database provides the user with the specific source and the industry from which the wastewater was generated. EPA used the NRMRL database to augment the POTW database for the pollutants for which the 50-POTW Study did not cover. EPA applied the following data editing rules to the data in the NRMRL database:

1) Only use treatment technologies representative of typical POTW secondary treatment operations (aerobic lagoons, activated sludge, activated sludge with sedimentation and/or filtration).

2) Only use domestic or industrial wastewater data.

3) Use pilot-scale and full-scale data; eliminate bench-scale data.

4) Use data from a paper in a peer-reviewed journal or government report; edit out lesser quality references.

5) Eliminate zero or negative percent removals.

6) For each of the NRMRL sources, EPA first selected data having at least three pairs (influent/effluent) of data points. If no data source contained three pairs of data points, then EPA selected only those facilities having at least two pairs of data points. If none of the data sources contained two pairs of data points, then EPA selected those with one pair (influent/effluent) of data points. EPA applied the paired data editing criteria explained above to the following hierarchy of NRMRL data sources:

    a. NRMRL Treatability data at > 10xMDL – Domestic wastewater.
    b. NRMRL Treatability data at > 5xMDL – Domestic wastewater.
    c. NRMRL Treatability data at >20 ug/L - Domestic wastewater.
    d. NRMRL Treatability data at > 10xMDL – Industrial wastewater.
    e. NRMRL Treatability data at > 5xMDL – Industrial wastewater.
    f. NRMRL Treatability data at >20 ug/L – Industrial wastewater.
    g. NRMRL Treatability data - any available Domestic and/or Industrial data.
    h. Generic pollutant group removal data.

From the NRMRL facilities remaining after applying the above editing criteria, EPA determined the median percent removal for a particular pollutant. The Agency used this median percent removal to represent

POTW removal and compared it to the median percent removal for the BAT option treatment technology in order to determine pass through.

Tables 7-3 and 7-4 present the POTW percent removals for each regulated pollutant in the Non-Hazardous and Hazardous subcategory, respectively. These tables indicate the source of the percent removal and which editing criteria applied.

7.7.2 Non-Hazardous Subcategory Pollutants to be Regulated for Indirect Dischargers

EPA conducted a removal comparison on the priority and nonconventional pollutants regulated under BAT for non-hazardous landfills. EPA did not perform this assessment for the regulated conventional pollutants, namely BOD_5 and TSS, since the conventional pollutants are generally not regulated under PSES and PSNS. For the proposal, EPA evaluated the seven nonconventional and toxic pollutants proposed for regulation under BAT for the Non-Hazardous subcategory, and concluded that ammonia removals were greater at the BAT facilities. Following the proposal, EPA reviewed the data used for the BAT percent removal calculations. In the proposal, EPA calculated the BAT percent removals using data from well-operated biological treatment facilities in EPA's database. However, some of these facilities did not pass the editing criteria for selection as a BPT/BAT facility. In the revised analysis, EPA calculated percent removals using data from only those seven facilities that passed the BPT/BAT editing criteria. In addition, in the proposal, EPA inadvertently failed to use selected BAT facilities in the calculation of percent removals for several pollutants even though the data that met the editing criteria for the facility were available. As a result of this review, the BAT facility removals for the analysis have changed for the Non-Hazardous subcategory since the proposal. Finally, after proposal, EPA decided not to set BPT limits for toluene. Therefore, this pollutant is not considered in the analysis, see Section 7.6.1.

In determining BAT percent removals, EPA used data from selected BAT facilities only if they met the following criteria:

1) The influent concentration for a particular pollutant was greater than 10xMDL,

2) The facility had demonstrated removal of the pollutant (EPA did not use facilities showing zero or negative percent removal), and

3) The facility did not employ treatment technologies in addition to the selected BAT that may contribute to further reduction of the pollutant.

Applying the editing criteria outlined above to those facilities selected as BAT resulted in a different set of facilities being used in the calculation of the percent removals than in proposal for each of the pollutants to be regulated. Table 7-5 lists the BAT facilities used in the calculation of percent removals for the non-hazardous regulated pollutants.

The Agency used EPA sampling episode data, Detailed Questionnaire Section C data and Detailed Monitoring Questionnaire data to calculate the non-hazardous BAT facility percent removals. However, if a particular facility had applicable Detailed Questionnaire Section C and Detailed Monitoring Questionnaire data, EPA used only the Detailed Monitoring Questionnaire data in calculating the BAT percent removals because of a potential overlap of the concentration data submitted for these two questionnaires. EPA used only data with matching influent and effluent data points. The Agency calculated a percent removal for each data source, and then determined an overall median percent removal for each regulated pollutant. Table 7-5 presents the summary of BAT performance data used in calculating the percent removals for the Non-Hazardous subcategory. Table 7-6 presents the results of the removal comparison for the Non-Hazardous subcategory. This table shows the median BAT percent removal and the median POTW percent removal. Although the removal comparison suggests that, at the time of proposal, only ammonia would pass through, as a result of further review of the applicable data contained in the Public Record, the comparison for the final rule suggests that three other pollutants (benzoic acid, p-cresol, and phenol) would pass through in the Non-Hazardous subcategory. However, for the reasons discussed in Chapter 11, EPA is not establishing pretreatment limits for any pollutant in the Non-Hazardous subcategory because it concluded the pollutants which might pass through were, in fact, in most cases susceptible to treatment and that national regulation was not required.

7.7.3 Hazardous Subcategory Pollutants to be Regulated for Indirect Dischargers

EPA conducted removal comparisons for the priority and nonconventional pollutants regulated under BAT for hazardous landfills. EPA did not perform the analysis for the regulated conventional pollutants, namely BOD_5 and TSS, since the conventional pollutants are generally not regulated under PSES and PSNS. For the proposal, EPA performed the analysis on the thirteen nonconventional and toxic pollutants proposed for regulation under BAT for the Hazardous subcategory and determined that seven pollutants appeared to pass through. EPA proposed pretreatment standards for the following six of these pollutants: ammonia as nitrogen, benzoic acid, toluene, alpha terpineol, p-cresol, and aniline. For the proposed rule, EPA used both of the BAT facilities in the calculation of percent removals. However, upon review of the data editing procedures, EPA determined that some of the facility data should not have been used in the calculation of percent removals. As a result of this review, the BAT facility removals for the removal comparison have changed for the Hazardous subcategory since the proposal. Finally, after proposal, EPA decided not to set BPT limits for toluene and benzene; therefore, these pollutants are not considered in the comparison (see Section 7.6.2).

In determining BAT percent removals, EPA used data from selected BAT facilities only if they met the following criteria:

1) The influent concentration for a particular pollutant was greater than 10xMDL,

2) The facility had demonstrated removal of the pollutant (EPA did not use facilities showing zero or negative percent removal), and

3) The facility did not employ treatment technologies in addition to the selected BAT that may contribute to further reduction of the pollutant.

Applying the editing criteria outlined above to those facilities selected as BAT resulted in a different set of facilities being used in the calculation of the percent removals for each of the pollutants to be regulated. Table 7-7 lists the BAT facilities used in the calculation of percent removals for the hazardous regulated pollutants.

The Agency used EPA sampling episode data Detailed Questionnaire Section C data and Detailed Monitoring Questionnaire data to calculate the hazardous BAT facility percent removals. However, if a particular facility had applicable Detailed Questionnaire Section C and Detailed Monitoring Questionnaire data, EPA used only the Detailed Monitoring Questionnaire data in calculating the BAT percent removals because of a potential overlap of the concentration data submitted for these two questionnaires. EPA used only data with matching influent and effluent data points. The Agency calculated a percent removal for each data source, and then determined an overall median percent removal for each regulated pollutant. Table 7-7 presents the summary of BAT performance data used in calculating the percent removals for the Hazardous subcategory. Table 7-8 presents the results of the removal comparison for the Hazardous subcategory. This table shows the median BAT percent removal and the median POTW percent removal. At the time of proposal, the removal comparison suggested better removals at BAT facilities than at POTWs for seven pollutants (ammonia, alpha terpineol, aniline, benzoic acid, p-cresol, phenol, and toluene). As a result of EPA's assessment, the comparison now suggests greater BAT removals for the following eight pollutants: ammonia, alpha terpineol, aniline, benzoic acid, naphthalene, p-cresol, phenol, and pyridine. However, for the reasons discussed in Chapter 11, EPA is not establishing pretreatment limits for any pollutant in the Hazardous subcategory.

Table 7-1: Non-Hazardous Subcategory Pollutants of Interest

Non-Hazardous Pollutant of Interest	Cas #	Subtitle D Municipal Pollutant of Interest	Subtitle D Non-Municipal Pollutant of Interest
Conventional			
BOD	C-002	X	X
TSS	C-009	X	X
Nonconventional			
Ammonia as Nitrogen	7664417	X	X
COD	C-004	X	X
Nitrate/Nitrite	C-005	X	X
TDS	C-010	X	X
TOC	C-012	X	X
Total Phenols	C-020	X	X
Organic			
1,4-Dioxane	123911	X	
2-Butanone	78933	X	
2-Propanone	67641	X	
4-Methyl-2-Pentanone	108101	X	
Alpha Terpineol	98555	X	
Benzoic Acid	65850	X	
Hexanoic Acid	142621	X	
Methylene Chloride	75092	X	
N,N-Dimethylformamide	68122	X	
O-Cresol	95487	X	
P-Cresol	106445	X	
Phenol	108952	X	
Toluene	108883	X	
Tripropyleneglycol Methyl Ether	20324338	X	
Metals			
Barium	7440393	X	
Chromium	7440473	X	
Hexavalent Chromium	18540299	X	
Strontium	7440246	X	X
Titanium	7440326	X	
Zinc	7440666	X	
Pesticides/Herbicides			
Dichloroprop	120365	X	
Disulfoton	298044	X	
Dioxins/Furans			
1234678-HpCDD	35822469	X	
OCDD	3268879	X	

Table 7-2: Hazardous Subcategory Pollutants of Interest

Pollutant of Interest	Cas #	Pollutant of Interest	Cas #
Conventional		**Organics (cont.)**	
BOD	C-002	P-Cresol	106445
Hexane Extractable Material	C-036	Toluene	108883
TSS	C-009	Trans-1,2-Dichloroethene	156605
Nonconventional		Trichloroethene	79016
Amenable Cyanide	C-025	Tripropyleneglycol Methyl Ether	20324338
Ammonia as Nitrogen	7664417	Vinyl Chloride	75014
COD	C-004	**Metals**	
Nitrate/Nitrite	C-005	Arsenic	7440382
TDS	C-010	Chromium	7440473
TOC	C-012	Copper	7440508
Total Phenols	C-020	Lithium	7439932
Organics		Molybdenum	7439987
1,1-Dichloroethane	75343	Nickel	7440020
1,4-Dioxane	123911	Selenium	7782492
2,4-Dimethylphenol	105679	Strontium	7440246
2-Butanone	78933	Tin	7440315
2-Propanone	67641	Titanium	7440326
4-Methyl-2-Pentanone	108101	Total Cyanide	57125
Alpha Terpineol	98555	Zinc	7440666
Aniline	62533	**Pesticides/Herbicides**	
Benzene	71432	2,4,5-TP	93721
Benzoic Acid	65850	2,4-D	94757
Benzyl Alcohol	100516	2,4-DB	94826
Diethyl Ether	60297	Dicamba	1918009
Ethylbenzene	100414	Dichloroprop	120365
Hexanoic Acid	142621	MCPA	94746
Isobutyl Alcohol	78831	MCPP	7085190
Methylene Chloride	75092	Picloram	1918021
M-Xylene	108383	Terbuthylazine	5915413
Naphthalene	91203	**Dioxins/Furans**	
O+P Xylene	136777612	1234678-HpCDD	35822469
O-Cresol	95487	1234678-HpCDF	67562394
Phenol	108952	OCDD	3268879
Pyridine	110861	OCDF	39001020

Table 7-3: Non-Hazardous Subcategory - POTW Percent Removals

Pollutant	MDL (ug/L)	Median % Removal	POTW Percent Removal Source
Ammonia as Nitrogen	10	39	50 POTW 10xMDL
Alpha-Terpineol	10	95	NRMRL 10xMDL - Industrial
Benzoic Acid	50	81	NRMRL 10xMDL - Industrial
P-Cresol	10	68	NRMRL 10xMDL - Domestic & Industrial Sources
Phenol	10	95	50 POTW 10xMDL
Zinc	20	81	50 POTW 10xMDL

Table 7-4: Hazardous Subcategory - POTW Percent Removals

Pollutant	MDL (ug/L)	Median % Removal	POTW Percent Removal Source
Ammonia as Nitrogen	10	39	50 POTW 10xMDL
Alpha-Terpineol	10	95	NRMRL 10xMDL - Industrial
Aniline	10	98	NRMRL 10xMDL - Industrial
Benzoic Acid	50	81	NRMRL 10xMDL - Industrial
Napthalene	10	95	50 POTW 10xMDL
Phenol	10	95	50 POTW 10xMDL
Pyridine	10	95	NRMRL 10xMDL - Industrial
P-Cresol	10	75	NRMRL 10xMDL - Domestic & Industrial Sources
Arsenic	10	66	50 POTW >20 ppb
Chromium	10	82	50 POTW 10xMDL
Zinc	20	81	50 POTW 10xMDL

Table 7-5: Non-Hazardous Subcategory - BAT Performance Data

Pollutants of Interest	Facility /Episode	Avg Inf	Avg Eff	% Removal
Ammonia	16041 (DMQ)	679	5.39	99.21
	16041 (ANL)	475	1.4	99.71
	16122 (ANL)	181	1.14	99.37
	16132 (DMQ)	206	5.9	97.14
				99.29 Median
Alpha Terpineol	16041 (ANL)	653	10	98.47
	16122 (ANL)	123	10	91.87
				95.17 Median
Benzoic Acid	16041 (ANL)	15400	50	99.68
	16122 (ANL)	9300	50	99.46
				99.57 Median
P-Cresol	16041 (ANL)	1360	10	**99.26 Median**
Phenol	16041 (ANL)	5120	10	99.80
	16118 (DET)	350	10	97.14
	16122 (ANL)	395	10	97.47
				97.47 Median
Zinc	16041 (DMQ)	505	214	57.62
	16041 (ANL)	310	87	71.94
	16132 (DMQ)	490	50	89.80
				71.94 Median

All units in ug/L, except ammonia in mg/L.
ANL: EPA sampling episode data
DMQ: Detailed Monitoring Questionnaire data
DET: Detailed Questionnaire data

Table 7-6: Pass-Through Analysis for the Non-Hazardous Subcategory

Pollutant	Average BAT Percent Removal	Average POTW Percent Removal
Ammonia	99%	39%
Alpha Terpineol	95%	95%
Benzoic Acid	99%	81%
P-Cresol	99%	68%
Phenol	97%	95%
Zinc	72%	81%

Table 7-7: Hazardous Subcategory - BAT Performance Data

Pollutants of Interest	Facility /Episode	Avg Inf	Avg Eff	% Removal
Ammonia	16041 (DMQ)	679	5.39	99.21
	16041 (ANL)	475	1.4	99.71
	16122 (ANL)	181	1.14	99.37
	16132 (DMQ)	206	5.9	97.14
				99.29 Median
Alpha-Terpineol	16041 (ANL)	653	10	**98.47 Median**
Aniline	16041 (ANL)	1060	10	99.06
	16087 (ANL)	533	10	98.12
				98.59 Median
Benzoic Acid	16041 (ANL)	15400	50	99.68
	16087 (ANL)	64957	50	99.92
				99.80 Median
Naphthalene	16041 (ANL)	645	10	**98.45 Median**
P-Cresol	16041 (ANL)	1360	10	99.26
	16087 (ANL)	5022	10	99.80
				99.53 Median
Phenol	16041 (ANL)	5120	10	99.80
	16087 (DET)	98500	814	99.17
	16087 (ANL)	65417	31	99.95
				99.80 Median
Pyridine	16087 (ANL)	301	10	**96.68 Median**
Arsenic	16087 (DMQ)	1400	325	76.79
	16087 (ANL)	584	308	47.26
				62.02 Median
Chromium	16041 (DET)	210	120	42.86
	16087 (DMQ)	730	312	57.26
	16087 (ANL)	415	82	80.24
				57.26 Median
Zinc	16041 (DMQ)	505	214	57.62
	16041 (ANL)	310	87	71.94
	16087 (DMQ)	550	380	30.91
				57.62 Median

All units in ug/L, except ammonia in mg/L.
ANL: EPA sampling episode data
DMQ: Detailed Monitoring Questionnaire data
DET: Detailed Questionnaire data

Table 7-8: Pass-Through Analysis for the Hazardous Subcategory

Pollutant	Average BAT Percent Removal	Average POTW Percent Removal
Ammonia	99%	39%
Alpha Terpineol	98%	95%
Aniline	99%	98%
Benzoic Acid	99%	81%
Naphthalene	98%	95%
P-Cresol	99%	68%
Phenol	99%	95%
Pyridine	97%	95%
Arsenic	62%	66%
Chromium	57%	82%
Zinc	58%	81%

Figure 7-1: Development of Pollutants of Interest

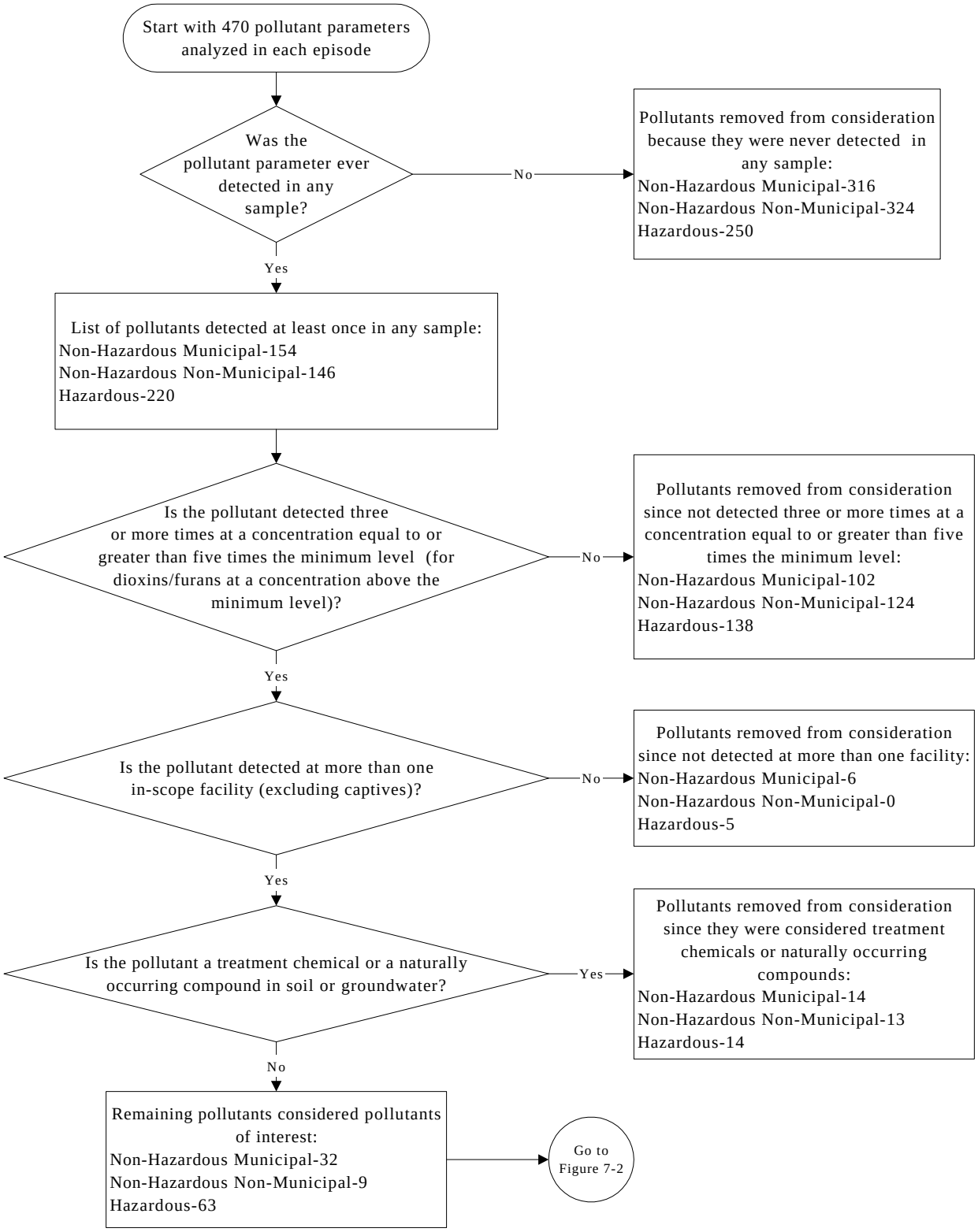
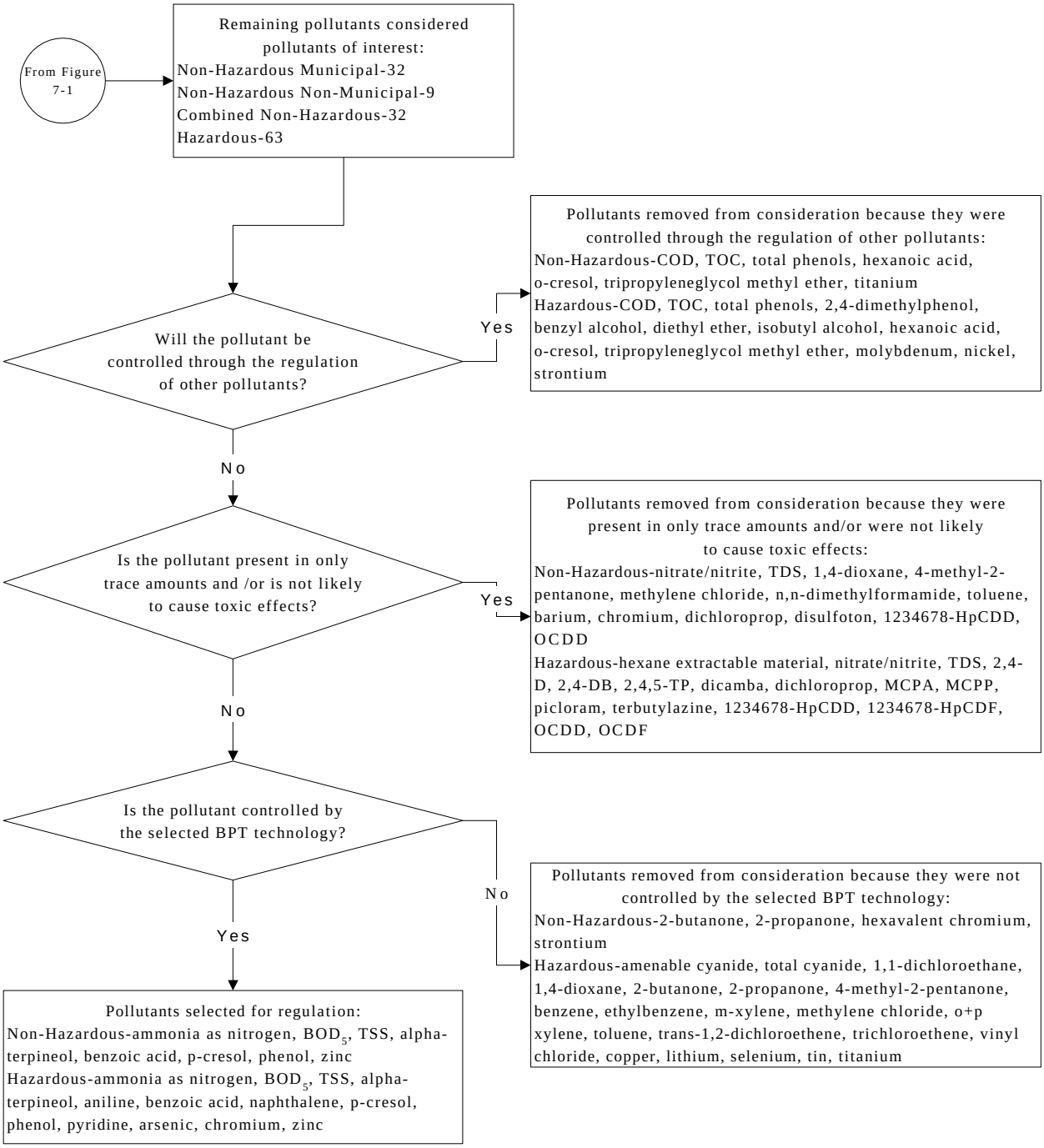


Figure 7-2: Selection of Pollutants to be Regulated



8.0 WASTEWATER TREATMENT TECHNOLOGY DESCRIPTION

This chapter consists of the following two main parts: Section 8.1, describing the wastewater treatment and sludge handling methods currently in use in the Landfills industry and Section 8.2, presenting a discussion on the performance of treatment systems evaluated by EPA using data collected during engineering site visits and field sampling programs.

8.1 Available BAT and PSES Technologies

The Landfills industry uses a wide variety of technologies for treating wastewater discharges. These technologies can be classified into the following five areas:

		Section
C	Best Management Practices	8.1.1
C	Physical/Chemical Treatment	8.1.2
C	Biological Treatment	8.1.3
C	Sludge Handling	8.1.4
C	Zero Discharge options	8.1.5

The EPA's Detailed Questionnaire obtained information on 14 treatment technologies currently in use in the Landfills industry. Table 8-1 presents the technologies most commonly used by in-scope Subtitle D non-hazardous and Subtitle C hazardous landfill facilities by discharge type. The table reports the percent of landfill facilities which use each treatment technology. In addition, EPA collected detailed information on available technologies from engineering site visits to a number of landfill facilities. The data presented below are based on these data collection efforts.

8.1.1 Best Management Practices

Best management practices with regard to wastewater generation at landfills can be designed to do one of

two things: reduce the volume of leachate produced by the landfill or reduce the toxicity of the leachate produced by the landfill. The volume of leachate generated by a landfill is largely dependent on the annual precipitation that falls within the landfill area, percolates through the landfilled waste, and collects in the leachate collection system. State and Resource Conservation and Recovery Act (RCRA) regulations require closed landfills to install an impermeable cap over the landfill to prevent infiltration of rainwater, which will eventually reduce the volume of wastewater produced by the landfill. Open landfills, however, can similarly use methods to reduce rainwater infiltration to the landfill and, hence, reduce wastewater generation. The open face of the landfill is the active area where solid waste is deposited, compacted, and covered with daily fill. This area can act as a collection point for rainwater. By maintaining a small open face on the landfill, along with using impermeable materials on the closed or inactive sections, a landfill operator can reduce the volume of wastewater collected and produced by an open landfill.

The criteria outlined by the Office of Solid Waste and Emergency Response in 40 CFR § 257, 258, 264, and 265 provide additional controls to reduce the volume and/or toxicity of landfill leachate. 40 CFR Part 257 ("Criteria for Classification of Solid Waste Disposal Facilities and Practices") establishes disposal practices for non-municipal, non-hazardous waste disposal units (including waste disposal units that receive conditionally-exempt small quantity generator waste). In Part 257.3-3(c), the regulations state that a facility shall not cause non-point source pollution of waters of the United States that violates the applicable legal requirements implementing an area or Statewide water quality management plan. 40 CFR Part 258 ("Criteria for Municipal Solid Waste Landfills") requires municipal solid waste landfills to design, construct and maintain run-on/run-off control systems (40 CFR 258.26), cover the disposed solid waste with six inches of earthen material at the end of each operating day (40 CFR 258.21), and subject these facilities to closure criteria, which require a final cover to be applied to cover the wastes (40 CFR 258.60). These requirements greatly reduce the risk of storm water becoming contaminated as a result of direct contact with the deposited solid waste. Subpart N of 40 CFR Part 264 ("Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities") establishes design and operating requirements for hazardous waste landfills. Hazardous waste landfills must design, construct, operate, and

maintain run-on/run-off control systems (264.301(g)) and, if the landfill contains particulate matter which may be subject to wind dispersal, the operator must cover or otherwise manage the landfill to control wind dispersal (264.301(j)). Subpart N of 40 CFR Part 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," defines similar controls to those identified above for Part 264 for the control of storm water contamination.

In addition, many municipal solid waste landfills and communities have developed programs to prevent toxic materials from being deposited in landfills. Solid waste generated by households may contain many types of waste which may present an environmental hazard, including paints, pesticides, and batteries. Many communities have developed household hazardous waste collection programs which collect and dispose of these hazardous wastes in an appropriate manner, thus avoiding deposition of hazardous wastes in the municipal landfill and reducing the risks associated with the leachate produced by the landfill.

8.1.2 Physical/Chemical Treatment

8.1.2.1 Equalization

Wastewater and leachate generation rates at landfills vary due to their direct relationship to rainfall, storm water run-on and run-off, ground water entering the waste-containing zone, and the moisture content and absorption capability of the wastes. To allow for the equalization of pollutant loadings and flow rates, leachate and other landfill generated wastewater is often collected prior to treatment in tanks or ponds with sufficient capacity to hold the peak flows generated at the facility. A constant flow is delivered to the treatment system from these holding tanks in order to dampen the variation in hydraulic and pollutant loadings to the wastewater treatment system. This reduction in hydraulic and pollutant variability increases the performance and reliability of down stream treatment systems and can reduce the size of subsequent treatment tanks and chemical or polymer feed rates by reducing the maximum flow rates and concentrations of pollutants. Equalization also lowers the operating costs associated with treatment units by reducing instantaneous treatment capacity demand and by optimizing the amount of treatment chemicals required for a less erratic set of treatment variables. National estimates based on EPA's Detailed Questionnaire data

show that 21 percent of direct and 12 percent of indirect non-hazardous landfill facilities use some form of equalization as part of wastewater treatment systems.

Equalization systems consist of steel or fiberglass holding tanks or lined ponds that provide sufficient capacity to contain peak flow conditions. Detention times are determined using a mass balance equation and are dependent on site-specific generation rates and treatment design criteria. According to data collected by EPA's Detailed Questionnaire, detention times can range from less than a day to 90 days, with a median value of about two days. Equalization systems contain either mechanical mixing systems or aeration systems to enhance the equalization process by keeping the tank contents well mixed and prohibiting the settling of solids.

A breakdown of equalization systems used in the Landfills industry based on the responses to the Detailed Questionnaire is as follows:

Equalization Type	% Non-Hazardous Facilities		% Hazardous Facilities
	Direct	Indirect	Indirect
Unstirred	13	7	0
Mechanically Stirred	>1	<1	0
Aerated	11	6	0

A typical equalization system is shown in Figure 8-1.

8.1.2.2 Neutralization

Wastewater generated by landfills may have a wide range of pH depending on the types of waste deposited in the landfill. In many instances, raw wastewater may require neutralization to eliminate either high or low pH values that may upset a treatment system, such as activated sludge biological treatment. However, landfill facilities also use neutralization systems in conjunction with certain chemical treatment processes, such as chemical precipitation, to adjust the pH of the wastewater to optimize process control. Acids, such as sulfuric acid or hydrochloric acid, are added to reduce pH, and alkalies, such as sodium hydroxide,

are added to raise pH values. Neutralization may be performed in a holding tank, rapid mix tank, or an equalization tank. Typically, neutralization systems at the end of a treatment system are designed to control the pH of the discharge to between 6 and 9. National estimates based on EPA's Detailed Questionnaire data show that 33 percent of indirect hazardous landfills, 6 percent of indirect non-hazardous landfills, and 7 percent of direct non-hazardous landfill facilities employ neutralization as part of wastewater treatment systems using a variety of chemical additives to control pH.

Figure 8-2 presents a flow diagram for a typical neutralization system.

8.1.2.3 Flocculation

Flocculation is a treatment technology used to enhance sedimentation or filtration treatment system performance. Flocculation precedes these processes and usually consists of a rapid mix tank, or in-line mixer, and a flocculation tank. The waste stream is initially mixed while a flocculation chemical is added. Flocculants adhere readily to suspended solids and each other to facilitate gravity sedimentation or filtration. Coagulants can be added to reduce the electrostatic surface charges and enhance the formation of complex hydrous oxides. Coagulation allows for the formation of larger, heavier particles, or flocculants (which usually form in a flocculation chamber), that can settle faster. There are three different types of flocculants commonly used: inorganic electrolytes, natural organic polymers, and synthetic polyelectrolytes. The selection of the specific treatment chemical is highly dependent upon the characteristics and chemical properties of the contaminants. A rapid mix tank is usually designed for a detention time from 15 seconds to several minutes (see reference 3). After mixing, the coagulated wastewater flows to a flocculation basin where slow mixing of the waste occurs. The slow mixing allows for the particles to agglomerate into heavier, more settleable solids. Mixing is provided either by mechanical paddle mixers or by diffused air. Flocculation basins are typically designed for a detention time of 15 to 60 minutes (see reference 3). Since many landfill facilities employ gravity-assisted separation and chemical precipitation as part of wastewater treatment systems, EPA assumes that many of these facilities employ flocculation to enhance system performance.

8.1.2.4 Gravity Assisted Separation

Gravity-assisted separation or sedimentation is a simple, economical, and widely used method for the treatment of landfill wastewater. Clarification systems remove suspended matter, flocculated impurities, and precipitates from wastewater. By allowing the wastewater to become quiescent, the suspended matter, which is heavier than water, can settle to the bottom of the clarifier, forming a sludge blanket which can be removed. This process can occur in specially designed tanks, or in earthen ponds and basins. Clarification systems can also be equipped to allow for the removal of materials lighter than water, such as oils, which are skimmed from the surface and collected for disposal. Sedimentation units at landfills are used as either primary treatment options to remove suspended solids or as a secondary treatment option following a biological or chemical precipitation process. Sedimentation processes are highly sensitive to flow fluctuations and, therefore, usually require equalization at facilities with large flow variations.

Clarifiers can be rectangular, square, or circular in shape. In rectangular or square tanks, wastewater flows from one end of the tank to the other with settled sludge collected into a hopper located at one end of the tank. In circular tanks, flow enters from the center and flows towards the outside edge with sludge collected in a center hopper. Treated wastewater exits the clarifier by flowing over a weir located at the top of the clarifier. Sludge which accumulates at the bottom of the clarifier is periodically removed and is typically stabilized and/or dewatered prior to disposal. National estimates based on EPA's Detailed Questionnaire data suggest that 67 percent of indirect hazardous landfills, 9 percent of indirect non-hazardous landfills, and 27 percent of direct non-hazardous landfill facilities employ some form of gravity-assisted separation as part of wastewater treatment systems.

Flocculation systems are commonly used in conjunction with gravity-assisted clarification systems to improve their solids removal efficiency. Some clarifiers are designed with a center well to introduce flocculants and allow for coagulation in order to improve removal efficiencies. A schematic of a typical clarification system using coagulation and flocculation is shown in Figure 8-3. The main design parameters used in designing a clarifier are the overflow rate, detention time, and the side water depth. Overflow rate

is the measure of the flow as a function of the surface area of the clarifier. Typical design parameters used for both primary and secondary clarifiers are presented below (see reference 7):

Design Parameter	Primary	Secondary
Overflow rate, gpd/sq ft	600-1,000	500-700
Detention time, min	90-150	90-150
Minimum Side water depth, ft	8	10

A variation of conventional clarification process is the chemically-assisted clarification process. Coagulants are added to clarifiers to enhance liquid-solid separation, permitting solids denser than water to settle to the bottom and materials less dense than water (including oil and grease) to flow to the surface. Settled solids form a sludge at the bottom of the clarifier which can be pumped out continuously or intermittently. Oil and grease and other floating materials may be skimmed.

Chemically assisted clarification may be used alone or as part of a more complex treatment process. It also may be used in the following capacities:

- The first process applied to wastewater containing high levels of settleable suspended solids.
- The second stage of most biological treatment processes to remove the settleable materials, including microorganisms, from the wastewater; the microorganisms then can be either recycled to the biological reactor or sent to the facility's sludge handling system.
- The final stage of most chemical precipitation (coagulation/flocculation) processes to remove the inorganic flocs from the wastewater.

As discussed in Chapter 9, chemically-assisted clarification was a component of the model wastewater treatment technology for estimating the BPT engineering costs of compliance and applied in certain cases. In developing regulatory compliance costs, EPA used chemically-assisted clarification processes as an additional polishing process after biological treatment. Chemically- assisted clarification processes consist of both a clarifier and a polymer feed system. For facilities currently with sedimentation following biological

treatment, EPA provided additional costs only for a polymer feed system. EPA included chemically-assisted clarification systems in the BPT option to aid in the settling process following biological treatment to enhance both TSS and BOD_5 removals through the wastewater treatment process. Higher BOD_5 removals can be obtained by the additional removal of microbial floc in the clarifier. EPA costed facilities for a chemically-assisted clarification system when their current performance for TSS and/or BOD_5 was slightly out of compliance with regulatory levels (up to 10 mg/L for BOD_5 and 50 mg/L for TSS). For instance, if a facility had an aerobic lagoon treatment system and exceeded the regulatory level for TSS by 20 mg/L, EPA costed the facility for a chemically-assisted clarification system.

Although no landfill facilities in EPA's database reported using chemical addition, chemically-assisted clarification is a proven technology for the removal of BOD_5 and TSS in a variety of industrial categories (see reference 19).

National estimates indicate that less than one percent of direct and indirect non-hazardous landfills use an alternative clarification system design based on corrugated plate interceptor (CPI) technology. These systems include a series of small (approximately two inch square) inclined tubes in the clarification settling zone. The suspended matter must only travel a short distance, when settling or floating, before they reach a surface of the tube. At the tubes' surface, the suspended matter further coagulate. Because of the increased surface area provided by the inclined tubes, CPI units can have much smaller settling chambers than standard clarifiers.

8.1.2.5 Chemical Precipitation

Chemical precipitation is used for the removal of metal compounds from wastewater. In the chemical precipitation process, soluble metallic ions and certain anions found in landfill wastewater are converted to insoluble forms, which precipitate from solution. Most metals are relatively insoluble as hydroxides, sulfides, or carbonates. Coagulation processes are used in conjunction with precipitation to facilitate removal by agglomeration of suspended and colloidal materials. The precipitated metals are subsequently

removed from the wastewater stream by liquid filtration or clarification (or some other form of gravity assisted separation). Other treatment processes such as equalization, chemical oxidation, or reduction (e.g., hexavalent chromium reduction) usually precede the chemical precipitation process. The performance of the chemical precipitation process is affected by chemical interactions, temperature, pH, solubility of waste contaminants, and mixing effects.

Common precipitates used at landfills facilities include lime, sodium hydroxide, soda ash, sodium sulfide, and alum. Other chemicals used in the precipitation process for pH adjustment and/or coagulation include sulfuric and phosphoric acid, ferric chloride, and polyelectrolytes. Often, facilities use a combination of these chemicals. Precipitation using sodium hydroxide or lime is the conventional method of removing metals from wastewater at landfill facilities. Hydroxide precipitation is effective in removing metals such as antimony, arsenic, chromium, copper, lead, mercury, nickel, and zinc. However, sulfide precipitation is used, instead of hydroxide precipitation, to remove specific metal ions such as mercury, lead, and silver. Carbonate precipitation is another method of chemical precipitation and is used primarily to remove antimony and lead. Use of alum as a precipitant/coagulant agent results in the formation of aluminum hydroxides in wastewater containing calcium or magnesium bicarbonate. Aluminum hydroxide is an insoluble gelatinous floc which settles slowly and entraps suspended materials. It is effective for removing metals such as arsenic and cadmium.

Since lime is less expensive than caustic (sodium hydroxide), it is more frequently used at landfill facilities employing hydroxide precipitation. However, lime is more difficult to handle and feed, as it must be slaked, slurried, and mixed and can often plug feed system lines. Lime precipitation also produces a larger volume of sludge. The reaction mechanism for precipitation of a divalent metal using lime is shown below:

$$M^{++} + Ca(OH)_2 \rightarrow M(OH)_2 + Ca^{++}$$

And, the reaction mechanism for precipitation of a divalent metal using sodium hydroxide is:

$$M^{++} + 2NaOH \; 6 \; M(OH)_2 + 2Na^{++}$$

In addition to the type of treatment chemical chosen, an important design factor in the chemical precipitation operation is pH. Metal hydroxides are amphoteric, meaning they can react chemically as acids or bases. As such, their solubilities increase toward both lower and higher pH levels. Therefore, there is an optimum pH for precipitation for each metal, which corresponds to its point of minimum solubility. Figure 8-4 presents calculated solubilities of metal hydroxides. For example, as demonstrated on this figure, the optimum pH range where zinc is least soluble is 8 to 10.

Another key consideration in a chemical precipitation application is the detention time in the sedimentation phase of the process. The optimal detention time is dependent on the wastewater being treated and the desired effluent quality.

The first step of a chemical precipitation process is pH adjustment and the addition of coagulants. This process usually takes place in separate mixing and flocculation tanks. After mixing the wastewater with treatment chemicals, the resultant mixture agglomerates in the flocculation tank, and is mixed slowly by either mechanical means, such as mixers or recirculation pumping. The wastewater then undergoes a separation/dewatering process, such as clarification or filtration, where the precipitated metals are removed from solution. In a clarification system, a flocculant, such as a polymer, is sometimes added to aid in the settling process. The resulting sludge from the clarifier or filter must be further treated, disposed, or recycled.

National estimates based on EPA's database indicate that 33 percent of indirect hazardous landfills, 5 percent of indirect non-hazardous landfills, and 9 percent of direct non-hazardous landfill facilities employ chemical precipitation as part of wastewater treatment systems. A typical chemical precipitation system is presented in Figure 8-5.

8.1.2.5.1 Iron (Fe) Coprecipitation

One cost-effective approach to remove metals is the iron adsorption and coprecipitation process. This process involves adding an iron salt, such as ferric chloride or ferric sulfate, to wastewater (unless it already contains sufficient quantities of dissolved iron) to form iron hydroxide precipitate [$Fe(OH)_3(s)$]. Above a pH of 4, the formation of this amorphous precipitate occurs rapidly, causing entrapment of many dissolved and suspended forms of various metals. This "sweep floc" results in the formation of a large quantity of solids (sludge) that can be gravity separated in a conventional clarifier (see reference 57).

8.1.2.6 Chemical Oxidation/Reduction

Chemical oxidation treatment processes can be used to remove ammonia, to oxidize cyanide, to reduce the concentration of residual organics, and to reduce the bacterial and viral content of wastewater. Both chlorine and ozone are two chemicals that are commonly used to destroy residual organics in wastewater. When these chemicals are used for this purpose, disinfection of the wastewater is usually an added benefit. A further benefit of using ozone is the removal of color. Ozone can also be combined with hydrogen peroxide to remove organic compounds in contaminated ground water. Another use of oxidation is for the conversion of pollutants to end products or to intermediate products that are more readily biodegradable or removed more readily by adsorption. National estimates based on the Detailed Questionnaire data show that 33 percent of indirect hazardous landfills, 11 percent of direct non-hazardous landfills, and less than one percent of indirect non-hazardous landfill facilities use chemical oxidation units as part of wastewater treatment systems.

Chemical oxidation is a chemical reaction process in which one or more electrons are transferred from the chemical being oxidized to the chemical initiating the transfer (the oxidizing agent). The electron acceptor may be another element, including an oxygen molecule, or it may be a chemical species containing oxygen, such as hydrogen peroxide, chlorine dioxide (see Section 8.1.2.6.1), permanganate, or ozone. This process is also effective in destroying cyanide and toxic organic compounds. Figure 8-6 presents a process schematic for a chemical oxidation system that uses an alkaline chlorination process.

Chemical oxidation is a potential treatment option for the removal of certain organic pollutants from leachate or ground water. The amount of oxidant required in practice is generally greater than the theoretical mass calculated. The reasons for this are numerous and include incomplete oxidant consumption and oxidant demand caused by other species in solution. Oxidation reactions are catalysts and pH dependent; hence, pH control is an important design variable. For many facilities utilizing chemical oxidation, partial oxidation of organics, followed by additional treatment options, may be more efficient and cost effective than using a complete oxidation treatment scheme alone.

According to the Detailed Questionnaire data, landfill facilities use chemical oxidation processes to treat cyanide-bearing wastes and organic pollutants and as a disinfectant. When treating cyanide or organic wastes, these processes use strong oxidizing chemicals, such as chlorine in elemental or hypochlorite salt form. As a disinfection process, an oxidant (usually chlorine) is added to the wastewater in the form of either chlorine dioxide or sodium hypochlorite (see Section 8.1.2.6.1). Other disinfectant chemicals include ozone, hydrogen peroxide, sulfur dioxide, and calcium hypochlorite. Once the oxidant is mixed with the wastewater, sufficient detention time (usually 30 minutes) is allowed for the disinfecting reactions to occur (see reference 7).

Chemical reduction processes involve a chemical reaction in which electrons are transferred from one chemical to another to reduce the chemical state of a contaminant. The main application of chemical reduction in leachate treatment is the reduction of hexavalent chromium to trivalent chromium. Chromium reduction is necessary due to the inability of hexavalent chromium to form a hydroxide, and enables the trivalent chromium to be precipitated from solution in conjunction with other metallic salts. Figure 8-7 presents a flow diagram of a chromium reduction system. Sulfur dioxide, sodium bisulfate, sodium metabisulfate, and ferrous sulfate are typical reducing agents used at landfill facilities.

8.1.2.6.1 <u>Breakpoint Chlorination</u>

Breakpoint chlorination, in wide use as a wastewater treatment technology, is a physical-chemical means

of removing ammonia from wastewater. Chlorine is added to process waters until the chlorine demand of the wastewater has been satisfied. At this point, the total dissolved residual chlorine has reached a minimum (the breakpoint) and the ammonia has been oxidized to form nitrogen gas and hydrochloric acid. EPA evaluated breakpoint chlorination as an alternative to biological treatment for removing ammonia at landfill facilities with low BOD concentrations. EPA concluded that these facilities may have difficulty operating biological treatment systems due to the low organic content of the wastewater.

The most common chlorine compounds used in wastewater treatment plants are chlorine gas (Cl_2), calcium hypochlorite [$Ca(OCl)_2$], sodium hypochlorite (NaOCl), and chlorine dioxide (ClO_2). Calcium and sodium hypochlorite are most often used in very small treatment plants, such as package plants, where simplicity and safety are far more important than cost. Sodium hypochlorite is often used at large facilities, primarily for reasons of safety as influenced by local conditions. Because chlorine dioxide does not react with ammonia, it is also used in a number of treatment facilities where interferences with ammonia are a concern.

The maintenance of a chlorine residual for the purpose of wastewater disinfection is complicated by the fact that free chlorine not only reacts with ammonia, but is also a strong oxidizing agent. As chlorine is added, readily oxidizable substances, such as Fe^{+2}, Mn^{+2}, H_2S, and organic matter, react with the chlorine and reduce most of it to the chloride ion. After meeting this immediate demand, the chlorine continues to react with the ammonia to form chloramines. Additional chlorine will cause some of the chloramines to be converted to nitrogen trichloride (NCl_3), the remaining will be oxidized to nitrous oxide (N_2O) and nitrogen (N_2), and the chlorine will be reduced to the chloride ion. With continued addition of chlorine, most of the chloramines will be oxidized at the breakpoint. Continued addition of chlorine past the breakpoint will result in a directly proportional increase in the free available chlorine (unreacted hypochlorite). The main reason for adding enough chlorine to obtain a free chlorine residual is that usually disinfection can then be ensured (see reference 56).

8.1.2.7 Air Stripping

Stripping is an effective treatment method for removing dissolved volatile organic compounds from wastewater. The removal is accomplished by passing air or steam through the agitated waste stream. The process results in a contaminated off-gas stream which, depending upon the air emissions standards, usually requires air pollution control equipment. National estimates based on EPA's Detailed Questionnaire data indicate that 4 percent of direct and approximately one percent of indirect non-hazardous landfill facilities use air stripping as part of wastewater treatment systems.

The driving force of air stripping mass-transfer operation is the difference in concentrations between the air and liquid streams. Pollutants are transferred from the more concentrated wastewater stream to the less concentrated air stream until equilibrium is reached. This equilibrium relationship is defined by Henry's Law. The strippability of a pollutant is expressed as its Henry's Law Constant, which is a function of its volatility and solubility.

Air stripping (or steam stripping) can be performed in tanks or in spray or packed towers. Treatment in packed towers is the most efficient application. The packing typically consists of plastic rings or saddles. The two types of towers that are commonly used, cross-flow and countercurrent, differ in design only in the location of the air inlets. In the cross-flow tower, the air is drawn through the sides for the total length of the packing. The countercurrent tower draws its entire air flow from the bottom. The cross-flow towers have been found to be more susceptible to scaling problems and are less efficient than countercurrent towers.

Figure 8-8 presents a flow diagram of a countercurrent air stripper.

8.1.2.8 Filtration

Filtration is a method for separating solid particles from a fluid through the use of a porous medium. The driving force in filtration is a pressure gradient caused by gravity, centrifugal force, or a vacuum. Filtration

treatment processes can be used at landfills to remove solids from wastewater after physical/chemical or biological treatment or as the primary source of leachate treatment. Filtration processes include a broad range of media and membrane separation technologies from ultrafiltration to reverse osmosis. To aid in removal, the filter medium may be precoated with a filtration aid such as ground cellulose or diatomaceous earth.

National estimates based on the Detailed Questionnaire data indicate that 11 percent of direct and two percent of indirect non-hazardous landfill facilities have some form of filtration as part of wastewater treatment systems, including the following:

Type of Filtration System	% Non-Hazardous Facilities	
	Direct	Indirect
Sand	6	<1
Diatomaceous earth	0	<1
Granular multimedia	6	<1
Membrane	0	1
Fabric	0	<1

Dissolved compounds in landfill wastewater are sometimes pretreated to convert the compound to an insoluble solid particle prior to filtration. Polymers are sometimes injected into the filter feed piping downstream of feed pumps to enhance flocculation of smaller flocs that may escape an upstream clarifier. Pretreatment for iron and calcium is sometimes necessary to prevent fouling and scaling.

The following sections discuss the various types of filtration in use at landfills facilities.

8.1.2.8.1 Sand Filtration

Sand filtration processes consist of either a fixed or moving bed of media that traps and removes suspended solids from water passing through the media. There are two types of fixed sand bed filters: pressure and gravity. Pressure filters contain media in an enclosed, watertight pressure vessel and require a feed pump

to force the water through the media. A gravity filter operates on the basis of differential pressure of a static head of water above the media, which causes flow through the filter. Filter loading rates for sand filters are typically between 2 to 6 gpm/sq ft (see reference 7).

All fixed media filters have influent and effluent distribution systems consisting of pipes and fittings. Strainers in the tank bottom are usually stainless steel screens. Layers of uniformly sized gravel also serve as bottom strainers and as a support for the sand. For both types of filters, the bed builds up head loss over time. Head loss is a measure of solids trapped in the filter. As the filter becomes filled with trapped solids, the efficiency of the filtration process falls off, and the filter must be backwashed. Filters are backwashed by reversing the flow so that the solids in the media are dislodged and can exit the filter; sometimes air is dispersed into the sand bed to scour the media.

Fixed-bed filters can be automatically backwashed when the differential pressure exceeds a preset limit or when a timer starts the backwash cycle. Powered valves and a backwash pump are activated and controlled by adjustable cam timers or electronic programmable-logic controllers to perform the backwash function. A supply of clean backwash water is required. Backwash water and trapped particles are commonly discharged to an equalization tank upstream of the wastewater treatment system's primary clarifier or screen for removal.

Moving bed filters use an air lift pump and draft tube to recirculate sand from the filter bottom to the top of the filter vessel, which is usually open at the top. Dirty water entering the filter at the bottom must travel upward, countercurrently, through the downward moving fluidized sand bed. Particles are strained from the rising water and carried downward with the sand. Due to the difference in specific gravity, the lighter particles are removed from the filter when the sand is recycled through a separation box at the top of the filter or in a remote location. The heavier sand falls back into the filter, while the lighter particles flow over a weir to waste. Moving bed filters are continuously backwashed and have a constant rate of effluent flow.

8.1.2.8.2 Diatomaceous Earth

These filtration systems use diatomaceous earth, a natural substance, as a precoat on either a vacuum or pressure filter arrangement to enhance removal efficiencies. In these instances, the diatomaceous earth is placed as a thin layer over a screen. The wastewater then is passed through the layer of earth and screen, with the suspended particles being filtered. A vacuum can be drawn across the screen, or pressure applied to the wastewater to help the liquid pass through the filter medium.

8.1.2.8.3 Multimedia Filtration

Multimedia, or granular bed, filtration is used for achieving supplemental removal of residual suspended solids from the effluent of chemical or biological treatment processes. These filters can be operated either by gravity or under pressure in a vessel. In granular-bed filtration, the wastewater stream is sent through a bed containing one or more layers of different granular materials. The solids are retained in the voids between the media particles while the wastewater passes through the bed. Typical media used in granular-bed filters include anthracite coal, sand, and garnet. These media can be used alone, such as in sand filtration, or in a multimedia combination. Multimedia filters are designed such that the individual layers of media remain fairly discrete. This is accomplished by selecting appropriate filter loading rates, media grain size, and bed density. Hydraulic loading rates for a multimedia filter are between 4 to 10 gpm/sq ft (see reference 7).

A multimedia filter operates with the finer, denser media at the bottom and the coarser, less dense media at the top. A common arrangement is garnet at the bottom of the bed, sand in the middle, and anthracite coal at the top. Some mixing of these layers occurs. During filtration, the removal of the suspended solids is accomplished by a complex process involving one or more mechanisms, such as straining, sedimentation, interception, impaction, and adsorption. The medium size is the principal characteristic that affects the filtration operation. If the medium is too small, much of the driving force will be wasted in overcoming the frictional resistance of the filter bed. If the medium is too large, small particles will travel through the bed, preventing optimum filtration.

The flow pattern of multimedia filters is usually top-to-bottom. Upflow filters, horizontal filters, and biflow filters are also used. A top-to-bottom multimedia filter is represented in Figure 8-9.

8.1.2.8.4 Membrane Filtration

Membrane filtration systems employ a semi-permeable membrane and a pressure differential. Both ultrafiltration and reverse osmosis are commonly used membrane filtration processes.

8.1.2.8.4.1 Ultrafiltration

Ultrafiltration uses a semipermeable microporous membrane, through which the wastewater is passed under pressure. Water and low molecular weight solutes, such as salts and surfactants, pass through the membrane and are removed as permeate. Emulsified oils and suspended solids are rejected by the membrane and removed with some of the wastewater as a concentrated liquid. The concentrate is recirculated through the membrane unit until the flow of permeate drops. The permeate can either be discharged or passed along to another treatment unit. The concentrate is contained and held for further treatment or disposal. Several types of ultrafiltration membranes configurations are available: tubular, spiral wound, hollow fiber, and plate-and-frame. A typical ultrafiltration system is presented in Figure 8-10.

Ultrafiltration is commonly used for the treatment of metal-bearing and oily wastewater. It can remove substances with molecular weights greater than 500, including suspended solids, oil and grease, large organic molecules, and complexed heavy metals (see reference 8). Ultrafiltration is used when the solute molecules are greater than ten times the size of the solvent molecules and less than one-half micron. The primary design consideration in ultrafiltration is the membrane selection. A membrane pore size is chosen based on the size of the contaminant particles targeted for removal. Other design parameters to be considered are the solids concentration, viscosity, and temperature of the feed stream, and the membrane permeability and thickness.

8.1.2.8.4.2 Reverse Osmosis

Reverse osmosis is a separation process that uses selective semipermeable membranes to remove dissolved solids, such as metal salts, from water. The membranes are more permeable to water than to contaminants or impurities. The wastewater is forced through the membrane at an applied pressure that exceeds the osmotic pressure caused by the dissolved solids. Molecules of water pass through the membrane as permeate while contaminants are flushed along the surface of the membrane and exit as concentrate. The concentrate flow from a reverse osmosis system ranges from 10 to 50 percent of the feed flow, with concentrations of dissolved solids and contaminants approaching 10 times that of the feed water (see reference 6). The percentage of permeate that passes through the membranes is a function of operating pressure, membrane type, and concentration of the contaminants in the feed.

Cellulose acetate, aromatic polyamide, and thin-film composites are commonly used membrane materials. Reverse osmosis membranes are configured into tubular, spiral wound, hollow fiber, or plate-and-frame modules. Modules are inserted into long pressure vessels that can hold one or more modules. Reverse osmosis systems consist of a pretreatment pump, a high pressure feed pump, one or more pressure vessels, controls, and instrumentation. A tubular reverse osmosis module is shown in Figure 8-11.

Membranes have a limited life depending upon application and are replaced when cleaning is no longer effective. Membranes can be cleaned manually or chemically by recirculating the cleaning solution through the membranes to restore performance. Membranes can also be removed from the reverse osmosis system and sent off site for flushing and rejuvenation. Membranes are replaced when cleaning is no longer effective.

Membrane pore sizes for a typical reverse osmosis system range from 0.0005 to 0.002 microns, while pressures of 300 to 400 psi are usually required (see reference 39). Therefore, reverse osmosis feed-water needs to be very low in turbidity. Pretreatment of landfill wastewater prior to reverse osmosis treatment may be necessary, including chemical addition and clarification, or cartridge filtration using 5 micron filters

to remove suspended particulates from the influent in order to protect pumps and membranes. Carbon adsorption is recommended as pretreatment for membranes sensitive to chlorine. Biofouling can be prevented by chlorination and dechlorination of the feed water. To maintain the solubility of metals such as calcium, magnesium, and iron, the pH can be adjusted with acid. Aside from pH adjustment, chemical requirements include the following: bactericide, dechlorination, and chelating agents.

One variation of conventional reverse osmosis technology used at landfill facilities is an innovative membrane separation technology using disc tube modules. This innovative process is designed to treat liquid waste that is higher in dissolved solids content, turbidity, and contaminant levels than waste treated by conventional membrane separation processes. This process also reduces the potential for membrane fouling and scaling, allowing it to be the primary treatment for waste streams such as landfill leachate.

The disc tube membrane module features larger feed-flow channels and a higher feed-flow velocity than typical membrane separation systems (see reference 48). These characteristics allow the disc tube module greater tolerance for dissolved solids and turbidity and a greater resistance to membrane fouling and scaling. The high flow velocity, short feed-water path across each membrane, and the circuitous flow path create turbulent mixing reducing boundary layer effects, and minimizing membrane fouling and scaling.

Membrane material for the disc tube module is formed into a cushion with a porous spacer material on the inside. The membrane cushions are alternately stacked with hydraulic discs on a tension rod. The hydraulic disks support the membranes and provide the flow channels for the feed liquid to pass over the membranes. After passing through the membrane material, permeate flows through collection channels to a product recovery tank. A stack of cushions and disks is housed in a pressure vessel. The number of disks per module, number of modules, and the membrane materials can be varied to suit the application. Modules are typically combined in a treatment unit or stage. Disc tube module units can be connected in series to improve permeate water quality or in parallel to increase system treatment capacity (see reference 48).

Like all membrane separation processes, reverse osmosis technology reduces the volume of the waste. The degree of volume reduction is dependent on the waste characteristics and the system design. Reverse osmosis technology can treat liquid waste streams containing low molecular weight volatile and semivolatile organics, metals, and other inorganic compounds.

8.1.2.8.5 Fabric Filters

Fabric filters consist of a vessel that contains a cloth or paper barrier through which the wastewater must pass. The suspended matter is screened by the fabric and the effectiveness of the filter depends on the mesh size of the fabric. Fabric filters can either be backwashed or built as disposable units.

For waters having less than 10 mg/L suspended solids, cartridge fabric filters may be cost effective. Cartridge filters have very low capital cost and can remove particles of 1 micron or larger (see reference 39). Using two-stage cartridge filters (coarse and fine) in series extends the life of the fine cartridge. Disposable or backwashable bag filters also are available and may be quite cost effective for certain applications. Typically, these fabric filters are used to remove suspended solids prior to other filtration systems to protect membranes and equipment and reduce solids fouling.

8.1.2.9 Carbon Adsorption

Activated-carbon adsorption is a physical separation process in which organic and inorganic materials are removed from wastewater by sorption, or attraction, and accumulation of the compounds on the surface of the carbon granules. This process is commonly referred to as granular activated carbon adsorption. While the primary removal mechanism is adsorption, biological degradation and filtration are additional pollutant removal mechanisms provided by the activated- carbon filter. Adsorption capacities of 0.5 to 10 percent by weight are typical in industrial applications (see reference 5). Spent carbon can either be regenerated on site, by processes such as wet-air oxidation or steam stripping, or, for smaller operations, be regenerated off site or sent directly for disposal. Vendors of carbon can exchange spent carbon with fresh carbon under contract.

Activated-carbon systems consist of a vessel containing a bed of carbon (usually 4 to 12 feet in depth), whereby the wastewater is either passed upflow or downflow through the filter bed (see reference 6). Carbon vessels are typically operated under pressure, though some designs use gravity beds. For smaller applications, granular activated carbon systems also are available in canister systems, which can be readily changed-out and sent for off-site regeneration.

Often more than one carbon vessel is used in series, such that the first column can be used until the carbon is "exhausted" before it is regenerated. The partially-exhausted second column is then used as the first column and another column is rotated behind it to provide polishing. Up to three columns are typically used in a rotating fashion. When all of the available adsorption sites on the granular activated carbon are occupied, a rise in organic concentrations is observed in the effluent leaving the vessel. At this point the granular activated carbon in the vessel is saturated and is said to have reached break-through.

The key design parameter is the adsorption capacity of the granular activated carbon. This is a measure of the mass of contaminant adsorbed per unit mass of carbon and is a function of the chemical compounds being removed, type of carbon used, and process and operating conditions. The volume of carbon required is based upon the COD and/or pollutant-specific concentrations in the wastewater to be treated and desired frequency of carbon change-outs. The vessel is typically designed for an empty bed contact time of 15 to 60 minutes (see reference 5). Non-polar, high molecular weight organics with low solubility are readily adsorbed using GAC. Certain organic compounds have a competitive advantage for adsorption onto GAC, which results in compounds being preferentially adsorbed or causing other less competitive compounds to be desorbed from the GAC. Most organic compounds and some metals typically found in landfill leachate are effectively removed using GAC.

National estimates based on EPA's Detailed Questionnaire data indicate that greater than one percent of indirect and greater than one percent of direct non-hazardous landfill facilities employ carbon adsorption

as part of wastewater treatment systems. Figure 8-12 presents a flow diagram of a typical carbon adsorption vessel.

8.1.2.10 Ion Exchange

Ion exchange is an adsorption process that uses a resin media to remove contaminants from wastewater. Ion exchange is commonly used for the removal of heavy metals from relatively low-concentration waste streams. A key advantage of the ion exchange process is that it allows for the recovery and reuse of the metals in a wastewater. Ion exchange also can be designed to be selective to certain metals and can provide effective removal from wastewater having high concentrations of background compounds such as iron, magnesium, and calcium. A disadvantage is that the resins can be fouled by oils and heavy polymers. Pretreatment for ground water or leachate treated by an ion exchange system typically includes a cartridge filtration unit. Additional tanks and pumps are required for regeneration, chemical feed, and collection of spent solution.

In an ion exchange system, the wastewater stream is passed through a bed of resin. The resin contains bound groups of ionic charge on its surface, which are exchanged for ions of the same charge in the wastewater. Resins are classified by type, either cationic or anionic. The selection of a resin is dependent upon the wastewater contaminant to be removed. Cation resins adsorb metals, while anion resins adsorb such contaminants as nitrate and sulfate. A commonly-used resin is polystyrene copolymerized with divinylbenzene. Key parameters for designing an ion-exchange system include a resin bed loading rate of 2 to 4 gallons per minute per cubic foot, and a pressure vessel diameter providing for a cross-sectional area loading rate of 5 to 8 gallons per minute per square foot (see reference 5).

The ion exchange process involves the following four steps: treatment, backwash, regeneration, and rinse. During the treatment step, wastewater is passed through the resin bed. The ion exchange process continues until pollutant breakthrough occurs. The resin is then backwashed to clean the bed and to remove suspended solids. During the regeneration step, the resin is contacted with either an acidic or alkaline

solution containing the ion originally present in the resin. This "reverses" the ion exchange process and removes the ions that were originally present in the wastewater and were retained by the resin. The bed is then rinsed to remove residual regenerating solution. The resulting contaminated regenerating solution must be further processed for reuse or disposal. Depending upon system size and economics, some facilities choose to remove the spent resin and replace it with resin regenerated off-site instead of regenerating the resin in-place.

Ion exchange equipment ranges from simple, inexpensive systems such as domestic water softeners, to large, continuous industrial applications. A common industrial setup is fixed-bed resin in a vertical column, where the resin is regenerated in-place. Other operating modes include batch and fluidized bed. These systems can be designed so that the regenerant flow is concurrent or countercurrent to the treatment flow. A countercurrent design, although more complex to operate, provides a higher treatment efficiency. The beds can contain a single type of resin for selective treatment, or the beds can be mixed to provide for more complete deionization of the waste stream. Often, individual beds containing different resins are arranged in series, which makes regeneration easier than in the mixed bed system.

National estimates based on the Detailed Questionnaire data show that less than one percent of indirect non-hazardous landfills employ some form of ion exchange as part of wastewater treatment systems. Figure 8-13 presents a flow diagram of a typical ion exchange setup, fixed-bed resin in a vertical column.

8.1.3 Biological Treatment

Biological treatment uses microbes which consume, and thereby destroy, organic compounds as a food source. Leachate from landfills can contain large quantities of organic materials that can be readily stabilized using biological treatment processes. In addition to the carbon food source supplied by the organic pollutants, the microbes also require energy and supplemental nutrients for growth, such as nitrogen and phosphorus. There are several different classes of microbes that are commonly used in the biological treatment of organic bearing wastes. Aerobic microbes require oxygen to grow, whereas anaerobic

microbes grow in the absence of oxygen. An adaptive type of anaerobic microbe, called a facultative anaerobe, can grow with or without oxygen.

The success of biological treatment in treating wastewater is dependent on several factors, such as the pH and temperature of the wastewater, the nature of the pollutants, the nutrient requirements of the microbes, the presence of other inhibiting pollutants (such as toxic heavy metals), and variations in the feed stream loading.

Aerobic biological treatment systems utilize an acclimated community of microorganisms to degrade, coagulate, and remove organic and other contaminants from wastewater. Organic contaminants in the wastewater are used by the treatment organisms for biological synthesis and growth, with a small portion for cellular maintenance. Resulting products from biological treatment include cellular biomass, carbon dioxide, water and, sometimes, the nondegradable fraction of the organic material.

In the biological treatment process, wastewater is mixed or introduced to the biomass. The microorganisms responsible for stabilization can be maintained in suspended form or can be attached to a solid media. Examples of the suspended growth biological treatment systems include various activated sludge treatment processes and aerobic lagoons. Biological treatment processes which employ the use of fixed film media include trickling filtration, biotowers, and rotating biological contactors.

Anaerobic biological treatment systems can degrade organic matter in wastewater and ultimately convert carbonaceous material into methane and carbon dioxide. Anaerobic systems have been shown to be most effective for high strength leachate (COD over 4,000 mg/L) and for wastewater containing refractory contaminants because of effectiveness of methanotropic microorganisms in metabolizing these compounds. A disadvantage to anaerobic treatment systems is the sensitivity of the methanotropic microorganisms to certain toxic substances.

Initially, in an anaerobic treatment process, the complex organic matter in the raw waste stream is converted to soluble organics by extra-cellular enzymes. This step facilitates the later conversion of soluble organic matter into simple organic acids. The final step involves the conversion of organic acids into methane and carbon dioxide. The bacteria responsible for the conversions have very slow growth rates. In addition, methanotropic bacteria are very sensitive to environmental conditions, require the complete absence of oxygen, a narrow pH range (6.5 to 7.5), and can be readily inhibited by the presence of toxic compounds such as certain heavy metals.

The table below presents EPA's estimated number of landfill facilities that use variations of biological treatment as part of landfill wastewater treatment systems:

Type of Biological Treatment	% Non-Hazardous Facilities		% Hazardous Facilities
	Direct	Indirect	Indirect
Activated Sludge	8	1	33
Aerobic Lagoon Systems	7	3	0
Facultative Lagoons	7	<1	0
Trickling Filters	0	0	0
Anaerobic Systems	2	<1	0
Powdered Activated Carbon Treatment (PACT)*	>1	<1	0
* with Activated Sludge			
Nitrification Systems	2	<1	0
Rotating Biological Contactors (RBCs)	0	0	0
Sequencing Batch Reactors (SBRs)	>1	0	33
Denitrification Systems	>1	0	0
Other+	13	0	0
+ includes aerated submerged fixed film and wetlands			

The following sections present a discussion of biological treatment systems in use at landfill facilities.

8.1.3.1 Lagoon Systems

A lagoon, stabilization pond, or oxidation pond is a body of water contained in an earthen dike and designed for biological treatment. While in the lagoon, wastewater is treated to reduce degradable organics through biodegradation and reduce suspended solids through sedimentation. The biological process taking

place in the lagoon can be aerobic, anaerobic, or both (facultative), depending on the design. Because of the low construction and operating costs, lagoons offer a financial advantage over other treatment methods and are popular where sufficient land is available at reasonable cost.

Lagoons are used in wastewater treatment for stabilization of suspended, dissolved, and colloidal organics either as a main biological treatment process or as a polishing treatment process following other biological treatment systems. Aerobic, facultative, and aerated lagoons are generally used for wastewater of low and medium organic strength. High-strength wastewater and wastewater of variable strength often are treated by a series of lagoons. A common configuration is an anaerobic lagoon, followed by a facultative lagoon and an aerobic lagoon.

The performance of lagoons in removing degradable organics depends on detention time, temperature, and the nature of the waste. Aerated lagoons generally provide a high degree of BOD_5 reduction more consistently than aerobic or facultative lagoons. Typical problems associated with lagoons are excessive algae growth, offensive odors from anaerobic lagoons if sulfates are present and the lagoon is not covered, and seasonal variations in effluent quality. The major classes of lagoons that are based on the nature of biological activities are discussed below.

Aerobic lagoons depend on algae photosynthesis and natural aeration to assist in the biological activity. These shallow lagoons (3 to 4 feet in depth) rely on both the natural oxygen transfer occurring through the surface area of the lagoon and the production of oxygen from photosynthetic algae. Aerobic lagoons are generally suitable for treating low- to medium-strength landfill leachates due to the recommended smaller food to mass ratios. Because of this design limitation, aerobic lagoons are used in combination with other lagoons to treat higher-strength landfill leachates to achieve additional organic removal following conventional wastewater treatment processes. The typical hydraulic detention time for an aerobic lagoon is 10 to 40 days, with an organic loading of 60 to 120 pounds of BOD_5 per day per acre (see reference 7).

A variation of the aerobic lagoon is the aerated lagoon. These lagoons do not depend on algae and sunlight to furnish dissolved oxygen, but require additional oxygen to be introduced to prevent anaerobic conditions. In these systems, mechanical or diffused aeration devices are used in the lagoons for oxygen transfer and to create some degree of mixing (see Figure 8-14). Due to this mixing, additional suspended solids removal in the effluent from the lagoon may be required. The recommended hydraulic detention time is 3 to 20 days, with an organic loading of 20 to 400 pounds of BOD_5 per day per acre (see reference 7). Based on these higher design loading rates, aerated lagoons are well suited for treatment of medium-strength landfill leachates.

Aerated lagoons are relatively simple to operate. The influent is fed into the basin where it is mixed and aerated with the lagoon contents. Settled sludge is not routinely withdrawn from the lagoon. Lagoons require only periodic cleanings when the settled solids significantly reduce lagoon volume. Since operation requires no sludge recycle, the hydraulic detention time is equal to the sludge retention time. Contaminant reduction in a lagoon system is typically less than other biological treatment systems. As a result, aerobic lagoons are commonly used together with other physical/chemical treatment processes, such as lime addition and settling, to ensure sufficient pollutant removal efficiencies.

Anaerobic lagoons are relatively deep ponds (up to 6 meters) with steep sidewalls in which anaerobic conditions are maintained by keeping organic loading so high that complete deoxygenation is prevalent. Some oxygenation is possible in a shallow surface zone. If floating materials in the waste form an impervious surface layer, complete anaerobic conditions will develop. Treatment or stabilization results from anaerobic digestion of organic wastes by acid-forming bacteria that break down organics. The resultant acids are then converted to carbon dioxide, methane, and other end products. Anaerobic lagoons are capable of providing treatment of high-strength wastewater and are resistant to shock loads.

In the typical anaerobic lagoon, raw wastewater enters near the bottom of the pond (often at the center) and mixes with the active microbial mass in the sludge blanket, which can be as much as 2 meters (6 feet)

deep. The discharge is located near one of the sides of the pond, submerged below the liquid surface. Excess sludge is washed out with the effluent and recirculation of waste sludge is not required.

Anaerobic lagoons are customarily contained within earthen dikes. Depending on soil and wastewater characteristics, lining with various impervious materials, such as rubber, plastic, or clay may be necessary. Pond geometry may vary, but surface area-to-volume ratios are minimized to enhance heat retention.

Waste stabilization in a facultative lagoon treatment system is accomplished by a combination of anaerobic microorganisms, aerobic microorganisms, and a preponderance of facultative microorganisms that thrive under anaerobic as well as aerobic conditions. Facultative systems consist of lagoons of intermediate depth (3 to 8 feet) in which the wastewater is stratified into three zones (see Figure 8-15). These zones consist of an anaerobic bottom layer, an aerobic surface layer, and an intermediate zone dominated by the facultative microorganisms. Stratification is a result of solids settling and temperature-water density variations. Oxygen in the surface zone is provided by natural oxygen transfer and photosynthesis or, as in the case of an aerated facultative lagoon, by mechanical aerators or diffusers. Facultative lagoons usually consist of earthen dikes, but some are lined with various impervious materials, such as synthetic geomembranes or clay.

A facultative lagoon is designed to permit the accumulation of settleable solids on the basin bottom. This sludge at the bottom of the facultative lagoon will undergo anaerobic digestion, producing carbon dioxide and methane. The liquid and gaseous intermediate products from the accumulated solids, together with the dissolved solids furnished in the influent, provide the food for the aerobic and facultative bacteria in the upper layers of the liquid in the lagoon. Recommended hydraulic detention time for a facultative lagoon without aeration is 7 to 30 days, with an organic loading of 15 to 50 pounds of BOD_5 per day per acre (see reference 7).

8.1.3.2 Anaerobic Systems

Types of anaerobic biological treatment systems include complex mix anaerobic digestors (see Figure 8-16), contact reactors with sludge recycle, and anaerobic filters. A digestor uses an air tight reactor where wastes are mixed with digestor contents that contain the suspended anaerobic microorganisms. A digestor operated in a complete mix mode without sludge recycling has a hydraulic detention time equal to the solids retention time. Anaerobic digestion in a reactor can also occur with sludge recycling. This permits a much larger solids retention time (SRT) than the hydraulic detention time. System stability is greater at increased SRTs, and since the hydraulic detention time can be decreased, the reactor volume can also be reduced. The anaerobic filter or biotower microbes are maintained in a film on packed solid media within an air-tight column. A variation of the anaerobic fixed-film process is a fluidized bed process. The basic tower design is similar to that of an aerobic reactor in that the influent is fed into the reactor at countercurrent flow. This process provides for very high SRTs and variable hydraulic detention times.

Stabilization of leachate in an anaerobic treatment unit requires the maintenance of a viable community of anaerobic microbes. Treatment efficiency is dependent on many interrelated factors such as hydraulic detention time, SRT, temperature, and, to a lesser extent, organic loading, nutrients, and toxics. Microorganisms responsible for degrading the organic waste must remain in the reactor long enough to reproduce. When the microbes spend less time in the system than they require to reproduce, the solids are eventually washed out of the system. Anaerobic treatment facilities are typically designed with an SRT of 2 to 10 times the washout time (typical washout time reported for organic acids is about 3.5 days). For degradation of organic acids in leachate, this washout time would yield an SRT of 7 to 35 days (see reference 7). The most common temperature regime for an anaerobic reactor is in the range of 25 to 38 degrees C (see reference 7). Typical loadings for anaerobic systems are from 30 to 100 pounds of COD per 1,000 cubic feet of reactor volume (see reference 7). Since the synthesis of new cellular material is slow in anaerobic systems, nutrient requirements are not as large as in aerobic systems. Nutrient addition needs to be evaluated and, in the case of leachate with low phosphorus concentrations, will require phosphorus addition.

8.1.3.3 Attached-Growth Biological Treatment Systems

Attached-growth biological treatment systems are used to biodegrade the organic components of a wastewater. In these systems, the biomass adheres to the surfaces of rigid supporting media. As wastewater contacts the supporting medium, a thin-film biological slime develops and coats the surfaces. As this film (consisting primarily of bacteria, protozoa, and fungi) grows, the slime periodically breaks off the medium and is replaced by new growth. This phenomenon of losing the slime layer is called sloughing and is primarily a function of organic and hydraulic loadings on the system. The effluent from the system is usually discharged to a clarifier to settle and remove the agglomerated solids.

Attached-growth biological systems are applicable to industrial wastewater amenable to aerobic biological treatment in conjunction with suitable pre- and post-treatment units. These systems are effective for the removal of suspended or colloidal materials.

The three major types of attached-growth systems used at landfills facilities are rotating biological contactors, trickling filters, and fluidized-bed biological reactors. These processes are described below.

Rotating biological contactors are a form of aerobic attached-growth biological treatment system where the biomass adheres to the surface of a rigid media. In a rotating biological contactor, the rigid media usually consists of a plastic disk or corrugated plastic medium mounted on a horizontal shaft (see Figure 8-17). The medium slowly rotates in wastewater (with 40 to 50 percent of its surface immersed) as the wastewater flows past. During the rotation, the medium picks up a thin layer of wastewater, which flows over its surface absorbing oxygen from the air. The biological mass growing on the medium surface absorbs organic pollutants, which then are biodegraded. Excess microorganisms and other solids are continuously removed from the film on the disk by shearing forces created by the rotation of the disk in the wastewater. The sloughed solids are carried with the effluent to a clarifier, where they are separated from the treated effluent.

Rotating biological contactors provide a greater degree of flexibility for landfills with changing leachate characteristics. Modular construction of rotating biological contactors permit their multiple staging to meet increases or decreases in treatment demand. Staging, which employs a number of rotating biological contactors operated in series, enhances biological treatment efficiency, improves shock-handling ability, and also may aid in achieving nitrification.

Typical rotating biological contactor design parameters include a hydraulic loading of 2.0 to 4.0 gallons per square feet per day and an organic loading of 2.0 to 3.5 pounds BOD_5 per 1,000 square feet per day (see reference 12).

Factors which affect the efficiency of rotating biological contactor systems include the type and concentration of organic matter, hydraulic detention time, rotational speed, media surface area submergence, and pre- and post-treatment activities. Variations of the basic rotating biological contactor process design include the addition of air to the tanks, chemicals for pH control, use of molded covers or housing for temperature control, and sludge recycle to enhance nitrification. Rotating biological contactors are typically well suited for the treatment of soluble organics and adequate for nitrification. They are low-rate systems capable of handling limited loadings capacity and are not efficient for degrading refractory compounds or removing metals (see reference 7).

Trickling filtration is another aerobic fixed-film biological treatment process that consists of a suitable structure, packed with inert medium, such as rock, wood, or plastic. The wastewater is distributed over the upper surface of the medium by either a fixed spray nozzle system or a rotating distribution system (see Figure 8-18). The inert medium develops a biological slime that absorbs and biodegrades organic pollutants. Air flows through the filter by convection, thereby providing the oxygen needed to maintain aerobic conditions.

Trickling filters are classified as low-rate or high-rate, depending on the organic loading. Typical design organic loading values range from 5 to 25 pounds and 25 to 45 pounds BOD_5 per 1,000 cubic feet per day for low-rate and high-rate, respectively (see reference 11). A low-rate filter generally has a media bed depth of 1.5 to 3 meters and does not use recirculation. A high-rate filter can have a bed depth from 1 to 9 meters and recirculates a portion of the effluent for further treatment (see reference 7).

A variation of a trickling filtration process is the aerobic biotower which can be operated in a continuous or semi-continuous manner. Influent is pumped to the top of a tower, where it flows by gravity through the tower. The tower is packed with media, plastic or redwood, containing the microbial growth. Biological degradation occurs as the wastewater passes over the media. Treated wastewater collects into the bottom of the tower. If needed, additional oxygen is provided via air blowers countercurrent to the wastewater flow. Alternative variations of this treatment process involve the inoculation of the raw influent with bacteria, adding nutrients, and using upflow biotowers. Wastewater collected in the biotowers is delivered to a clarifier to separate the biological solids from the treated effluent.

An aerobic fluidized-bed biological reactor is a variation of a fixed-film biological treatment process. Microorganisms are grown on either granular activated carbon or sand media. Influent wastewater enters the reactor through a distributor which is designed to provide for fluidization of the media (see Figure 8-19). As the biofilm grows, the media bed expands, thereby reducing the density of the media. The rising bed is intercepted at a given height with the bulk of the biomass removed from the media. The media then is returned to the reactor. Additional oxygen can be predissolved in the influent to enhance performance. The use of granular activated carbon as a medium integrates biological treatment and carbon adsorption processes, which has the advantage of handling loading fluctuations, as well as greater removals of organic contaminants.

Due to a short hydraulic detention time, this process is favorable for low to moderate levels of contamination. The vertical installation of the reactor and high loading capability reduces conventional land

requirements. The maximum design loading is 400 pounds of BOD per 1,000 square feet of reactor area per day with a minimum hydraulic detention time of 5 to 10 minutes (see reference 7).

8.1.3.4 Activated Sludge

The activated sludge process is a specific continuous-flow, aerobic biological treatment process that employs suspended-growth aerobic microorganisms to biodegrade organic contaminants. In this process (shown in Figure 8-20), a suspension of aerobic microorganisms is maintained in a relatively homogeneous state by mechanical mixing or turbulence induced by diffused aerators in an aeration basin. This suspension of microorganisms is called the mixed liquor.

Wastewater is introduced into the basin and mixed with the tank contents. The biological process often is preceded by gravity settling to remove larger and heavier suspended solids. A series of biochemical reactions take place in the aeration tank. These reactions degrade organics and generate new biomass. Microorganisms oxidize the soluble and suspended organic pollutants to carbon dioxide and water using the available supplied oxygen. These organisms also agglomerate colloidal and particulate solids. After a specific contact period in the aeration basin, the mixture is passed to a settling tank where the microorganisms are separated from the treated water. A portion of the settled solids in the clarifier is recycled back to the aeration system to maintain the desired concentration of microorganisms in the reactor. The remainder of the settled solids is wasted and sent to sludge handling facilities.

To ensure biological stabilization of organic compounds in activated sludge systems, adequate nutrient levels must be available to the biomass. The primary nutrients are nitrogen and phosphorus. Lack of these nutrients can impair biological activity and result in reduced removal efficiencies. Certain leachates can have low concentrations of nitrogen and phosphorus relative to the oxygen demand. As a result, nutrient supplements (e.g., phosphoric acid addition for additional phosphorus) have been used in activated sludge systems at landfill facilities.

The effectiveness of the activated sludge process is governed by several design and operation variables. The key variables are organic loading, sludge retention time, hydraulic or aeration detention time, oxygen requirements, and the biokinetic rate constant (K). The organic loading is described as the food-to-microorganism (F/M) ratio, or kilograms of BOD_5 applied daily to the system per kilogram of mixed liquor suspended solids (MLSS). The MLSS in the aeration tank is determined by the rate and concentration of activated sludge returned to the tank. The organic loading (F/M ratio) affects the BOD_5 removal, oxygen requirements, biomass production, and the settleability of the biomass. The sludge (or solids) retention time (SRT) or sludge age is a measure of the average retention time of solids in the activated sludge system. Sludge retention time is important in the operating of an activated sludge system because it must be maintained at a level that is greater than the maximum generation time of microorganisms in the system. If adequate sludge retention time is not maintained, the bacteria are washed from the system faster than they can reproduce and the process fails. The SRT also affects the degree of treatment and production of waste sludge. A high SRT results in carrying a high quantity of solids in the system, obtaining a higher degree of treatment, and producing less waste sludge. The hydraulic detention time is used to determine the size of the aeration tank and should be determined by use of F/M ratio, SRT, and MLSS. The biokinetic rate constant (or K-rate) determines the speed of the biochemical oxygen demand reaction and generally ranges from 0.1 to 0.5 $days^{-1}$ for municipal wastewater (see reference 11). The value of K for any given organic compound is temperature-dependent. Because microorganisms are more active at higher temperatures, the value of K increases with increasing temperature. Oxygen requirements are based on the amount of oxygen required for BOD_5 synthesis and the amount required for endogenous respiration. The design parameters will also vary with the type of wastewater to be treated. The oxygen requirement to satisfy BOD_5 synthesis is established by the characteristics of the wastewater. The oxygen requirement to satisfy endogenous respiration is determined by the total solids maintained in the system and their characteristics.

Modifications of the activated sludge process are common, as the process is extremely versatile and can be adapted for a wide variety of organically contaminated wastewater. The typical modification may represent a variation in one or more of the key design parameters, including the F/M loading, aeration

location and type, sludge return, and contact basin configuration. The modifications in practice have been identified by the major characteristics that distinguish the particular configuration. The characteristic types and modifications are briefly described as follows:

- Conventional. The aeration tanks are long and narrow, with plug flow (i.e., little forward or backwards mixing).

- Complete Mix. The aeration tanks are shorter and wider, and the aerators, diffusers, and entry points of the influent and return sludge are arranged so that the wastewater mixes completely.

- Tapered Aeration. A modification of the conventional process in which the diffusers are arranged to supply more air to the influent end of the tank, where the oxygen demand is highest.

- Step Aeration. A modification of the conventional process in which the wastewater is introduced to the aeration tank at several points, lowering the peak oxygen demand.

- High Rate Activated Sludge. A modification of conventional or tapered aeration in which the aeration times are shorter, the pollutants loadings are higher per unit mass of microorganisms in the tank. The rate of BOD_5 removal for this process is higher than that of conventional activated sludge processes, but the total BOD_5 removals are lower.

- Pure Oxygen. An activated sludge variation in which pure oxygen instead of air is added to the aeration tanks. The tanks are covered, and the oxygen-containing off-gas is recycled. Compared to normal air aeration, pure oxygen aeration requires a smaller aeration tank volume and treats high-strength wastewater and widely fluctuating organic loadings more efficiently.

- Extended Aeration. A variation of complete mix in which low organic loadings and long aeration times permit more complete wastewater degradation and partial aerobic digestion of the microorganisms.

- Contact Stabilization. An activated sludge modification using two aeration stages. In the first stage, wastewater is aerated with the return sludge in the contact tank for 30 to 90 minutes, allowing finely suspended colloidal and dissolved organics to absorb to the activated sludge. The solids are settled out in a clarifier and then aerated in the sludge aeration (stabilization) tank for 3 to 6 hours before flowing into the first aeration tank (see reference 11).

- Oxidation Ditch Activated Sludge. An extended aeration process in which aeration and mixing are provided by brush rotors placed across a race-track-shaped basin. Waste enters the ditch at one end, is aerated by the rotors, and circulates.

Activated sludge systems are effective in the removal of soluble (dissolved) organics by biosorption as well as suspended and colloidal matter typically found in landfill leachate. Suspended matter is removed by entrapment in the biological floc while colloidal matter is removed by physiochemical adsorption to the biological floc. For example, inorganic contaminants, such as heavy metals, that are common in low concentrations in landfill wastewater are often precipitated and concentrated in the biological sludges generated from activated sludge systems at landfill facilities. Halogenated organic compounds may be driven off to a certain extent in the aeration process while other less volatile compounds are removed by a combination of biodegradation and air stripping in the aeration basin. Finally, activated sludge systems treating landfill leachates with an excess loading of certain nutrients (i.e. amounts of nitrogen that exceed the requirements of the biomass in the activated sludge system) can be operated so that nitrification of ammonia can occur in the activated sludge system. For higher concentrations, stand-alone nitrification systems may be required; these systems are discussed later in this chapter.

Conventional, plug-flow activated sludge systems can adequately treat the organic loadings found in low- to medium-strength landfill leachates. Higher-strength leachates often are treated at landfill facilities using extended aeration mode of activated sludge treatment. This process allows for a large hydraulic detention time of up to 29 hours and for a sludge detention time of 20 to 30 days (see reference 7). Aerator loading for the complete-mix extended-aeration process is between 10 to 15 pounds of BOD_5 per 1,000 cubic feet of aerator tank volume (see reference 7). Extended aeration also provides for minimal operator supervision in comparison to other activated sludge processes and occasional sludge wasting. EPA sampled a facility (EPA sampling episode 4759) in the Hazardous subcategory that employed a complete-mix extended-aeration treatment process for high-strength leachate. Design parameters for this system include influent BOD_5 loading of 3520 mg/L with a hydraulic detention time of 28 hours. Higher-strength leachates are also occasionally treated with a combination of biological processes, sometimes using a lagoon or attached growth system prior to the activated sludge system to reduce organic loading. Since activated sludge systems are sensitive to the loading and flow variations typically found at landfill facilities, equalization is often required prior to treatment using activated sludge systems. Also, activated sludge

systems treating landfill leachates typically generate excess amounts of secondary sludge that may require additional stabilization, dewatering, and disposal.

8.1.3.5 Powdered Activated Carbon Biological Treatment

In this biophysical treatment process, powdered activated carbon is added to a biological treatment system (usually an activated sludge system). The adsorbent qualities of the powdered carbon aid in the removal of organic compounds, particularly those that may be difficult to biodegrade. Powdered activated carbon also enhances color removal and the settling characteristics of the biological floc.

The mixture of influent, activated sludge biomass, and powdered activated carbon is held in the aeration basin for a sufficient detention time adequate for the desired treatment efficiencies (see Figure 8-21). After contact in the aeration basin, the mixture flows to a clarifier, where settled solids are fed back to the aeration basin to maintain adequate concentrations of microorganisms and carbon. Clear overflow from the clarifiers is either further processed or discharged. Fresh carbon is periodically added to the aeration basin as required and is dependent on desired removal efficiencies. Excess solids are removed directly from the recycled sludge stream. Wasted solids can be processed by conventional dewatering means or by wet-air oxidation for the destruction of organics and regeneration of activated carbon. Regeneration also can be handled off site for smaller applications.

Powdered activated carbon activated sludge treatment combines physical adsorption properties of carbon with biological treatment, achieving a higher degree of treatment than possible by either mode alone. Powdered activated carbon removes the more difficult to degrade refractory organics, enhances solids removal, and buffers the system against loading fluctuations and shock loads. Variations of the powdered activated carbon biological process includes operation in a batch fill and draw mode (similar to a sequencing batch reactor), multiple-stage powdered activated carbon units, and combinations of aerobic and anaerobic powdered activated carbon biological systems. Operation in a batch mode provides for flexibility in the system, by readily allowing for adjustments to the time and aeration mode in each process

stage. This mode of operation is particularly applicable to the treatment of leachate with variable composition and strength. The powdered activated carbon biological treatment process is well suited for the treatment of leachate containing high concentrations of soluble organics (particularly with low BOD_5 to COD ratios). It can obtain better color and refractive organics removal than conventional biological processes and can provide for treatment of leachates contaminated with various trace organic compounds.

8.1.3.6 Sequencing Batch Reactors (SBRs)

A sequencing batch reactor is a suspended-growth biological system in which the wastewater is mixed with existing biological floc in an aeration basin. SBRs are unique in that a single tank acts as an equalization tank, an aeration tank, and a clarifier (see Figure 8-22). A SBR is operated on a batch basis where the wastewater is mixed and aerated with the biological floc for a specific period of time. The contents of the basin then are allowed to settle and the liquid (or supernatant) is decanted. The batch operation of a sequencing batch reactor makes it applicable to wastewater that is highly variable because each batch can be treated differently, depending on its waste characteristics.

A sequencing batch reactor system has four cycles: fill, react, settle, and decant. The fill cycle has three phases. The first phase, called static fill, introduces the wastewater to the system under static conditions. During this phase, anaerobic conditions can exist. During the second phase, the wastewater is mixed to eliminate the scum layer and to initiate the oxygenation process. The third phase consists of aeration and biological degradation. The react cycle is a time-dependent process that continually mixes and aerates the wastewater while allowing the biological degradation process to complete. Because the reaction is a batch process, the period of time of aeration can vary to match the characteristics and loadings of the wastewater. The settling cycle utilizes a large surface area (entire reactor area) and a lower settling rate than used in conventional sedimentation processes, to allow for settling under quiescent conditions. Next, during the decant cycle, approximately one-third of the tank volume is removed by subsurface withdrawal. This treated effluent then can be further treated or disposed. The period of time that the reactor waits prior to the commencement of another batch processing is the idle period. Excess biomass is periodically removed

from the sequencing batch reactor when the quantity exceeds that needed for operation and is usually dewatered prior to disposal.

A sequencing batch reactor carries out all of the functions of a conventional continuous-flow activated sludge process, such as equalization, biological treatment, and sedimentation, in a time sequence rather than a space sequence. Detention times and loadings vary with each batch and are highly dependent on the loadings in the raw wastewater at that time. Typically, a sequencing batch reactor operates with a hydraulic detention time of 1 to 10 days with an SRT of 10 to 30 days. The MLSS is maintained at 3,500 to 10,000 mg/L (see reference 7). The overall control of the system can be accomplished automatically by using level sensors or timing devices. By using a single tank to perform all of the required functions associated with biological treatment, a sequencing batch reactor saves on land requirements. It also provides for greater operation flexibility for treating leachate with viable waste characteristics by being able to readily vary detention time and mode of aeration in each stage. Sequencing batch reactors also can be used to achieve complete nitrification/denitrification and phosphorus removal.

8.1.3.7 Nitrification Systems

In this process, nitrifying bacteria are used in an aerobic biological treatment system to convert ammonia compounds to nitrate compounds. Nitrification is usually followed by denitrification (see next section) which converts nitrates to nitrogen gas. Nitrifying bacteria, such as *nitrosomonas* and *nitrobacter*, derive their energy for growth from the oxidation of inorganic nitrogen compounds. *Nitrosomonas* converts ammonia to nitrites, and *nitrobacter* converts nitrites to nitrates.

The nitrification process usually follows a standard biological process that has already greatly reduced the organic content of the wastewater; however, there are some biological systems that can provide organic (BOD_5) removal concurrently with ammonia destruction. The nitrification process can be oriented as either a suspended growth process (e.g. activated sludge system) or an attached-growth process (e.g. trickling filter).

8.1.3.8 Denitrification Systems

Denitrification is an anoxic process whereby nitrate nitrogen is converted to gaseous nitrogen, and possibly nitrous oxide and nitric oxide. Denitrification is a two step process in which the first step converts nitrates to nitrites, and the second step converts nitrite to nitrogen gas. The bacteria use nitrogen as an electron source rather than oxygen in digesting a carbon food source. Since the waste stream reaching the denitrification process has low levels of organic material, a carbon source (usually methanol) must be added.

The denitrification process can occur as a suspended-growth process or as an attached-growth process. Attached growth systems can be designed as either fixed-bed or fluidized-bed reactor systems. Effluents from denitrification processes may need to be re-aerated to meet dissolved oxygen discharge requirements.

8.1.3.9 Wetlands Treatment

An alternative and innovative biological treatment technology for treating landfill wastewater is wetland treatment. Wetlands can either be natural or man-made (artificial) systems and contain vegetation that allow for the natural attenuation of contaminants. Wetlands are designed to provide for a contact time of usually 10 to 30 days. Vegetation in the wetlands transforms nutrients and naturally degrades organics. Certain metals also can be absorbed by vegetation through root systems. Key design variables include loading rates, climatic constraints, and site characteristics. Wetland systems are still mainly experimental and are not a widely accepted or proven treatment technology for the treatment of landfill leachate.

8.1.4 Sludge Handling

Sludges are generated by a number of treatment technologies, including equalization, gravity-assisted separation, chemical precipitation, and biological treatment. These sludges are further processed at landfill sites using various methods. The following sections describe each type of sludge-handling system used within the Landfills industry.

8.1.4.1 Sludge Slurrying

Sludge slurrying is the process of transporting sludge from one treatment process to another. It only can be applied to liquid sludges that can be pumped through a pipe under pressure. National estimates based on EPA's Detailed Questionnaire data indicate that 33 percent of indirect hazardous landfills and less than one percent of indirect non-hazardous landfills use sludge-slurrying systems as part of their wastewater treatment systems.

8.1.4.2 Gravity Thickening

Gravity thickening, as shown in Figure 8-23, consists of placing the sludge in a unit similar to a gravity-assisted separator, where the sludge is allowed to settle, with the liquid supernatant remaining at the top. The thickened sludge is then removed, and the separated liquid is returned to the wastewater treatment system for further treatment. Usually sludges that contain two to three percent solids can be thickened to approximately five to ten percent solids using gravity thickening. National estimates based on the Detailed Questionnaire responses show that 67 percent of indirect hazardous landfills, 4 percent of indirect non-hazardous landfills, and 7 percent of direct non-hazardous landfill facilities employ gravity thickening as part of their wastewater treatment systems.

8.1.4.3 Pressure Filtration

Plate-and-frame pressure-filtration systems are used at landfill facilities to dewater sludges from physical/chemical and biological treatment processes. Sludges generated at a total solids concentration of two to five percent by weight are dewatered to a 30 to 50 percent solids mass using plate-and-frame filtration (see reference 3). Sludges from treatment systems can be thickened by gravity or stabilized prior to dewatering by pressure filtration or may be processed directly with the plate-and-frame filtration unit.

A pressure filter consists of a series of screens (see Figure 8-24) upon which the sludge is applied under pressure. A precoat material may be applied to the screens to aid in solids removal. The applied pressure

forces the liquid through the screen, leaving the solids to accumulate behind the screen. Filtrate which passes through the screen media is recirculated back to the head of the on-site wastewater treatment plant. Screens (also referred to as plates) are held by frames placed side-by-side and held together with a vice-type mechanism. The unit processes sludge until all of the plates are filled with dry sludge as indicated by a marked rise in the application pressure. Afterwards, the vice holding the plates is loosened and the frames separated. Dried sludge is manually scraped from the plates and collected in a hopper for final disposal. The size of the filter and the number of plates utilized depends not only on the amount of solids produced by treatment processes, but also is highly dependent on the desired operational requirements for the filter. A plate-and-frame filter can produce a drier sludge than possible with most other methods of sludge dewatering. It is usually not operated continuously, but offers operational flexibility since it can be operated in a batch mode.

Pressure filtration is the most common method of sludge dewatering used at landfill facilities. National estimates indicate that 67 percent of indirect hazardous landfills, 5 percent of indirect non-hazardous landfills, and 8 percent of direct non-hazardous landfill facilities use pressure filtration systems as part of their wastewater treatment systems.

8.1.4.4 Sludge Drying Beds

Sludge-drying beds are an economical and effective means of dewatering sludge when land is available. Sludge may be conditioned by thickening or stabilization prior to application on the drying beds, which are typically made up of sand and gravel. Sludge is placed on the beds in an 8 to 12 inch layer and allowed to dry. The drying area is partitioned into individual beds, approximately 20 feet wide by 20 to 100 foot long (see reference 13), or a convenient size so that one or two beds will be filled by the sludge discharge from other sludge-handling units or sludge- storage facilities. The outer boundaries may be constructed with concrete or earthen embankments for open beds. Open beds are used where adequate area is available and sufficiently isolated to avoid complaints caused by odors. Covered beds with greenhouse-

type enclosures are used when it is necessary to dewater sludge continuously throughout the year, regardless of the weather, and where sufficient isolation does not exist for the installation of open beds.

Sludge is dried by drainage through the sludge mass and supporting sand and by evaporation from the surface exposed to the air. Most of the water leaves the sludge by drainage; thus, the provision of an adequate underdrainage system is essential. Drying beds are equipped with lateral drainage tiles that should be adequately supported and covered with coarse gravel or crushed stone. The sand layer should be from 9 to 12 inches deep (see reference 13) with an allowance for some loss from cleaning operations. Water drained from the sludge is collected and typically recirculated back to the on-site wastewater treatment system. Sludge can be removed from the drying bed after it has drained and dried sufficiently. The moisture content is approximately 60 percent after 10 to 15 days under favorable conditions (see reference 13). Dried sludge is manually removed from the beds and sent for on-site or off-site disposal. Figure 8-25 depicts the cross section of a typical drying bed.

8.1.5 Zero Discharge Treatment Options

In this section, additional treatment processes and disposal methods associated with zero or alternative discharge at landfill facilities are described. Based on the responses to the Detailed Questionnaire, national estimates indicate that 27 percent of all non-hazardous landfill facilities and 96 percent of all hazardous landfill facilities use zero-discharge treatment options. The most commonly used zero-discharge treatment method employed by these facilities is land application and recirculation. This section describes land application, recirculation, deep-well disposal, evaporation, solidification, and off-site disposal.

Land application involves the spreading of the wastewater over an area of land that is capped, closed, or an unused portion of a landfill. The land generally has sufficient percolation characteristics to allow the water to drain adequately into the soil. The area is assessed to insure that the soil can provide adequate biological activity to cause the degradation of organic pollutants and also to provide sufficient binding of any metals present.

Recirculation involves the spraying of recycled landfill leachate over areas of a landfill. Although this process promotes biodegradation and evaporation of the leachate volume, recirculation is primarily used as a means of dust control.

Deep well disposal consists of pumping the wastewater into a disposal well, which then discharges the liquid into a deep aquifer. Normally, these aquifers are thoroughly characterized to insure that they are not hydrogeologically connected to a drinking-water supply. The characterization requires the confirmation of the existence of impervious layers of rock above and below the aquifer.

Traditionally used as a method of sludge dewatering, evaporation, or solar evaporation, can also involve the discharge and ultimate storage of wastewater into a shallow, lined, on-site ditch. Since the system is open to the atmosphere, the degree of evaporation is greatly dependent upon climatic conditions.

Solidification is a process in which materials, such as fly ash, cements, and lime, are added to the waste to produce a solid. Depending on both the contaminant and binding material, the solidified waste may be disposed of in a landfill.

Some facilities that have a low leachate generation rate (either because of arid conditions or capping), transport their wastewater off site to either another landfill facility's wastewater treatment system or to a Centralized Wastewater Treatment (CWT) facility for ultimate disposal.

8.2 Treatment Performance and Development of Regulatory Options

This section presents an evaluation of performance data on treatment systems collected by EPA during field sampling programs. The results of these EPA sampling episodes assisted the Agency in evaluating the various types of treatment technologies. For those facilities employing the selected technologies, the sampling data were used to develop the effluent limitations. A more detailed discussion of the development of effluent limitations can be found in Chapter 11.

8.2.1 Performance of EPA Sampled Treatment Processes

To collect data on potential BAT treatment technologies, EPA reviewed responses to the Detailed Questionnaire to identify candidate facilities that had well-operated and designed wastewater treatment systems. EPA conducted 19 site visits to 18 facilities to evaluate treatment systems. Based on these site visits, EPA selected a total of six facilities for sampling which consisted of five consecutive days of sampling raw influent wastewater and intermediate and effluent points in the wastewater treatment system. EPA conducted one of these 5-day sampling episodes (4690) at a facility that was eventually excluded from the regulation because it is a captive landfill. In addition, the only technology sampled at this facility primarily treated contaminated ground water. For the reasons discussed in Chapter 2, EPA decided to exclude contaminated ground water flows from this regulation. EPA did not use the data collected during this sampling episode in selection of pollutants of interest or in the calculation of effluent limitations. Therefore, EPA does not discuss this facility further in this section. For the remaining five sampling facilities, EPA collected data on a variety of biological and chemical treatment processes. Technologies evaluated at the selected sampling facilities include hydroxide precipitation, activated sludge, sequencing batch reactors, multimedia filtration, and reverse osmosis. Table 4-2 in Chapter 4, presents a summary of the treatment technologies sampled during each EPA sampling episode. Presented below are the summaries of the treatment system performance data for each of the sampling episodes that EPA evaluated in the development of the effluent limitations guidelines and standards.

8.2.1.1 Treatment Performance for Episode 4626

EPA performed a 5-day sampling program during episode 4626 to obtain performance data on several treatment technologies including hydroxide precipitation, biological treatment using anaerobic and aerobic biotowers, and multimedia filtration. A flow diagram of the landfill wastewater treatment system sampled during episode 4626 is presented in Figure 8-26. The wastewater treatment system used at this Subtitle D municipal facility treats predominately landfill generated wastewater, including leachate and gas condensate. Table 8-2 presents a summary of percent removal data collected at episode 4626 for the performance of the biological treatment system and for the entire treatment system, excluding the multimedia

filtration system used to polish the discharge from the effluent holding tank. EPA calculated percent removal efficiencies for the processes by first obtaining an average concentration based upon the daily sampling results for each sample collection location (influent and effluent point to the treatment process). EPA calculated the percent removal efficiency of the system using the following equation:

$$\text{Percent Removal} = \frac{[\text{Influent Concentration - Effluent Concentration}]}{\text{Influent Concentration}} \times 100$$

EPA reported negative and zero percent removals for a treatment process on the table as 0.0 percent.

EPA determined the treatment efficiency of the biological treatment unit operation using the data obtained from sampling points 04 and 07 (see Figure 8-26). As demonstrated on the Table 8-2, the biological treatment unit experienced good overall removals for TOC (93.0 percent), COD (90.85 percent), and ammonia as nitrogen (99.14 percent). The biological unit operation alone did not demonstrate high removals for BOD_5 (10.2 percent), TSS (9.32 percent), or for various metals (generally less than 10 percent removals) because the pollutants were generally not present in the biological treatment unit influent at treatable levels. The unit's influent BOD_5 was 39.2 mg/L, TSS was 11.8 mg/L, and most metals were not at detectable levels even though the raw wastewater at this facility exhibited a BOD_5 concentration of 991 mg/L, TSS of 532 mg/L, and several metals at treatable levels. The biological treatment unit influent was low because this facility employed large aerated equalization tanks and a chemical precipitation system prior to biological treatment. The equalization tanks had a retention time of approximately 15 days and were followed by a chemical precipitation system using sodium hydroxide. Due to the long retention time and wastewater aeration, significant biological activity occurred in these tanks. The resulting insoluble pollutants were removed in the primary clarifier prior to entering the biological towers. EPA did not detect organic pollutant parameters in the effluent from the biological treatment process with the exception of 1,4-dioxane at a concentration of 13.8 ug/L.

To determine the treatment efficiency of the entire treatment system, EPA determined the influent concentration by taking a flow-weighted average of the two influent sampling points, sampling points 01 and 02. EPA represented the effluent from the treatment system by sample point 07. The entire treatment system experienced good removals for the following conventional and nonconventional pollutants parameters: BOD_5, TSS, ammonia as nitrogen, COD, TOC, and total phenols. Each of the organic pollutant parameters identified in the influent to the treatment system was removed to non-detectable levels, with the exception of 1,4-dioxane, which still experienced a high percent removal (94.2 percent). Most metals had good percent removals or were removed to non-detectable levels.

8.2.1.2 Treatment Performance for Episode 4667

EPA performed a 5-day sampling program during episode 4667 to obtain performance data on various treatment units, including ammonia removal, hydroxide precipitation, biological treatment using a sequencing batch reactor, granular activated-carbon adsorption, and multimedia filtration. A flow diagram of the landfill wastewater treatment system sampled during episode 4667 is presented in Figure 8-27. The wastewater treatment process used at this Subtitle D non-hazardous facility primarily treats landfill generated wastewater and a small amount of sanitary wastewater flow from the on-site maintenance facility. Table 8-3 presents a summary of percent removal data collected during episode 4667 for the biological treatment unit operation (SBR) and for the entire treatment system.

EPA determined the treatment efficiency of the biological treatment unit using the data obtained from sampling points 03 and 04 (see Figure 8-27). As demonstrated on Table 8-3, the SBR treatment unit experienced moderate overall removals for TOC (43.4 percent), COD (24.7 percent), and BOD_5 (48.7 percent). The Agency observed improved removal efficiencies for TSS (82.9 percent), total phenols (74.2 percent), and ammonia as nitrogen (80.7 percent). Metals, such as barium, chromium, and zinc, had low removal efficiencies. However, as also noted for facility 4626, the Agency observed these metals in the influent to the biological system at low concentrations, often close to the detection limit. Other metals also

had poor removal efficiencies including boron and silicon. EPA did not detect organic parameters in the effluent from the SBR treatment unit.

EPA determined the treatment efficiency of the entire treatment system at the facility using the data obtained from sampling points 01 and 06 (see Figure 8-27). Overall the treatment system experienced good removals for BOD_5, TSS, ammonia as nitrogen, COD, TOC and total phenols. Each of the organic pollutants detected in the influent was removed to non-detect levels in the effluent. Also, each of the metal parameters experienced a good removal rate through the treatment system.

8.2.1.3 Treatment Performance for Episode 4721

EPA performed a 5-day sampling program during episode 4721 to obtain performance data on the sequencing batch reactor (SBR) treatment unit operation installed at this Subtitle C hazardous facility. A flow diagram of the landfill wastewater treatment system sampled during episode 4721 is presented in Figure 8-28. The wastewater treatment process used at this facility treats predominately landfill generated wastewater. The majority of the landfill wastewater was generated by Subtitle D non-hazardous landfills. However, the facility also commingled wastewater generated by an on-site hazardous waste landfill for treatment. The facility also treats limited amounts of off-site generated wastewater at the on-site treatment plant, primarily from another landfill facility operated by the same entity. Table 8-4 presents a summary of percent removal data collected during episode 4721 for the SBR treatment unit.

EPA determined the treatment efficiency of the biological treatment unit using the data obtained from sampling points 01 and 02 (see Figure 8-28). As demonstrated on the Table 8-4, the SBR treatment unit experienced good overall removals for a number of convention/nonconventional and organic parameters, including total phenols, BOD_5, aniline, benzoic acid, 2-propanone, 2-butanone, naphthalene, alpha terpineol, ethylbenzene, p-cresol, m-xylene, 4-methyl-2-pentanone, toluene, phenol, hexanoic acid, and ammonia as nitrogen. EPA observed removal of all of the organic parameters detected in the influent to non-detect levels in the effluent. COD and TOC percent removals were observed at 72.2 and 66.3

percent, respectively. The percent removal for TSS was 72.1 percent. Metals with quantitative percent removals include arsenic (61.9 percent), chromium (46.3 percent), copper (61.2 percent), and zinc (66.3 percent).

8.2.1.4 Treatment Performance for Episode 4759

EPA performed a 5-day sampling program during episode 4759 to obtain performance data on various treatment processes installed at this Subtitle C hazardous facility, including chemical precipitation using ferric chloride and sodium hydroxide and biological treatment using an activated sludge process. A flow diagram of the landfill wastewater treatment system sampled during episode 4759 is presented in Figure 8-29. The wastewater treatment process used at this facility treats predominately landfill generated wastewater, but also handles limited amounts of contaminated storm water from storage containment systems. Table 8-5 presents a summary of percent removal data collected at episode 4759 for the biological treatment units only and for the entire treatment system (combined chemical precipitation and biological treatment processes).

EPA determined the treatment efficiency of the biological treatment unit operations using the data obtained from sampling points 02 and 03 (see Figure 8-29). As demonstrated on the Table 8-5, the biological treatment units experienced good overall removals for a number of conventional/nonconventional and organic parameters, including BOD_5, COD, TOC, total phenols, aniline, benzoic acid, 2,4-dimethylphenol, 2-propanone, methylene chloride, 2-butanone, benzyl alcohol, isobutyl alcohol, o-cresol, p-cresol, 4-methyl-2-pentanone, phenol, pyridine, toluene, and hexanoic acid. Most of the organic parameters detected in the influent were removed to non-detect levels in the effluent from the biological treatment units. Most of the metal parameters, such as chromium, copper, selenium, titanium, and zinc, were observed at low concentrations in the influent to the biological treatment units and, therefore, did not demonstrate good removal rates.

EPA determined the treatment efficiency of the entire treatment system at the facility using the data obtained from sampling points 01 and 03 (see Figure 8-29). As demonstrated on Table 8-5, the entire treatment system experienced good overall removals for a number of convention/nonconventional and organic parameters, including total phenols, BOD_5, 2,4-dimethylphenol, aniline, benzene, benzoic acid, 2-propanone, methylene chloride, 2-butanone, benzyl alcohol, isobutyl alcohol, o-cresol, p-cresol, 4-methyl-2-pentanone, phenol, pyridine, toluene, tripropyleneglycol methyl ether, and hexanoic acid. Most of the organic parameters detected in the influent were removed to non-detectable levels in the effluent. COD and TOC percent removals were observed at 76.4 percent and 84.2 percent, respectively. Ammonia as nitrogen and TSS had poor removal rates of 25.7 percent and 26.6 percent, respectively. Metals with quantitative percent removals include arsenic (46.6 percent), chromium (80.2 percent), copper (45.2 percent), strontium (66.8 percent), titanium (89.6 percent), and zinc (62.5 percent). Pesticide/herbicide parameters such as 2,4-DB, dicamba and dichloroprop had good removal efficiencies through the treatment system. Dioxin/furan parameters were not detected in either the influent or effluent samples.

8.2.1.5 Treatment Performance for Episode 4687

EPA performed a 5-day sampling program during episode 4687 to obtain performance data on the reverse osmosis treatment process installed at this Non-Hazardous Subtitle D facility. A flow diagram of the landfill wastewater treatment system sampled during episode 4687 is presented in Figure 8-30. The wastewater treatment process used at this facility treats on-site landfill generated wastewater. Table 8-6 presents a summary of percent removal data collected at episode 4687 for a single-pass reverse osmosis unit including the multimedia filtration unit and the entire treatment system consisting of a second pass reverse osmosis unit.

EPA determined the treatment efficiency of the single-pass reverse osmosis treatment system at the facility using the data obtained from sampling points 01 and 02 (see Figure 8-30). As demonstrated on Table 8-6, the single-pass reverse osmosis treatment system demonstrated good overall removals for a number of conventional/nonconventional and organic parameters, including TSS, TOC, BOD_5, TDS, COD, 4-methyl-

2-pentanone, alpha terpineol, benzoic acid, tripropyleneglycol methyl ether, and hexanoic acid. A number of other organic parameters also were observed to have been removed by the treatment process at various levels lower than 95 percent. Total phenols and ammonia as nitrogen percent removals were observed at 75.1 and 76.7 percent, respectively. Metals with quantitative percent removals include arsenic (87.4 percent), boron (54.1 percent), silicon (88.3 percent), and strontium (92.9 percent). All of the pesticide/herbicide parameters detected in the influent, including 2,4,5-TP, 2,4-D, 2,4-DB, dicamba, dichlorprop, MCPA and MCPP, were removed to non-detect levels.

EPA determined the treatment efficiency of the entire treatment system at the facility using the data obtained from sampling points 01 and 03 (see Figure 8-30). The additional polishing reverse osmosis unit caused the removal efficiency of most of the conventional and nonconventional parameters to increase. These parameters include BOD_5, ammonia as nitrogen, COD, TDS, TOC, and total phenols. The removal efficiency of several organic parameters were observed to increase from the single-pass treatment system including 2-butanone, 2-propanone, phenol, p-cresol, and toluene. The percent removal for boron also increased from 54.1 percent in the single-pass reverse osmosis system to 94.4 percent in the two-stage reverse osmosis treatment system.

Table 8-1: Wastewater Treatment Technologies Employed at In-Scope Landfill Facilities
(Percent of Landfills Industry)

Treatment Technology	Subtitle D Non-Hazardous		Subtitle C Hazardous
	Direct Discharge	Indirect Discharge	Indirect Discharge
Equalization	21.0	11.2	0.0
Neutralization	6.3	6.7	33.3
Chemical oxidation	11.2	0.5	33.3
Chemical precipitation	9.1	5.4	33.3
Adsorption	1.4	1.3	0.0
Filtration	10.5	1.5	0.0
Stripping	4.2	1.3	0.0
Biological treatment	32.2	3.8	66.7
Gravity assisted separation	27.3	9.0	66.7
Sludge preparation	3.5	0.5	33.3
Sludge dewatering	12.6	5.2	66.7

Table 8-2: Treatment Technology Performance for Facility 4626 - Subtitle D Municipal

Pollutant of Interest Subtitle D Municipal	CAS #		Biological Treatment Unit Operation Only: Sample Points 4 to 7					Entire Treatment System: Sample Points 1 & 2 (flow weighted) to 7					
			Influent		Effluent		%		Influent		Effluent		%
		DL	SP	Conc. (ug/L)	SP	Conc. (ug/L)	Removal	DL	SP	Conc. (ug/L)	SP	Conc. (ug/L)	Removal
Conventional													
BOD	C-002	2,000	04	39,200	07	35,200	10.2	2,000	1+2	991,067	07	35,200	96.5
TSS	C-009	4,000	04	11,800	07	10,700	9.3	4,000	1+2	532,800	07	10,700	98.0
Nonconventional													
Ammonia as Nitrogen	7664417	10.0	04	135,000	07	1,156	99.1	10.0	1+2	193,333	07	1,156	99.4
COD	C-004	5,000	04	1,742,600	07	159,400	90.9	5,000	1+2	4,028,000	07	159,400	96.0
Hexavalent Chromium	18540299	10.0	04	ND	07	ND		10.0	1+2	68.7	07	ND	85.4
Nitrate/Nitrite	C-005	50.0	04	1,535	07	130,500	0.0	50.0	1+2	693	07	130,500	0.0
TDS	C-010		04	5,960,000	07	5,181,000	13.1		1+2	5,012,667	07	5,181,000	0.0
TOC	C-012	1,000	04	758,000	07	52,800	93.0	1,000	1+2	1,316,200	07	52,800	96.0
Total Phenols	C-020	50.0	04	182	07	50.0	72.5	50.0	1+2	1,204	07	50.0	95.9
Organics													
1,4-Dioxane	123911	10.0	04	NS	07	13.8	NS	10.0	1+2	240	07	13.8	94.2
2-Butanone	78933	50.0	04	NS	07	ND	NS	50.0	1+2	227,893	07	ND	100
2-Propanone	67641	50.0	04	NS	07	ND	NS	50.0	1+2	27,655	07	ND	99.8
4-Methyl-2-Pentanone	108101	50.0	04	NS	07	ND	NS	50.0	1+2	598	07	ND	91.6
Alpha Terpineol	98555	10.0	04	NS	07	ND	NS	10.0	1+2	134	07	ND	92.6
Benzoic Acid	65850	50.0	04	NS	07	ND	NS	50.0	1+2	14,657	07	ND	99.7
Hexanoic Acid	142621	10.0	04	NS	07	ND	NS	10.0	1+2	36,256	07	ND	100
Methylene Chloride	75092	10.0	04	NS	07	ND	NS	10.0	1+2	50.3	07	ND	80.1
N,N-Dimethylformamide	68122	10.0	04	NS	07	ND	NS	10.0	1+2	39.3	07	ND	74.5
O-Cresol	95487	10.0	04	NS	07	ND	NS	10.0	1+2	86.4	07	ND	88.4
P-Cresol	106445	10.0	04	NS	07	ND	NS	10.6 /10.0	1+2	ND	07	ND	
Phenol	108952	10.0	04	NS	07	ND	NS	10.0	1+2	685	07	ND	98.5
Toluene	108883	10.0	04	NS	07	ND	NS	10.0	1+2	1,095	07	ND	99.1
Tripropyleneglycol Methyl Ether	20324338	99.0	04	NS	07	ND	NS	105 /99.0	1+2	ND	07	ND	
Metals													
Barium	7440393	200	04	10.3	07	21.8	0.0	200	1+2	2427	07	21.8	99.1
Boron	7440428	100	04	3,211	07	2,925	8.9	100	1+2	4330	07	2,925	32.5
Chromium	7440473	10.9	04	11.6	07	ND	6.5	10.9	1+2	36.6	07	ND	70.3
Silicon	7440213	100	04	784	07	648	17.4	100	1+2	768	07	648	15.7
Strontium	7440246	80.3	04	ND	07	82.5	0.0	100	1+2	2,912	07	82.5	97.2
Titanium	7440326	4.2	04	4.2	07	ND	1.0	4.2	1+2	13.0	07	ND	67.9
Zinc	7440666	10.6	04	ND	07	12.0	0.0	20.0	1+2	144	07	12.0	91.6
Pesticides/Herbicides													
Dichloroprop	120365	1.0	04	NS	07	NS	NS	1.0	1+2	NS	07	NS	NS
Disulfoton	298044	2.0	04	NS	07	NS	NS	2.0	1+2	NS	07	NS	NS
Dioxins/Furans													
1234678-HpCDD	35822469	50.0 pg/L	04	NS	07	NS	NS	50.0 pg/L	1+2	NS	07	NS	NS
OCDD	3268879	100 pg/L	04	NS	07	NS	NS	100 pg/L	1+2	NS	07	NS	NS

Negative percent removal are recorded as 0.0.
NS: Not Sampled SP: Sample point.
ND: Non-detect DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limit

Table 8-3: Treatment Technology Performance for Facility 4667 - Subtitle D Municipal

Pollutant of Interest Subtitle D Municipal	CAS #	Biological Treatment Unit Operation Only: Sample Points 3 to 4						Entire Treatment System: Sample Points 1 to 6					
		DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal	DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal
Conventional													
BOD	C-002	2,000	03	232,600	04	119,300	48.7	2,000	01	1,088,000	06	201,000	81.5
TSS	C-009	4,000	03	59,600	04	10,200	82.9	4,000	01	93,400	06	ND	95.7
Nonconventional													
Ammonia as Nitrogen	7664417	10.0	03	134,800	04	26,040	80.7	10.0	01	295,900	06	12,060	95.9
COD	C-004	5,000	03	635,000	04	478,200	24.7	5,000	01	2,932,000	06	251,000	91.4
Hexavalent Chromium	18540299	10.0	03	ND	04	ND		10.0	01	26.0	06	ND	61.5
Nitrate/Nitrite	C-005	50.0	03	14,400	04	87,800	0.0	50.0	01	494	06	87,000	0.0
TDS	C-010		03	4,024,000	04	3,987,000	0.9		01	6,232,000	06	3,834,000	38.5
TOC	C-012	1,000	03	212,600	04	120,400	43.4	1,000	01	1,098,600	06	82,000	92.5
Total Phenols	C-020	50.0	03	204	04	52.6	74.2	50.0	01	940	06	ND	94.7
Organics													
1,4-Dioxane	123911	10.0	03	NS	04	ND	NS	10.0	01	323	06	ND	96.9
2-Butanone	78933	50.0	03	NS	04	ND	NS	50.0	01	8,767	06	ND	99.4
2-Propanone	67641	50.0	03	NS	04	ND	NS	50.0	01	13,021	06	ND	99.6
4-Methyl-2-Pentanone	108101	50.0	03	NS	04	ND	NS	50.0	01	1,239	06	ND	96.0
Alpha Terpineol	98555	10.0	03	NS	04	ND	NS	10.0	01	430	06	ND	97.7
Benzoic Acid	65850	50.0	03	NS	04	ND	NS	50.0	01	33,335	06	ND	99.9
Hexanoic Acid	142621	10.0	03	NS	04	ND	NS	10.0	01	37,256	06	ND	100
Methylene Chloride	75092	10.0	03	NS	04	ND	NS	208 /10.0	01	ND	06	ND	
N,N-Dimethylformamide	68122	10.0	03	NS	04	ND	NS	10.0	01	1,008	06	ND	99.0
O-Cresol	95487	10.0	03	NS	04	ND	NS	10.0	01	2,215	06	ND	99.6
P-Cresol	106445	10.0	03	NS	04	ND	NS	10.0	01	ND	06	ND	
Phenol	108952	10.0	03	NS	04	ND	NS	10.0	01	387	06	ND	97.4
Toluene	108883	10.0	03	NS	04	ND	NS	10.0	01	668	06	ND	98.5
Tripropyleneglycol Methyl Ether	20324338	99.0	03	NS	04	ND	NS	99.0	01	ND	06	ND	
Metals													
Barium	7440393	200	03	19.4	04	32.4	0.0	200	01	283	06	42.6	85.0
Boron	7440428	100	03	2,842	04	2,483	12.6	100	01	6,700	06	2,334	65.2
Chromium	7440473	10.0	03	10.5	04	11.3	0.0	11.1	01	90.6	06	ND	87.7
Silicon	7440213	100	03	5,284	04	6,766	0.0	100	01	27,158	06	6,859	74.7
Strontium	7440246	100	03	193	04	237	0.0	100	01	1,935	06	249	87.1
Titanium	7440326	2.5	03	4.8	04	ND	48.1	2.5	01	69.9	06	ND	96.4
Zinc	7440666	20.0	03	25.2	04	58.6	0.0	20.0	01	494	06	27.1	94.5
Pesticides/Herbicides													
Dichloroprop	120365	1.0	03	NS	04	ND	NS	11.8 /1.0	01	ND	06	ND	
Disulfoton	298044	2.0	03	NS	04	ND	NS	2.0	01	6.1	06	ND	67.2
Dioxins/Furans													
1234678-HpCDD	35822469	50.0 pg/L	03	NS	04	NS	NS	50.0 pg/L	01	NS	06	NS	NS
OCDD	3268879	100 pg/L	03	NS	04	NS	NS	100 pg/L	01	NS	06	NS	NS

Negative percent removal are recorded as 0.0.

NS: Not Sampled DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limit

ND: Non-detect SP: Sample point

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Table 8-4: Treatment Technology Performance for Facility 4721 - Subtitle C Hazardous

Pollutant of Interest Subtitle C Hazardous	CAS #	Biological Treatment Unit: Sample Points 1 to 2					
		DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal
Conventional							
BOD	C-002	2,000	01	877,875	02	47,000	94.7
Oil and Grease	C-036	5,000	01	45,442	02	6,792	85.1
TSS	C-009	4,000	01	191,375	02	53,375	72.1
Nonconventional							
Amenable Cyanide	C-025	10.0	01	ND	02	ND	
Ammonia as Nitrogen	7664417	10.0	01	382,250	02	1,433	99.6
COD	C-004	5,000	01	2,033,750	02	565,750	72.2
Nitrate/Nitrite	C-005	50.0	01	1,770	02	333,375	0.0
TDS	C-010		01	12,275,000	02	12,075,000	1.6
TOC	C-012	1,000	01	562,250	02	189,625	66.3
Total Cyanide	57125	20.0	01	54.1	02	46.1	14.8
Total Phenols	C-020	50.0	01	3,195	02	67.6	97.9
Organics							
1,1-Dichloroethane	75343	10.0	01	31.5	02	ND	68.2
1,4-Dioxane	123911	10.0	01	ND	02	ND	
2-Butanone	78933	50.0	01	6,398	02	ND	99.2
2-Propanone	67641	50.0	01	4,398	02	ND	98.9
2,4-Dimethylphenol	105679	10.0	01	79.0	02	ND	87.4
4-Methyl-2-Pentanone	108101	50.0	01	2,175	02	ND	97.7
Alpha Terpineol	98555	10.0	01	691	02	ND	98.6
Aniline	62533	10.0	01	685	02	ND	98.5
Benzene	71432	10.0	01	127	02	ND	92.2
Benzoic Acid	65850	50.0	01	5,294	02	ND	99.1
Benzyl Alcohol	100516	10.0	01	23.7	02	ND	57.9
Diethyl Ether	60297	50.0	01	104	02	ND	51.8
Ethylbenzene	100414	10.0	01	545	02	ND	98.2
Hexanoic Acid	142621	10.0	01	1,632	02	ND	99.4
Isobutyl Alcohol	78831	10.0	01	ND	02	ND	
M-Xylene	108383	10.0	01	412	02	ND	97.6
Methylene Chloride	75092	10.0	01	49.2	02	ND	79.7
Naphthalene	91203	10.0	01	486	02	ND	97.9
O+P Xylene	136777612	10.0	01	155	02	ND	93.6
O-Cresol	95487	10.0	01	ND	02	ND	
P-Cresol	106445	10.0	01	218	02	ND	95.4
Phenol	108952	10.0	01	1,553	02	ND	99.4
Pyridine	110861	10.0	01	12.0	02	ND	16.5
Toluene	108883	10.0	01	1,468	02	ND	99.3
Trans-1,2-Dichloroethene	156605	10.0	01	52.7	02	ND	81.0
Trichloroethene	79016	10.0	01	ND	02	ND	
Tripropyleneglycol Methyl Ether	20324338	99.0	01	1,756	02	ND	94.4
Vinyl Chloride	75014	10.0	01	15.6	02	ND	36.0
Metals							
Arsenic	7440382	10.0	01	1,492	02	569	61.9
Boron	7440428	100	01	8,839	02	8,449	4.4
Chromium	7440473	10.0	01	86.7	02	46.5	46.4
Copper	7440508	8.0	01	20.6	02	ND	61.2
Lithium	7439932	100	01	277	02	316	0.0
Metals (Cont'd)							
Molybdenum	7439987	10.0	01	227	02	266	0.0
Nickel	7440020	40.0	01	131	02	125	4.1

Table 8-4: Treatment Technology Performance for Facility 4721 - Subtitle C Hazardous (continued)

Pollutant of Interest Subtitle C Hazardous	CAS #	Biological Treatment Unit: Sample Points 1 to 2					
		DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal
Selenium	7782492	15.5	01	20.0	02	ND	22.5
Silicon	7440213	100	01	5,518	02	5,024	9.0
Strontium	7440246	100	01	2,846	02	2,494	12.4
Tin	7440315	30.0	01	30.7	02	ND	2.4
Titanium	7440326	5.0	01	64.5	02	5.3	91.7
Zinc	7440666	20.0	01	253	02	85.3	66.3
Pesticides/Herbicides							
2,4-D	94757	1.0	01	1.2	02	ND	14.0
2,4-DB	94826	2.0	01	3.9	02	ND	48.4
2,4,5-TP	93721	0.2	01	0.5	02	ND	55.1
Dicamba	1918009	0.2	01	1.1	02	0.4	64.2
Dichloroprop	120365	1.0	01	2.1	02	1.3	37.7
MCPA	94746	50.0	01	59.1	02	ND	15.3
MCPP	7085190	50.0	01	153	02	51.9	66.1
Picloram	1918021	0.5	01	0.5	02	ND	2.0
Terbuthylazine	5915413	5.0	01	6.0	02	ND	16.8
Dioxins/Furans							
1234678-HpCDD	35822469	50.0 pg/L	01	588 pg/L	02	NS	NS
1234678-HpCDF	67562394	50.0 pg/L	01	63.3 pg/L	02	NS	NS
OCDD	3268879	100.0 pg/L	01	6,148 pg/L	02	NS	NS
OCDF	39001020	100.0 pg/L	01	237 pg/L	02	NS	NS

Negative percent removal are recorded as 0.0.
NS: Not Sampled
ND: Non-detect
DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limit
SP: Sample point.

Table 8-5: Treatment Technology Performance for Facility 4759 - Subtitle C Hazardous

Pollutant of Interest Subtitle C Hazardous	CAS #	Bioliogical Treatment Unit Only: Sample Points 2 to 3						Entire Treatment System Sample Points 1 to 3					
		DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal	DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal
Conventional													
BOD	C-002	2,000	02	2,650,000	03	62,800	97.6	2,000	01	2,664,000	03	62,800	97.6
Oil and Grease	C-036	5,000	02	30,167	03	9,333	69.1	5,000	01	37,333	03	9,333	75.0
TSS	C-009	4,000	02	47,300	03	90,000	0.0	4,000	01	122,600	03	90,000	26.6
Nonconventional													
Amenable Cyanide	C-025	20.0	02	NS	03	271	NS	20.0	01	3,990	03	271	93.2
Ammonia as Nitrogen	7664417	10.0	02	194,400	03	155,500	20.0	10.0	01	209,400	03	155,500	25.7
COD	C-004	5,000	02	5,200,000	03	1,180,000	77.3	5,000	01	5,006,000	03	1,180,000	76.4
Nitrate/Nitrite	C-005	50.0	02	263,196	03	240,423	8.7	50.0	01	259,242	03	240,423	7.3
TDS	C-010		02	17,230,000	03	15,680,000	9.0		01	16,360,000	03	15,680,000	4.2
TOC	C-012	1,000	02	1,800,000	03	284,700	84.2	1,000	01	1,804,000	03	284,700	84.2
Total Cyanide	57125	20.0	02	869	03	796	8.5	20.0	01	9,756	03	796	91.9
Total Phenols	C-020	50.0	02	97,340	03	155	99.8	50.0	01	97,860	03	155	99.8
Organics													
1,1-Dichloroethane	75343	10.0	02	23.8	03	ND	58.0	10.0	01	26.7	03	ND	62.5
1,4-Dioxane	123911	10.0	02	1,935	03	702	63.7	10.0	01	2,003	03	702	65.0
2-Butanone	78933	50.0	02	1,633	03	ND	96.9	50.0	01	1,724	03	ND	97.1
2-Propanone	67641	50.0	02	3,254	03	65.0	98.0	50.0	01	3,634	03	65.0	98.2
2,4-Dimethylphenol	105679	10.0	02	1,798	03	201	88.8	10.0	01	1,550	03	201	87.0
4-Methyl-2-Pentanone	108101	50.0	02	1,009	03	ND	95.1	50.0	01	1,027	03	ND	95.1
Alpha Terpineol	98555	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
Aniline	62533	10.0	02	577	03	ND	98.3	10.0	01	533	03	ND	98.1
Benzene	71432	10.0	02	32.0	03	ND	68.7	10.0	01	36.2	03	ND	72.4
Benzoic Acid	65850	50.0	02	70,690	03	ND	99.9	50.0	01	64,957	03	ND	99.9
Benzyl Alcohol	100516	10.0	02	859	03	ND	98.8	10.0	01	878	03	ND	98.9
Diethyl Ether	60297	50.0	02	ND	03	ND		50.0	01	ND	03	ND	
Ethylbenzene	100414	10.0	02	13.8	03	ND	27.3	10.0	01	15.8	03	ND	36.5
Hexanoic Acid	142621	10.0	02	5,266	03	ND	99.8	10.0	01	3,640	03	ND	99.7
Isobutyl Alcohol	78831	10.0	02	127	03	ND	92.1	10.0	01	138	03	ND	92.8
M-Xylene	108383	10.0	02	10.6	03	ND	5.3	10.0	01	10.7	03	ND	6.2
Methylene Chloride	75092	10.0	02	604	03	10.3	98.3	10.0	01	661	03	10.3	98.4
Naphthalene	91203	10.0	02	22.0	03	ND	54.6	10.0	01	24.8	03	ND	59.6
O+P Xylene	136777612	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
O-Cresol	95487	10.0	02	61.2	03	ND	83.7	10.0	01	188	03	ND	94.7
P-Cresol	106445	10.0	02	5,119	03	ND	99.8	10.0	01	5,022	03	ND	99.8
Phenol	108952	10.0	02	54,808	03	29.7	100	10.0	01	65,417	03	29.7	100
Pyridine	110861	10.0	02	309	03	ND	96.8	10.0	01	301	03	ND	96.7
Toluene	108883	10.0	02	120	03	ND	91.7	10.0	01	136	03	ND	92.6
Trans-1,2-Dichloroethene	156605	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
Trichloroethene	79016	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
Tripropyleneglycol Methyl Ether	20324338	99.0	02	ND	03	ND		99.0	01	1,021	03	ND	90.3
Vinyl Chloride	75014	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
Metals													
Arsenic	7440382	10.0	02	389	03	312	19.9	10.0	01	584	03	312	46.6
Boron	7440428	100	02	2,706	03	2,486	8.1	100	01	2,918	03	2,486	14.8
Chromium	7440473	10.0	02	158	03	82.4	47.8	10.0	01	415	03	82.4	80.2

Table 8-5: Treatment Technology Performance for Facility 4759- Subtitle C Hazardous (continued)

Pollutant of Interest Subtitle C Hazardous	CAS #	Bioliogical Treatment Unit Only: Sample Points 2 to 3						Entire Treatment System Sample Points 1 to 3					
		DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal	DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal
Metals (cont.)													
Copper	7440508	25.0	02	61.1	03	76.4	0.0	25.0	01	139	03	76.4	45.2
Lithium	7439932	100	02	253	03	239	5.5	100	01	266	03	239	10.2
Molybdenum	7439987	10.0	02	13,710	03	13,130	4.2	10.0	01	13,260	03	13,130	1.0
Nickel	7440020	40.0	02	2,014	03	1,878	6.8	40.0	01	2,060	03	1,878	8.8
Selenium	7782492	5.0	02	191	03	190	0.2	5.0	01	178	03	190	0.0
Silicon	7440213	100	02	6,924	03	6,153	11.1	100	01	6,036	03	6,153	0.0
Strontium	7440246	100	02	105	03	94.4	9.9	100	01	284	03	94.4	66.8
Tin	7440315	30.0	02	800	03	723	9.5	30.0	01	908	03	723	20.4
Titanium	7440326	5.0	02	5.1	03	2.4	52.1	5.0	01	23.3	03	2.4	89.6
Zinc	7440666	20.0	02	26.7	03	47.2	0.0	20.0	01	126	03	47.2	62.5
Pesticides/Herbicides													
2,4-D	94757	1.0	02	NS	03	11.8	NS	1.0	01	11.2	03	11.8	0.0
2,4-DB	94826	2.0	02	NS	03	4.3	NS	2.0	01	43.8	03	4.3	90.2
2,4,5-TP	93721	0.2	02	NS	03	0.4	NS	0.2	01	0.5	03	0.4	18.3
Dicamba	1918009	0.2	02	NS	03	0.9	NS	0.2	01	41.6	03	0.9	97.9
Dichloroprop	120365	1.0	02	NS	03	4.7	NS	1.0	01	18.3	03	4.7	74.3
MCPA	94746	50.0	02	NS	03	182	NS	50.0	01	332	03	182	45.3
MCPP	7085190	50.0	02	NS	03	288	NS	50.0	01	662	03	288	56.5
Picloram	1918021	0.5	02	NS	03	2.5	NS	0.5	01	4.5	03	2.5	45.2
Terbuthylazine	5915413	5.0	02	NS	03	28.4	NS	5.0	01	97.6	03	28.4	70.9
Dioxins/Furans													
1234678-HpCDD	35822469	50.0 pg/L	02	NS	03	ND	NS	50.0 pg/L	01	ND	03	ND	
1234678-HpCDF	67562394	50.0 pg/L	02	NS	03	ND	NS	50.0 pg/L	01	ND	03	ND	
OCDD	3268879	100 pg/L	02	NS	03	ND	NS	100 pg/L	01	ND	03	100 pg/L	
OCDF	39001020	100 pg/L	02	NS	03	ND	NS	100 pg/L	01	ND	03	ND	

Negative percent removal are recorded as 0.0.
NS: Not Sampled
ND: Non-detect
DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limit
SP: Sample point.

Table 8-6: Treatment Technology Performance for Facility 4687 - Subtitle D Municipal

Pollutant of Interest Subtitle D Municipal	CAS #	Single-Stage Reverse Osmosis Treatment System Only: Sample Point 1 to 2						Entire Treatment System: Sample Point 1 to 3					
		DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal	DL	SP	Influent Conc. (ug/L)	SP	Effluent Conc. (ug/L)	% Removal
Conventional													
BOD	C-002	2,000	01	1,182,000	02	54,000	95.4	2,000	01	1,182,000	03	5,400	99.5
TSS	C-009	4,000	01	171,800	02	ND	97.7	4,000	01	171,800	03	ND	97.7
Noconventional													
Ammonia as Nitrogen	7664417	10.0	01	58,480	02	13,600	76.7	10.0	01	58,480	03	608	99.0
COD	C-004	5,000	01	1,526,000	02	72,200	95.3	5,000	01	1,526,000	03	11,400	99.3
Hexavalent Chromium	18540299	10.0	01	28.0	02	ND	64.3	10.0	01	28.0	03	ND	64.3
Nitrate/Nitrite	C-005	50.0	01	1,300	02	666	48.8	50.0	01	1,300	03	502	61.4
TDS	C-010		01	2,478,000	02	116,600	95.3	10,000	01	2,478,000	03	ND	99.6
TOC	C-012	1,000	01	642,600	02	25,000	96.1	10,000	01	642,600	03	ND	98.4
Total Phenols	C-020	50.0	01	1,262	02	316	75.0	50.0	01	1,262	03	62.8	95.0
Organics													
1,4-Dioxane	123911	10.8 /14.9	01	ND	02	ND		10.8 /10.0	01	ND	03	ND	
2-Butanone	78933	50.0	01	3,250	02	1,774	45.4	50.0	01	3,250	03	372	88.6
2-Propanone	67641	50.0	01	1,580	02	1,842	0.0	50.0	01	1,580	03	470	70.3
4-Methyl-2-Pentanone	108101	50.5	01	382	02	ND	86.8	50.0	01	382	03	ND	86.9
Alpha Terpineol	98555	10.0	01	44.5	02	ND	77.5	10.0	01	44.5	03	ND	77.5
Benzoic Acid	65850	50.0	01	7,685	02	96.3	98.8	50.0	01	7,685	03	ND	99.4
Hexanoic Acid	142621	10.0	01	5,818	02	118	98.0	10.0	01	5,818	03	ND	99.8
Methylene Chloride	75092	10.0	01	ND	02	ND		10.0	01	ND	03	ND	
N,N-Dimethylformamide	68122	10.0	01	ND	02	ND		10.0	01	ND	03	ND	
O-Cresol	95487	10.0	01	ND	02	ND		10.0	01	ND	03	ND	
P-Cresol	106445	10.0	01	797	02	253	68.3	10.0	01	797	03	22.3	97.2
Phenol	108952	10.0	01	702	02	185	73.6	10.0	01	702	03	29.3	95.8
Toluene	108883	10.0	01	376	02	112	70.2	10.0	01	376	03	15.1	96.0
Tripropyleneglycol Methyl Ether	20324338	99.0	01	1,207	02	ND	91.8	99.0	01	1,207	03	ND	91.8
Metals													
Barium	7440393	200	01	280	02	5.6	98.0	200	01	280	03	1.4	99.5
Boron	7440428	100	01	1,808	02	830	54.1	100	01	1,808	03	101	94.4
Chromium	7440473	9.0	01	ND	02	ND		9.0	01	ND	03	ND	
Silicon	7440213	100	01	4,362	02	511	88.3	100	01	4,362	03	355	91.9
Strontium	7440246	100	01	1,406	02	ND	92.9	100	01	1,406	03	ND	92.9
Titanium	7440326	4.0	01	ND	02	ND		4.0	01	ND	03	ND	
Zinc	7440666	10.9 /9.0	01	ND	02	ND		10.9 /10.0	01	ND	03	ND	
Pesticides/Herbicides													
Dichloroprop	120365	1.0	01	6.1	02	ND	83.6	1.0	01	6.1	03	ND	83.6
Disulfoton	298044	2.0	01	14.3	02	ND	86.1	2.0	01	14.3	03	ND	86.1
Dioxins/Furans													
1234678-HpCDD	35822469	49.8 pg/L	01	ND	02	NS	NS	49.8 pg/L	01	ND	03	NS	NS
OCDD	3268879	99.5 pg/L	01	ND	02	NS	NS	99.5 pg/L	01	ND	03	NS	NS

Negative percent removal are recorded as 0.0.

NS: Not Sampled DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limit

ND: Non-detect SP: Sample point.

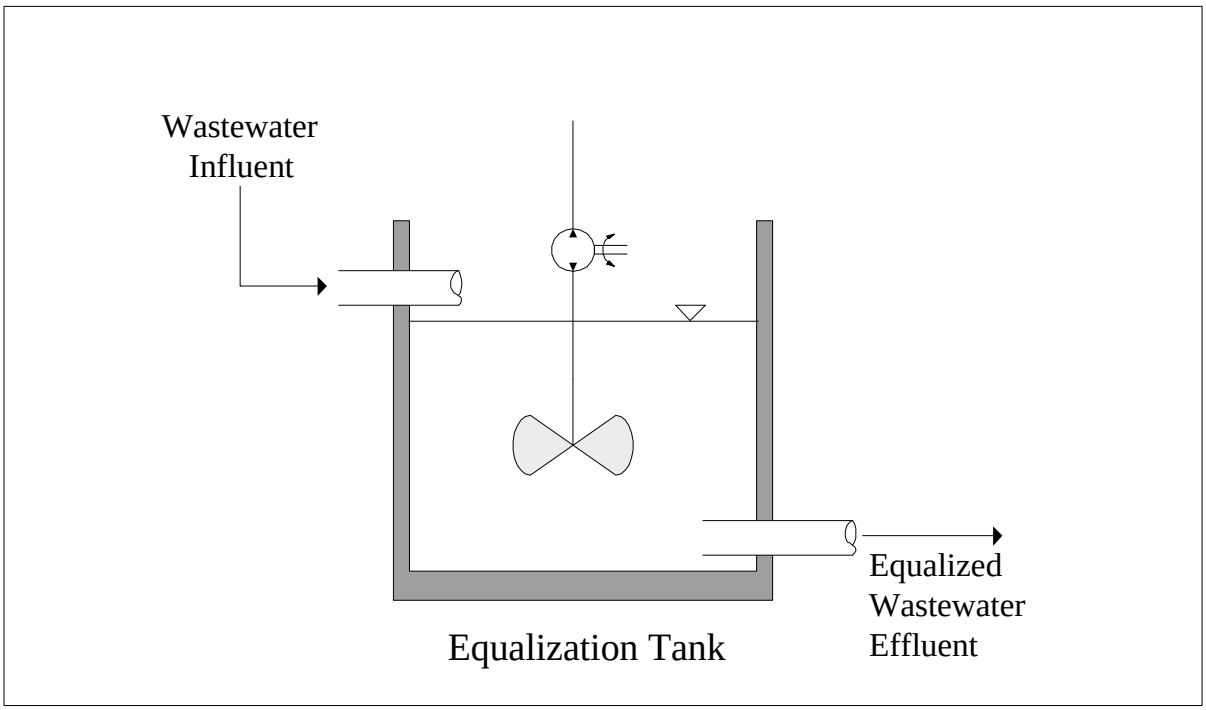


Figure 8-1: Equalization

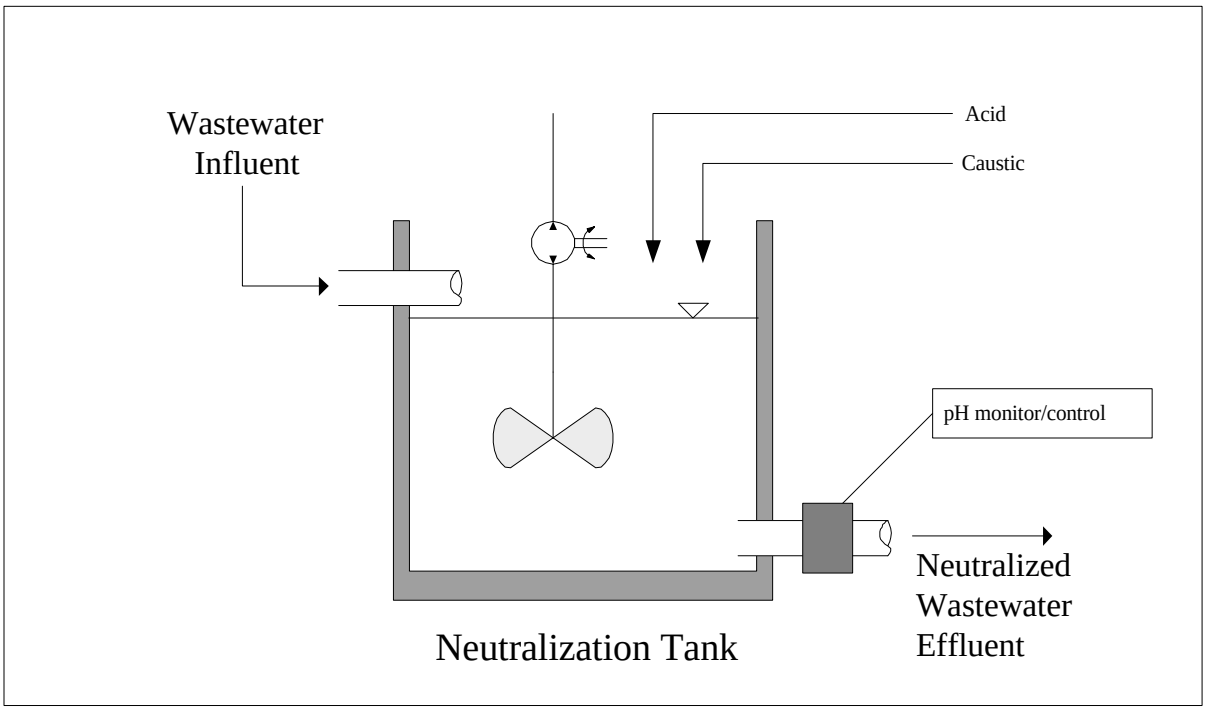


Figure 8-2: Neutralization

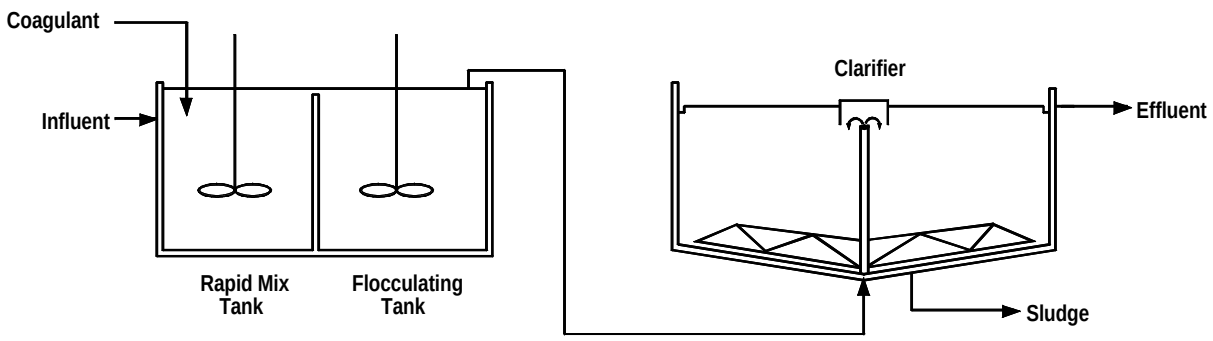


Figure 8-3: Clarification System Incorporating Coagulation and Flocculation

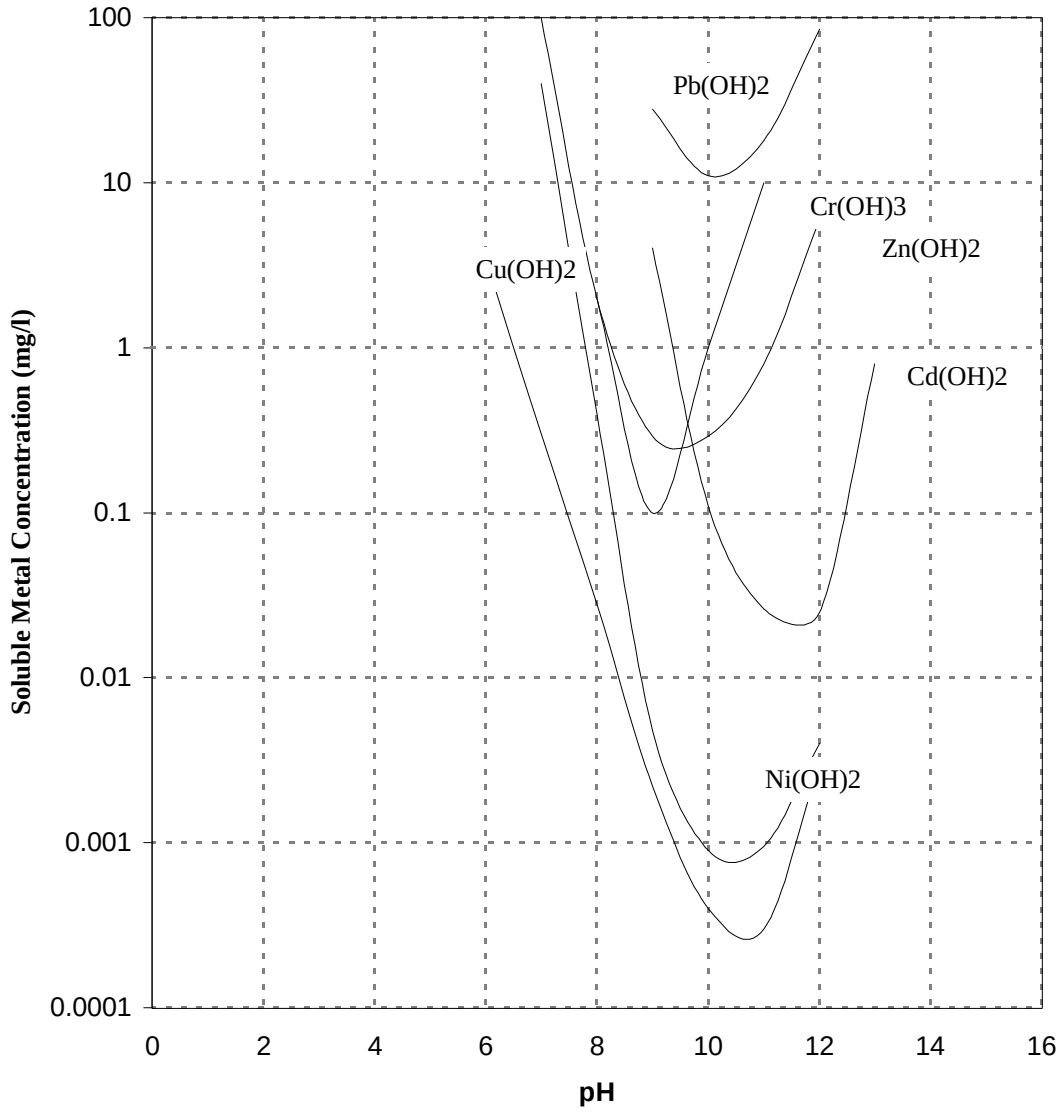


Figure 8-4: Calculated Solubilities of Metal Hydroxides

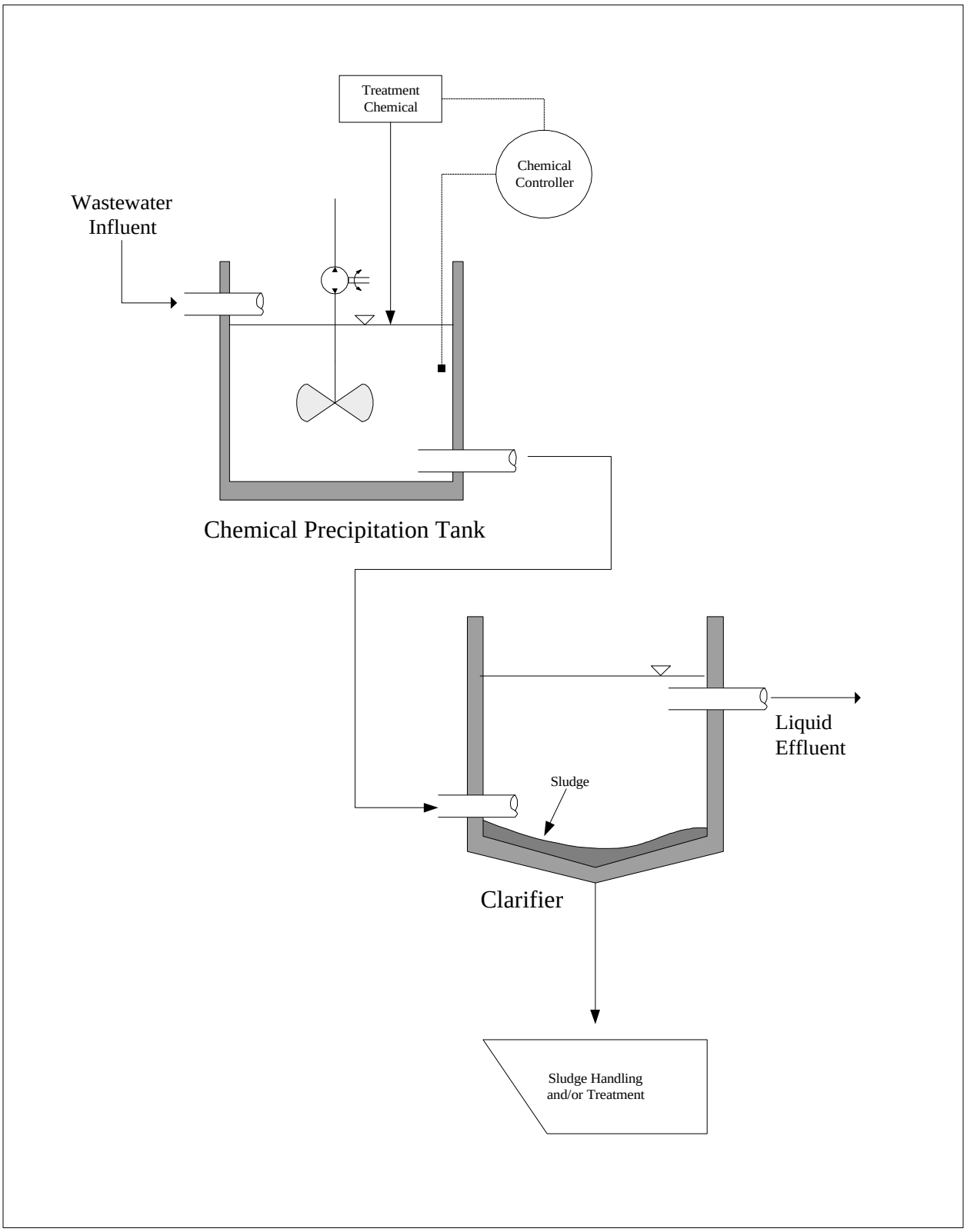


Figure 8-5: Chemical Precipitation System Design

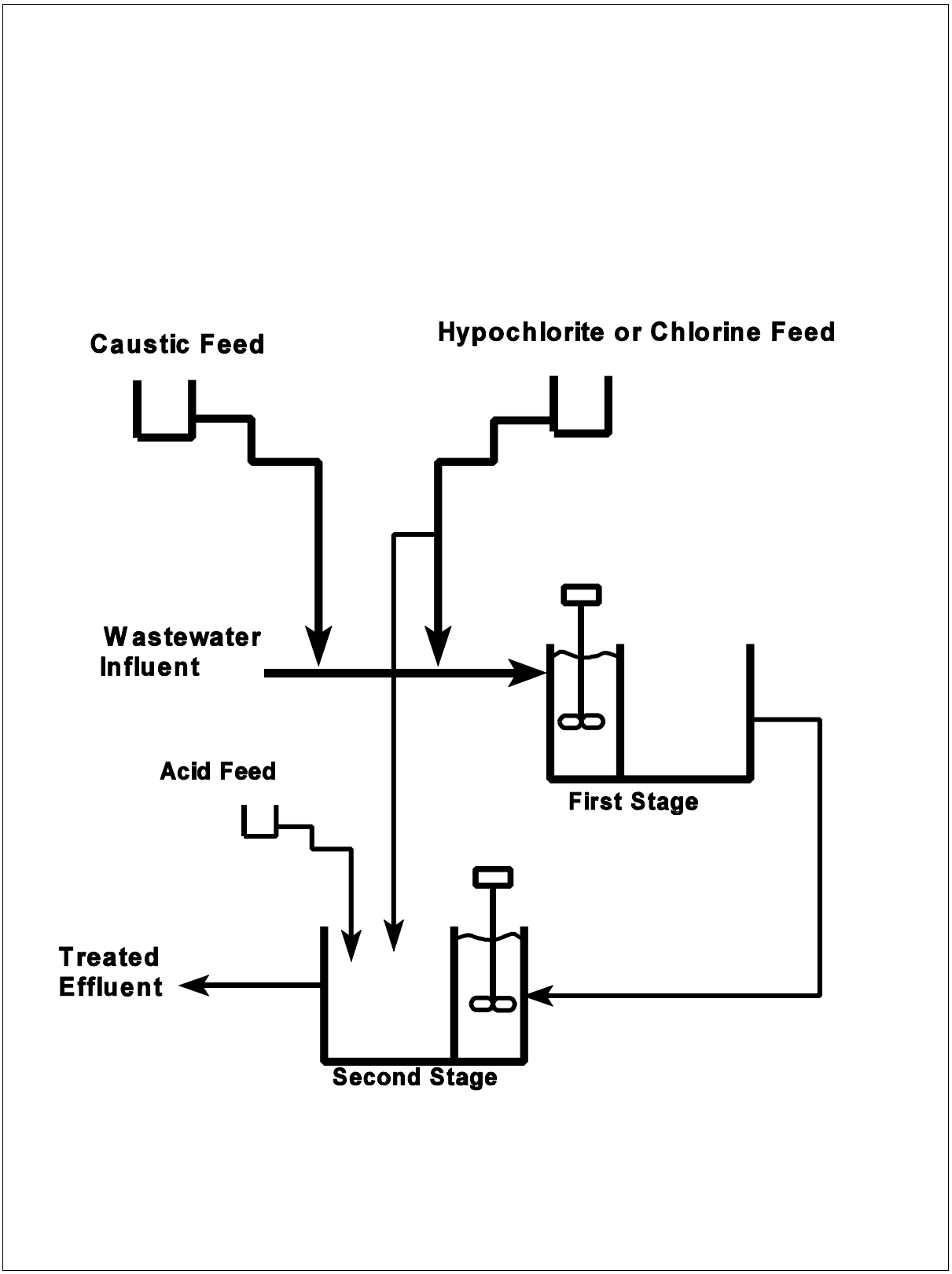


Figure 8-6: Cyanide Destruction

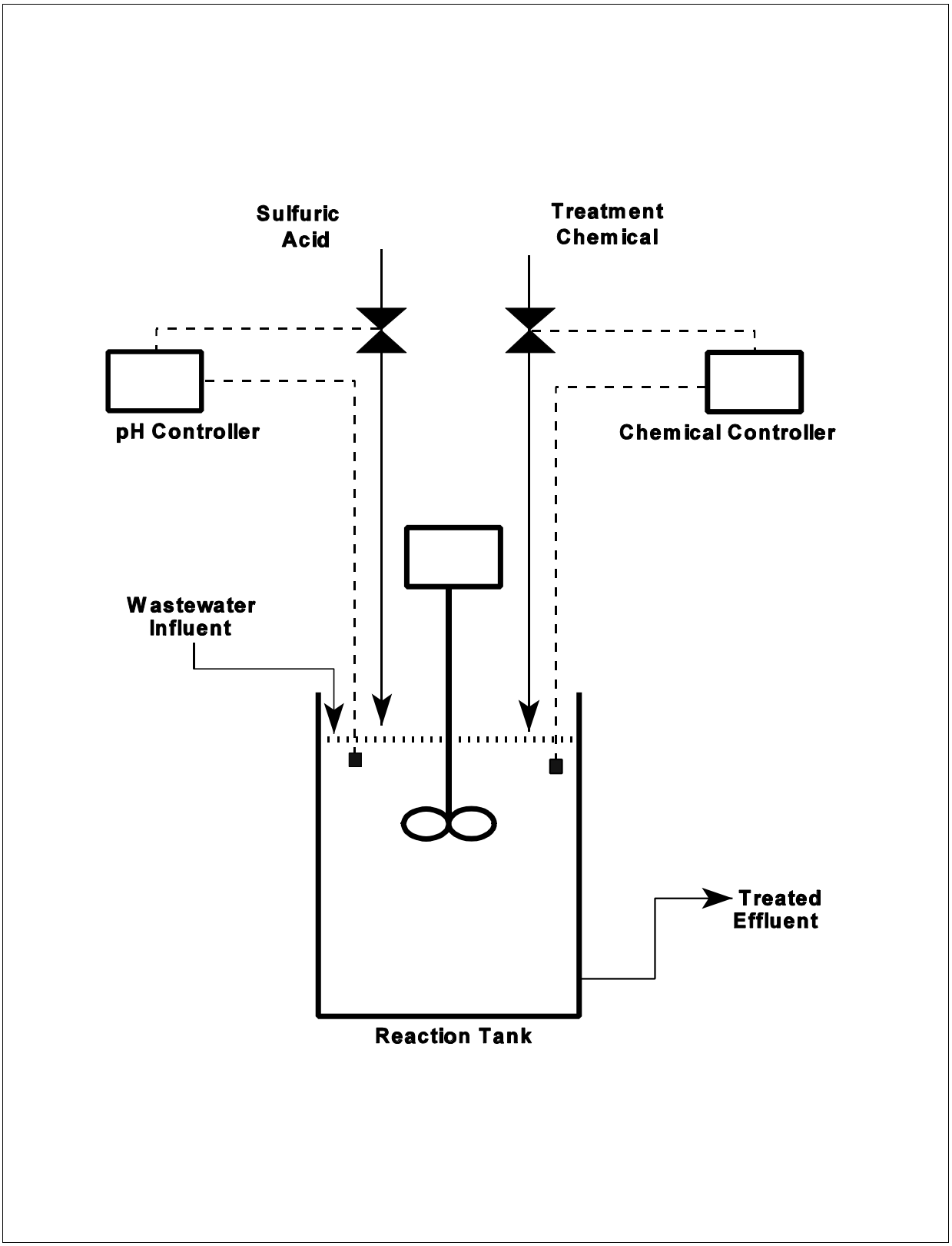


Figure 8-7: Chromium Reduction

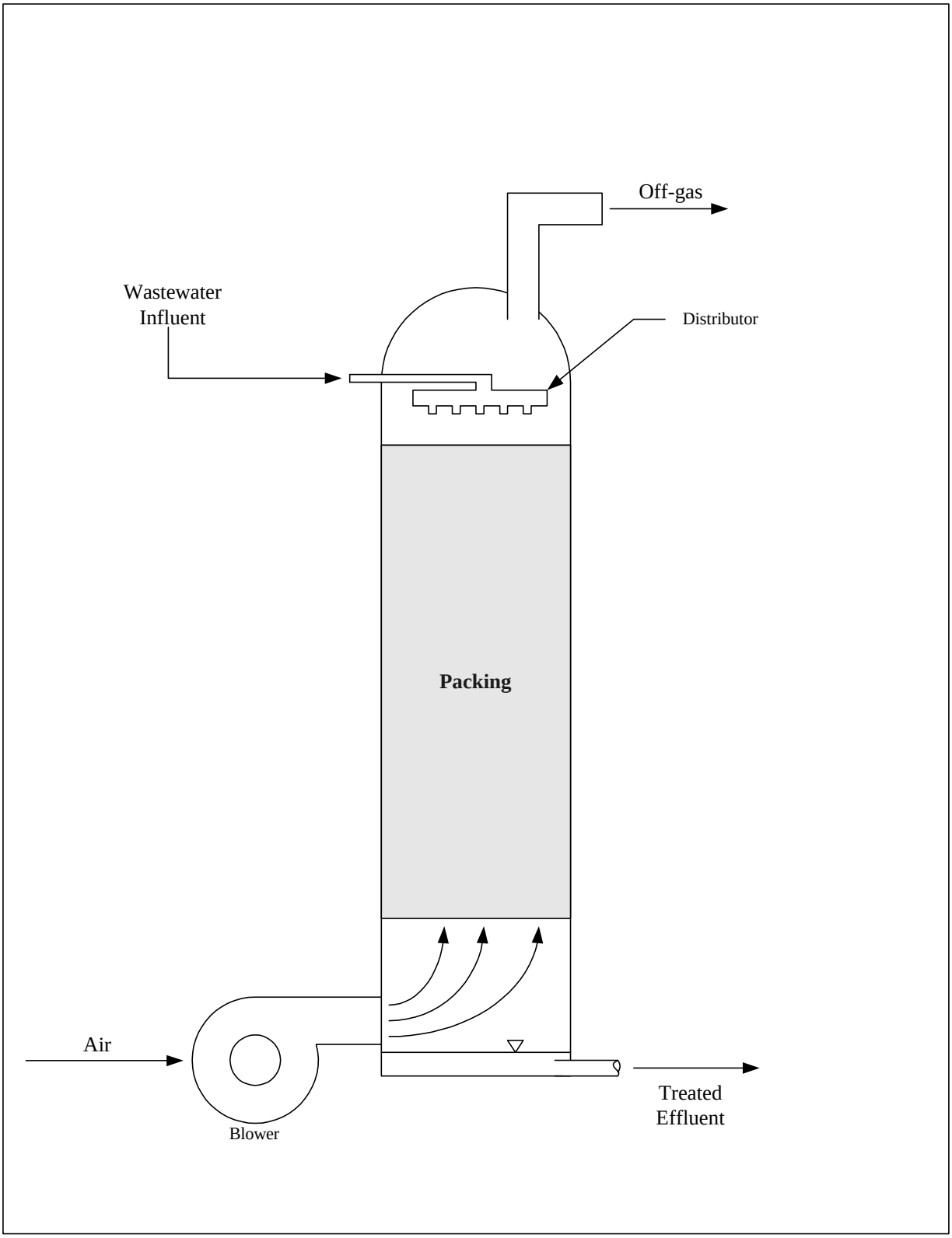


Figure 8-8: Typical Air Stripping System

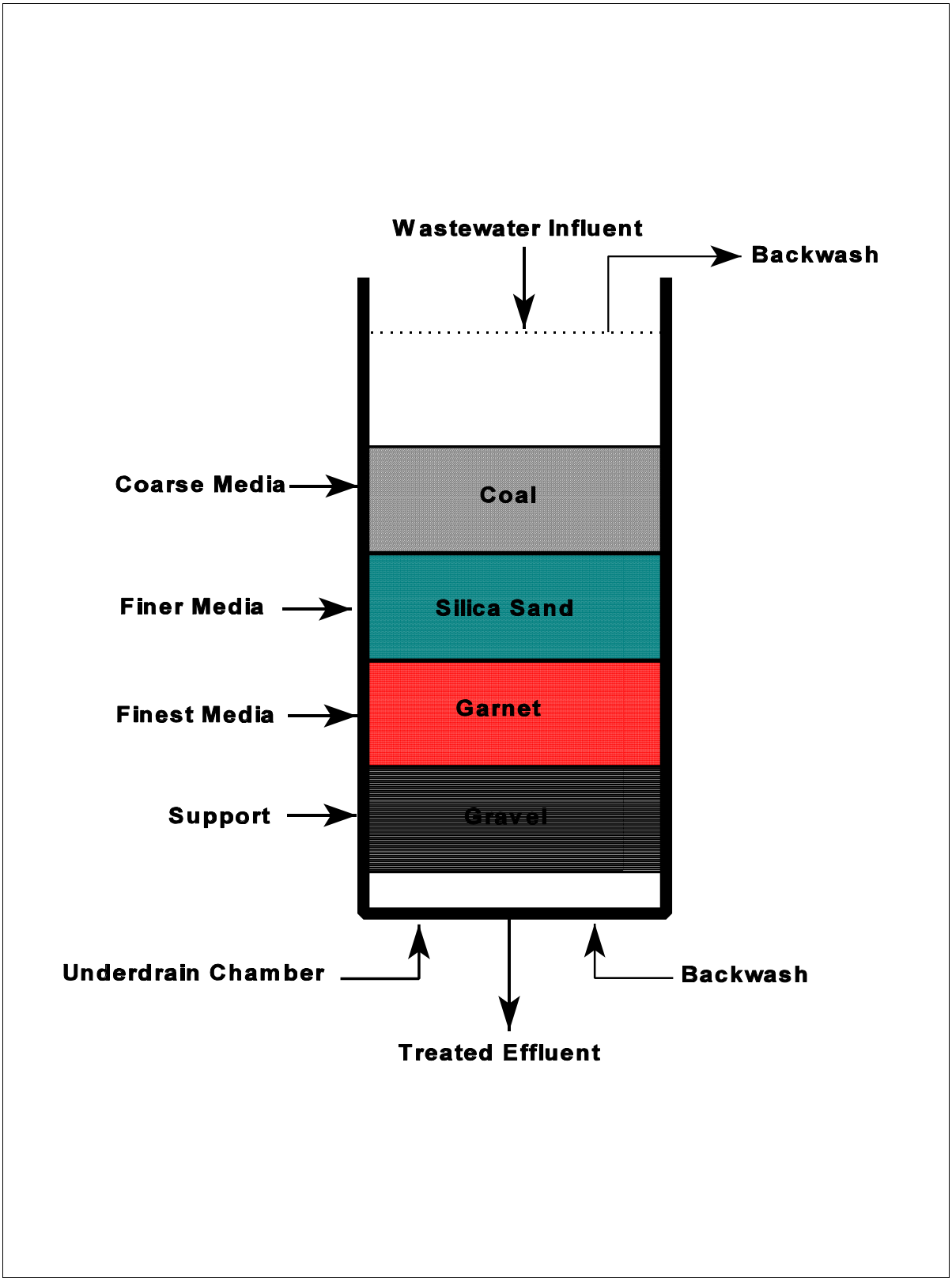


Figure 8-9: Multimedia Filtration

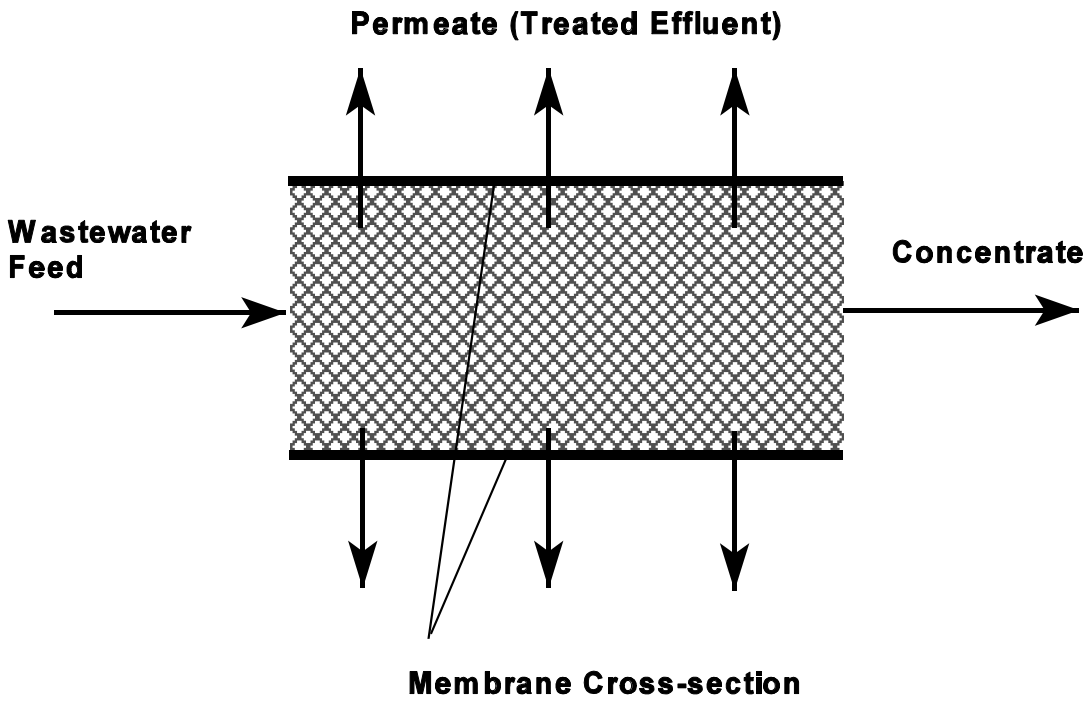


Figure 8-10: Ultrafiltration System Diagram

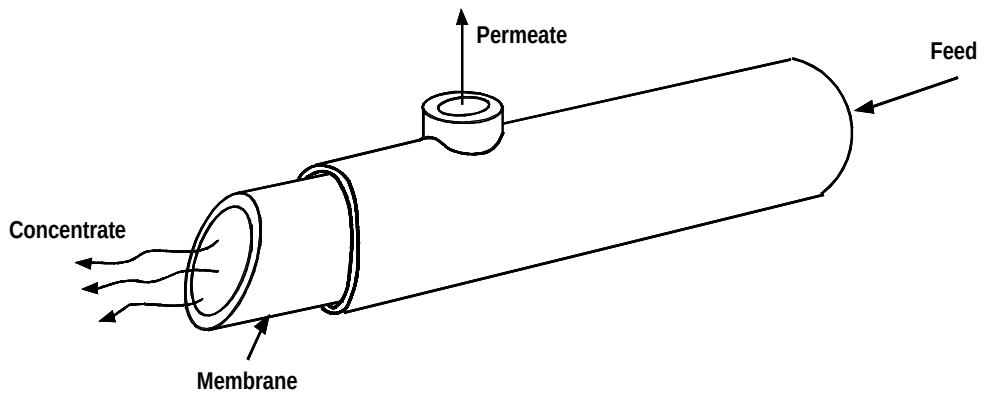


Figure 8-11: Tubular Reverse Osmosis Module

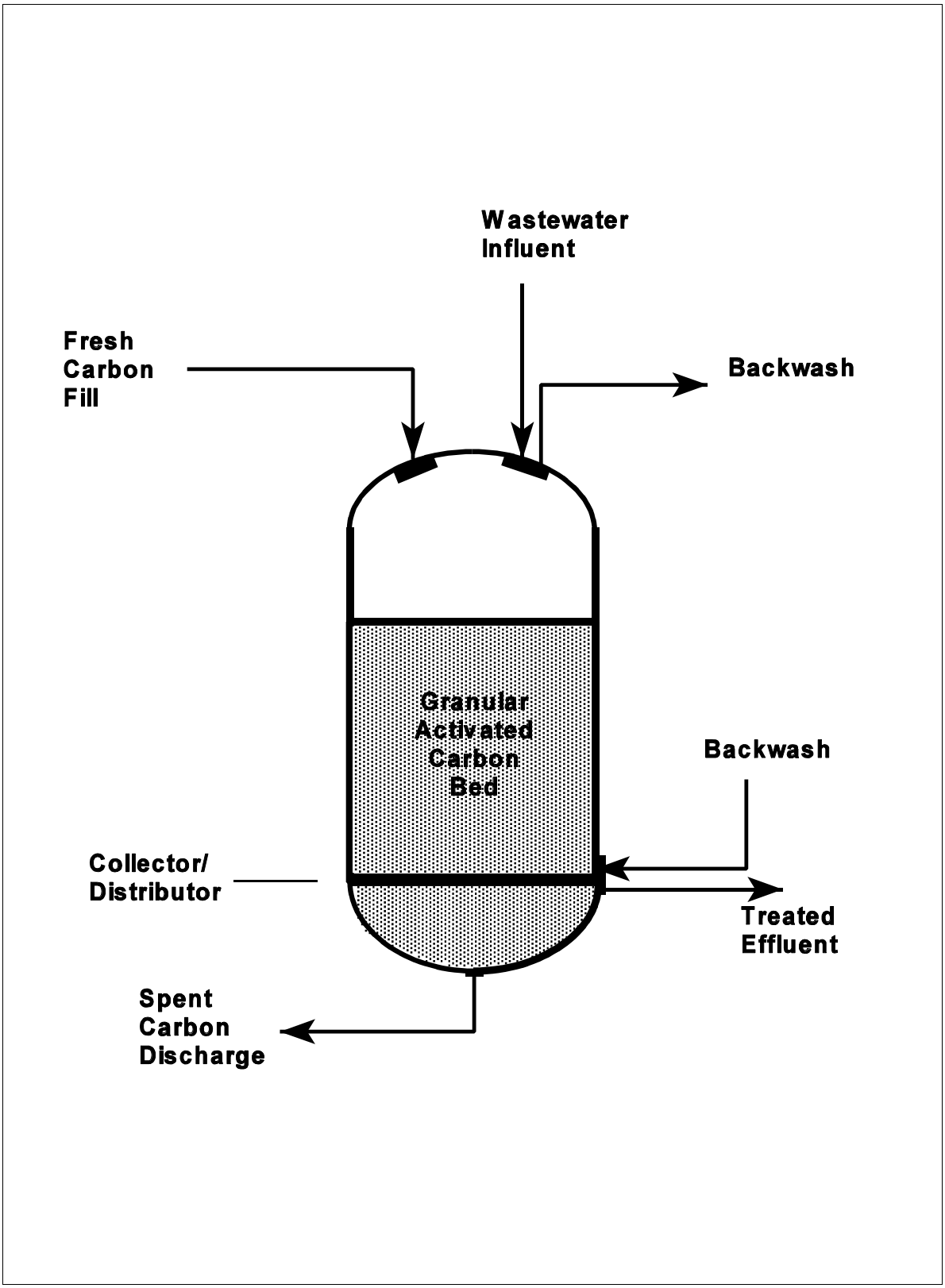


Figure 8-12: Granular Activated Carbon Adsorption

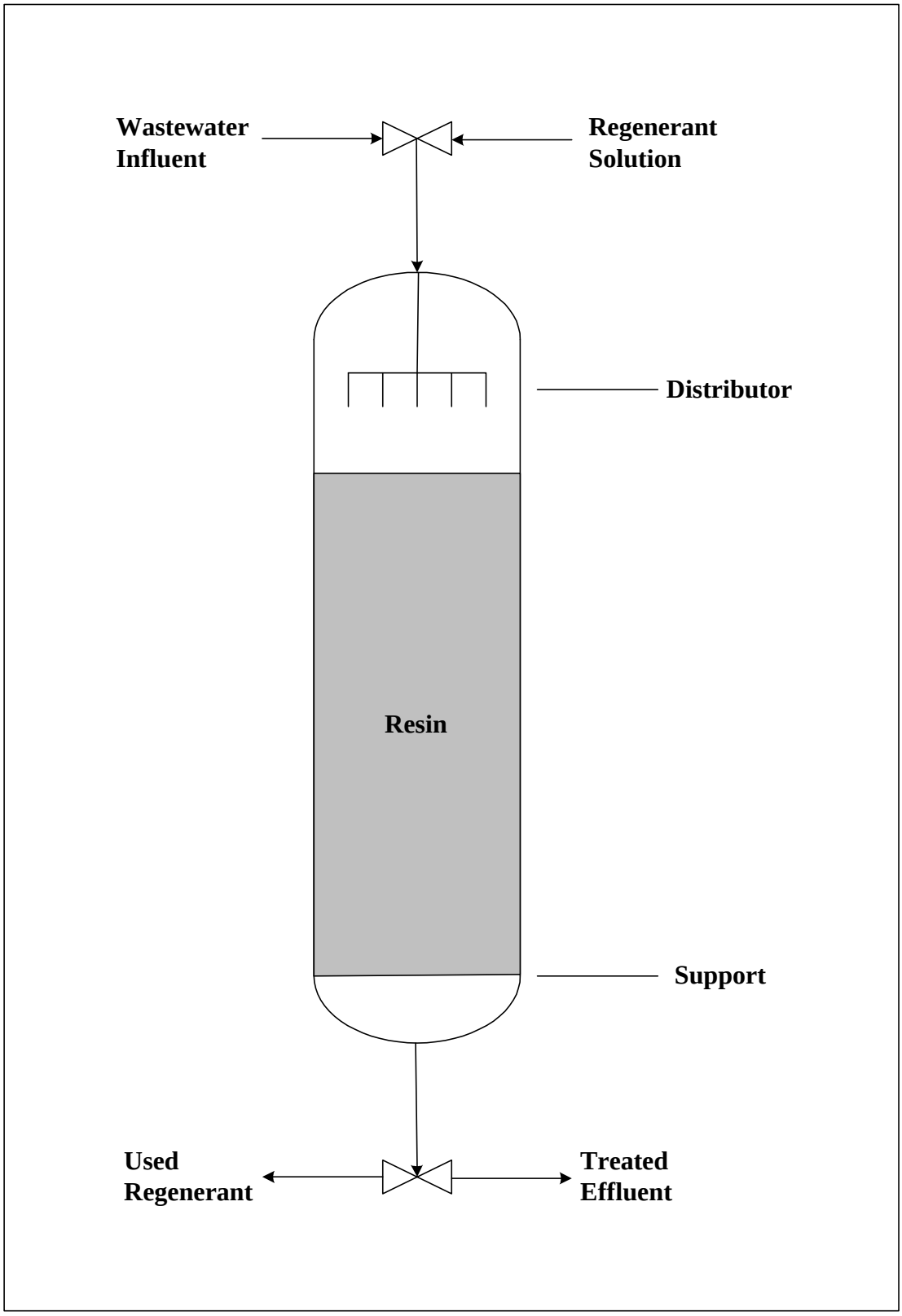


Figure 8-13: Ion Exchange

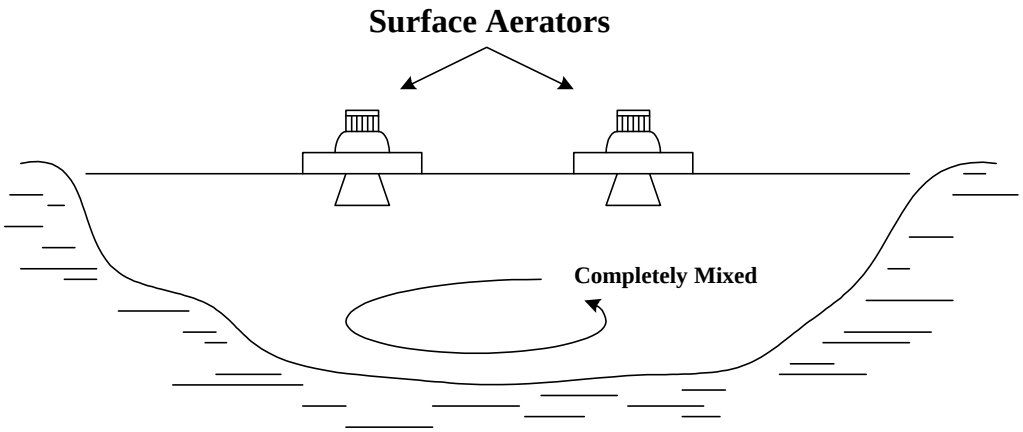


Figure 8-14: Aerated Lagoon

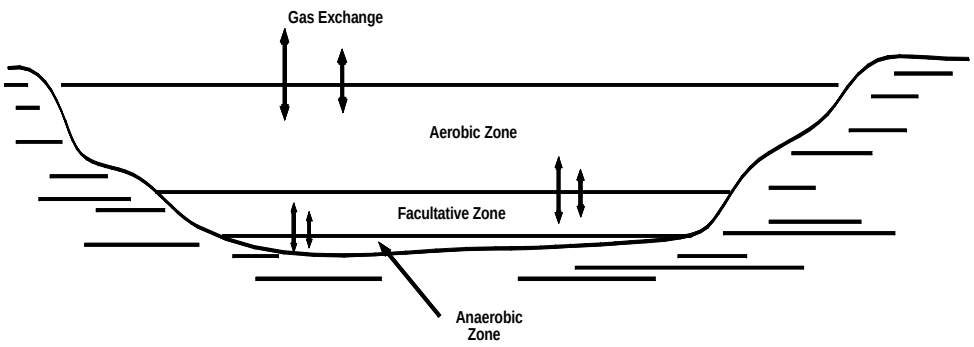


Figure 8-15: Facultative Pond

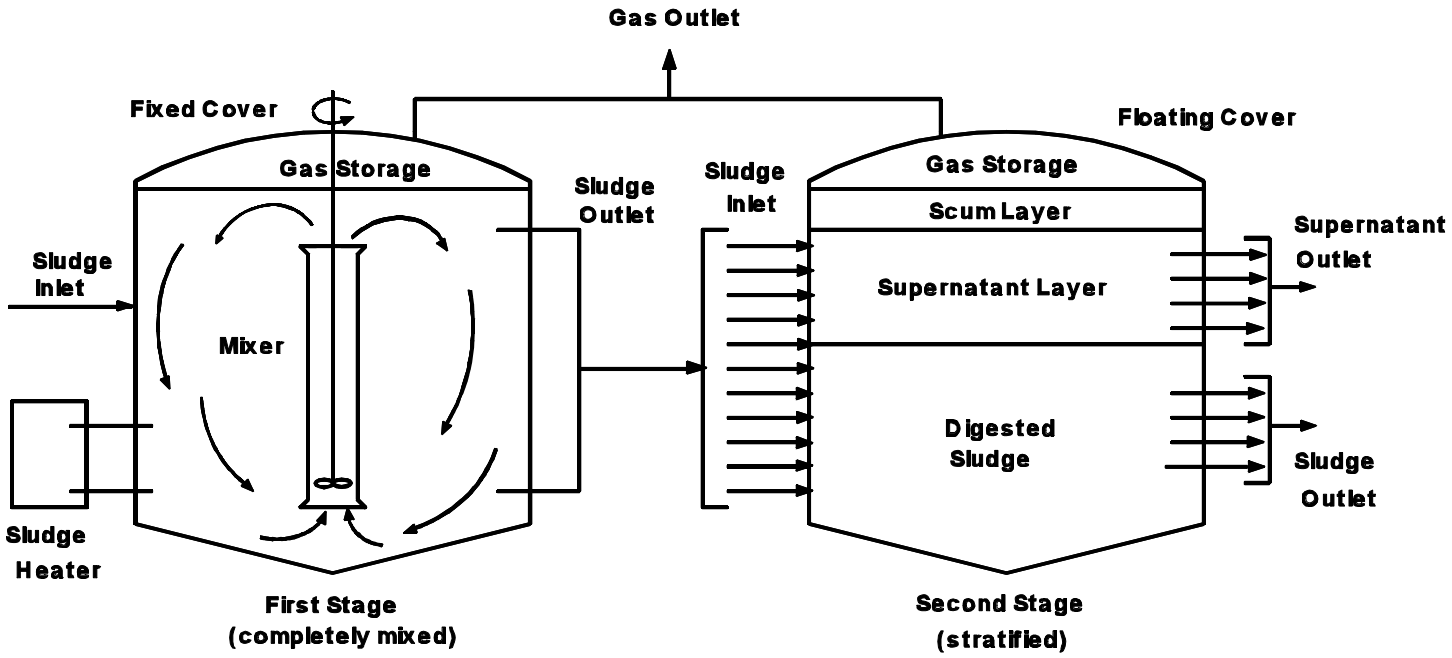


Figure 8-16: Completely Mixed Digestor System

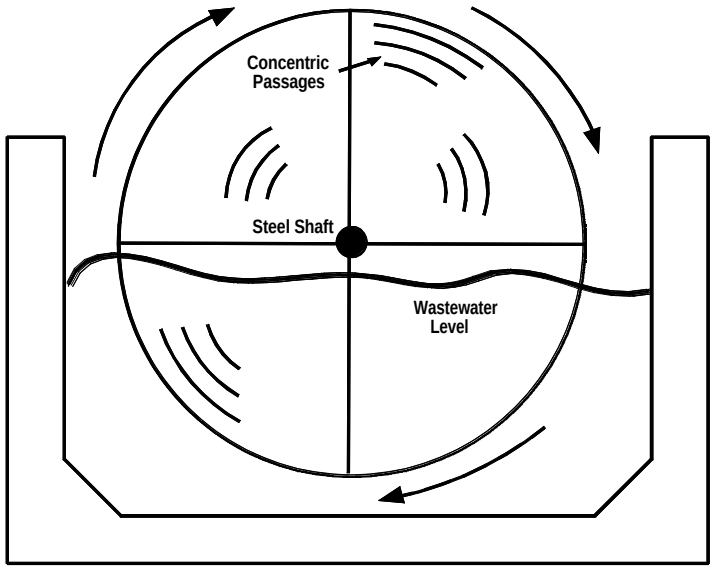


Figure 8-17: Rotating Biological Contactor Cross-Section

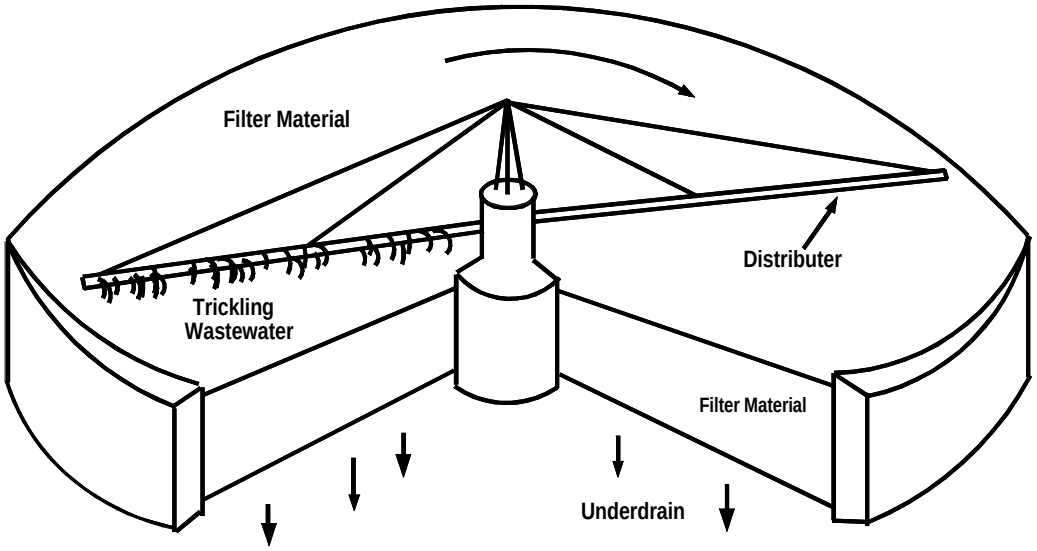


Figure 8-18: Trickling Filter

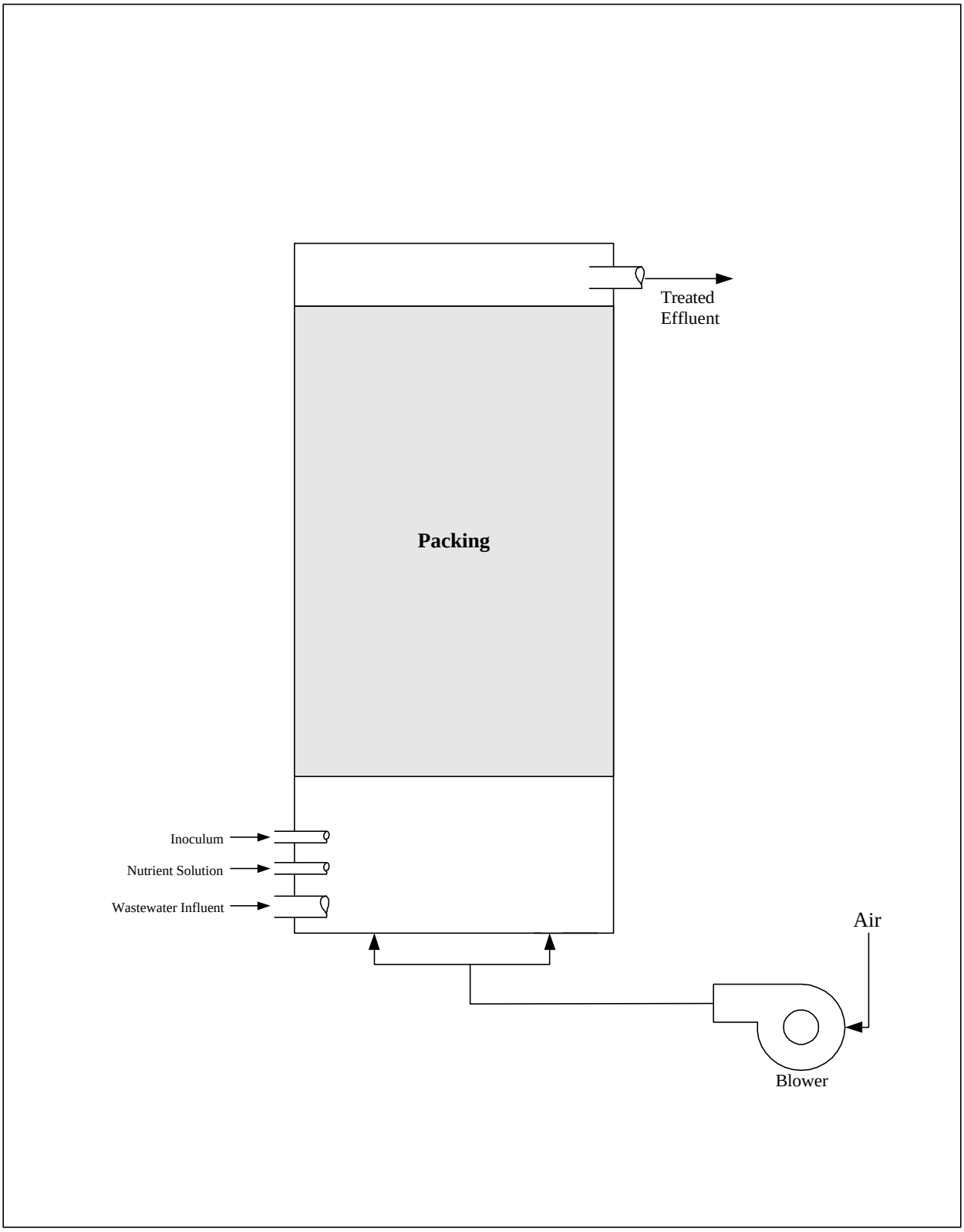


Figure 8-19: Fluidized Bed Reactor

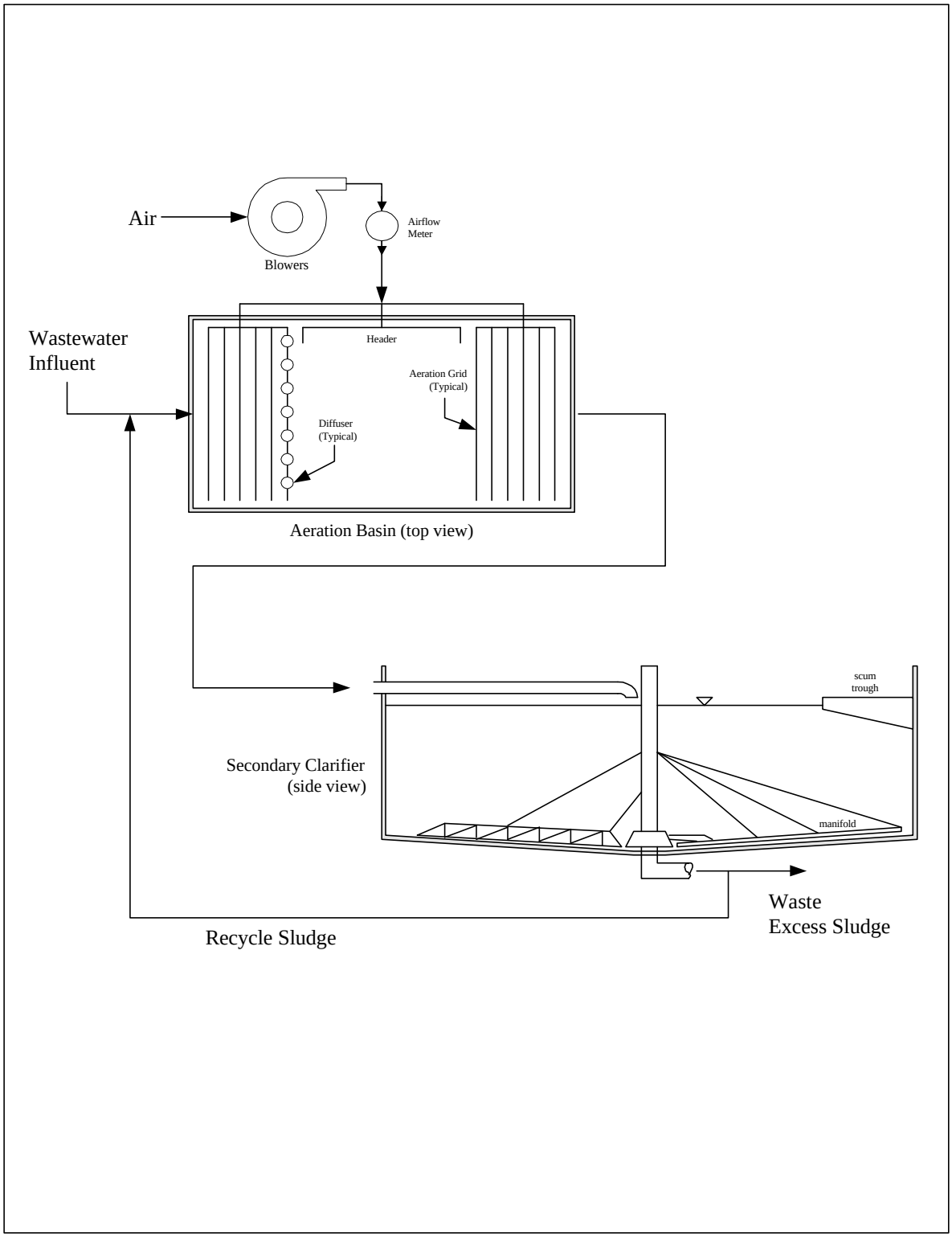


Figure 8-20: Activated Sludge System

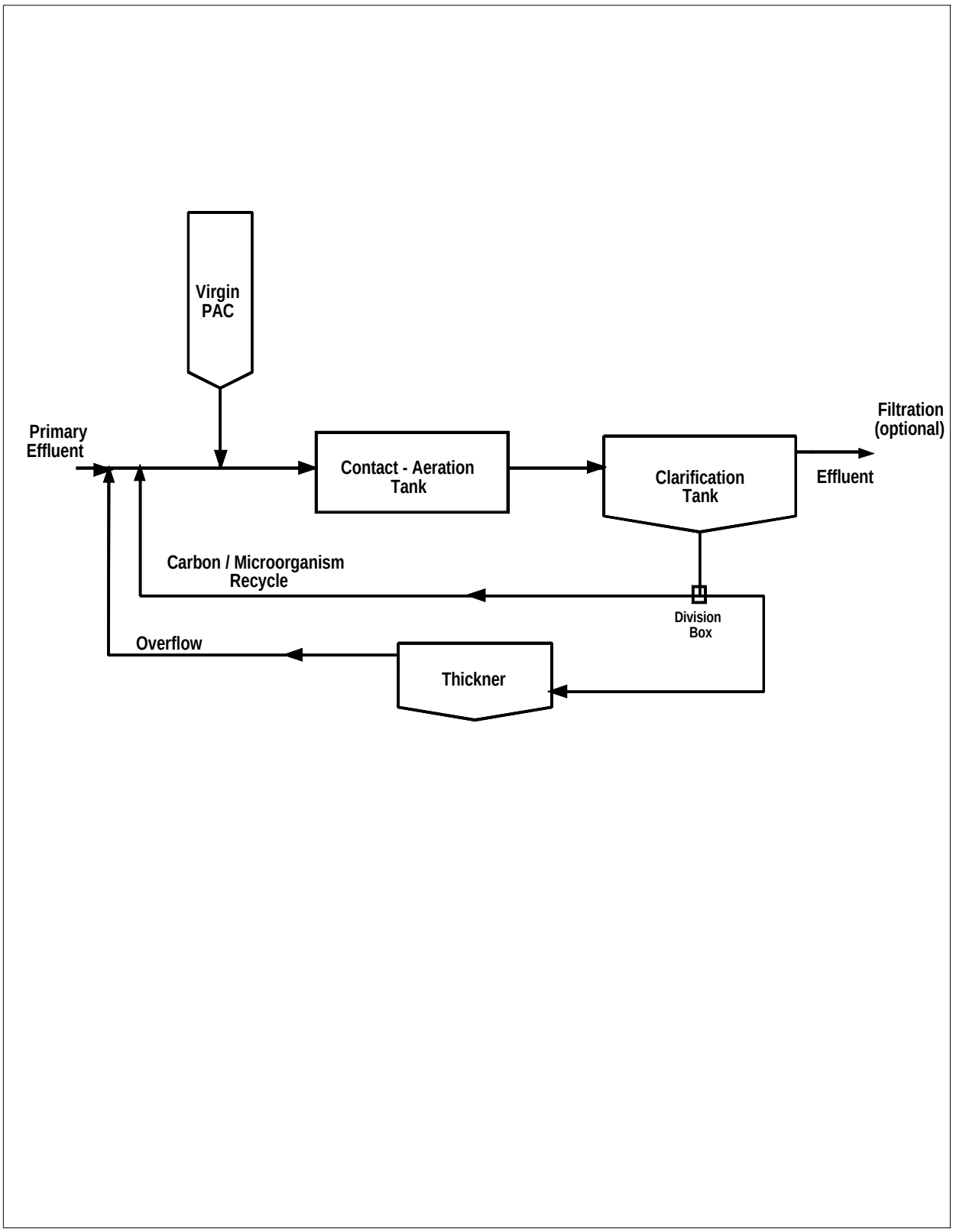


Figure 8-21: Powder Activated Carbon Treatment System

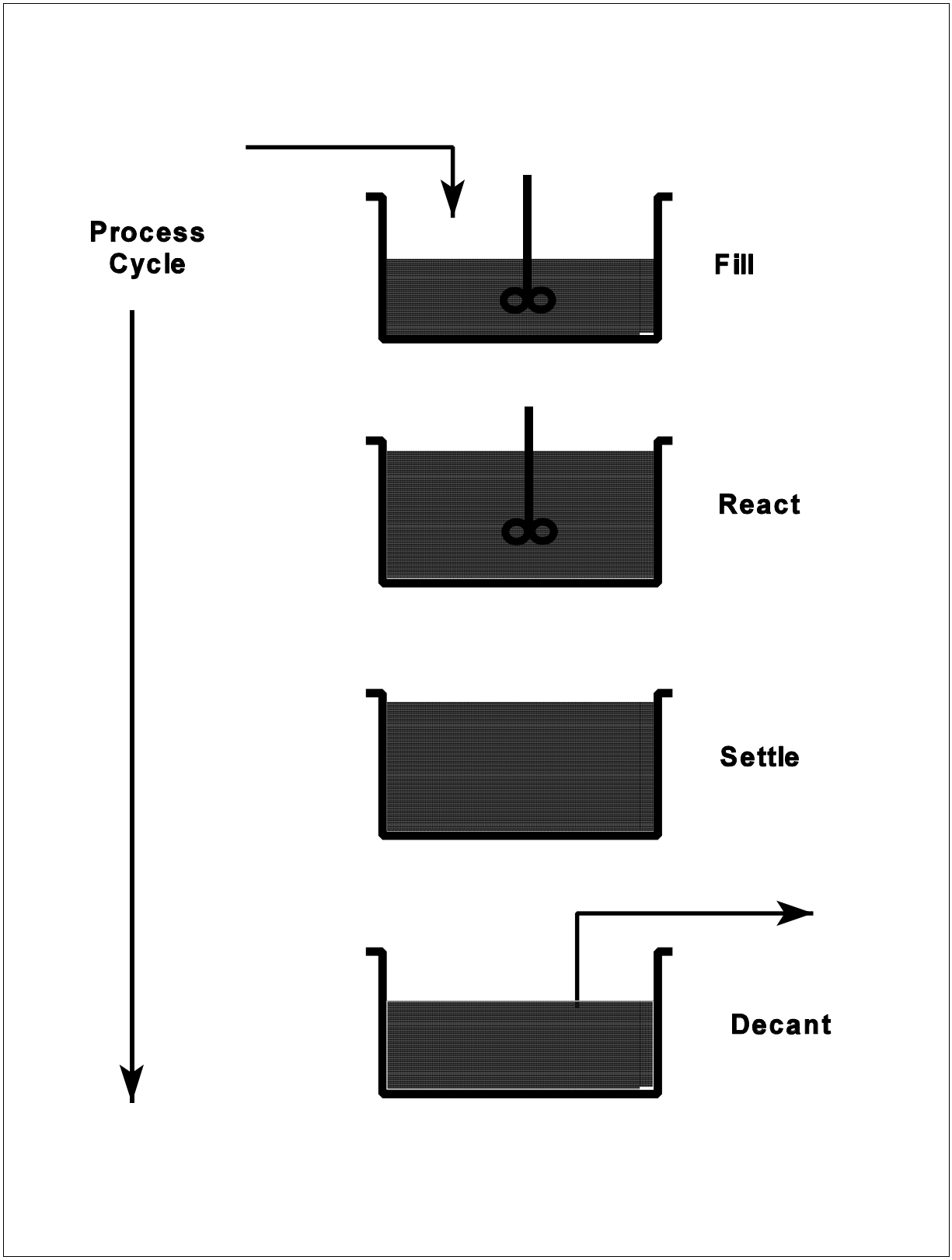


Figure 8-22: Sequencing Batch Reactor Process Diagram

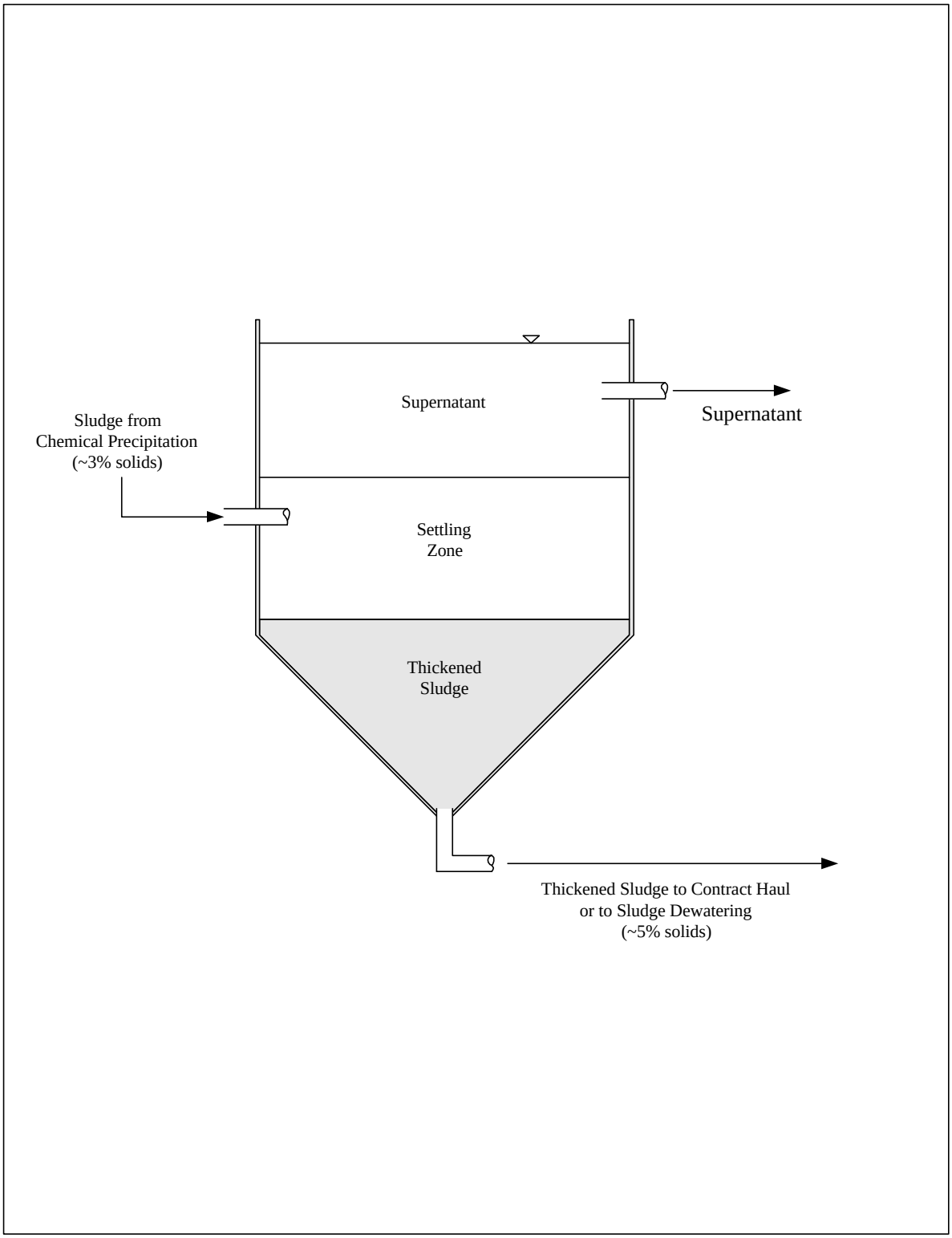


Figure 8-23: Gravity Thickening

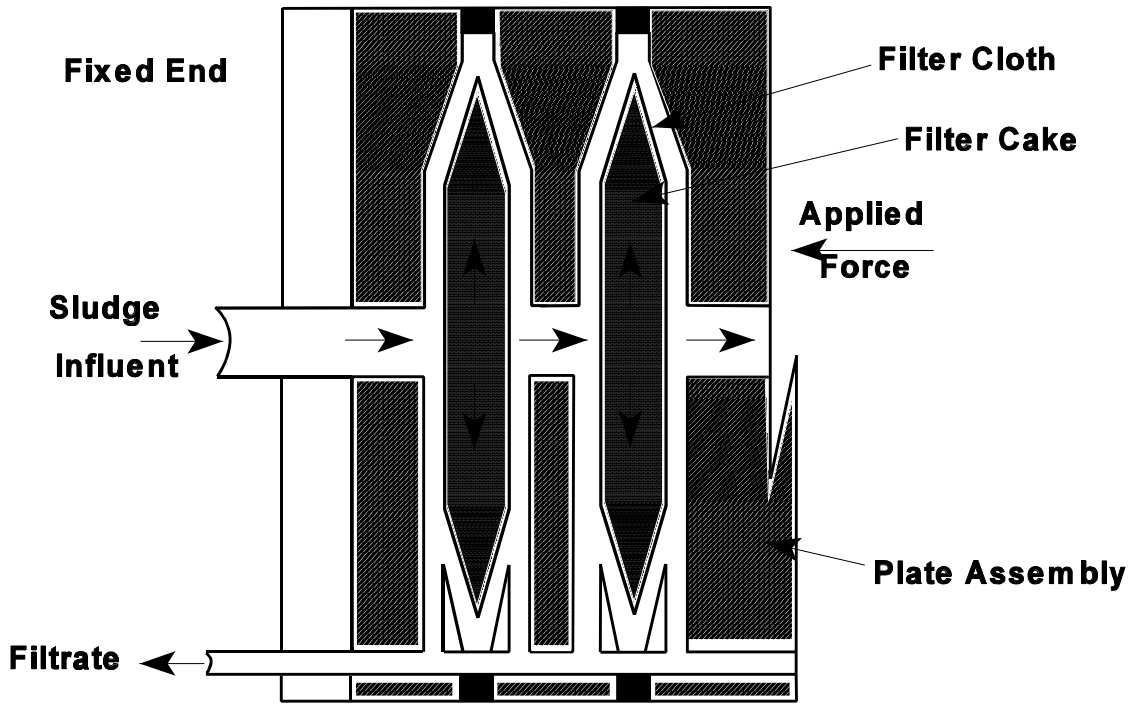


Figure 8-24: Plate-and-Frame Pressure Filtration System Diagram

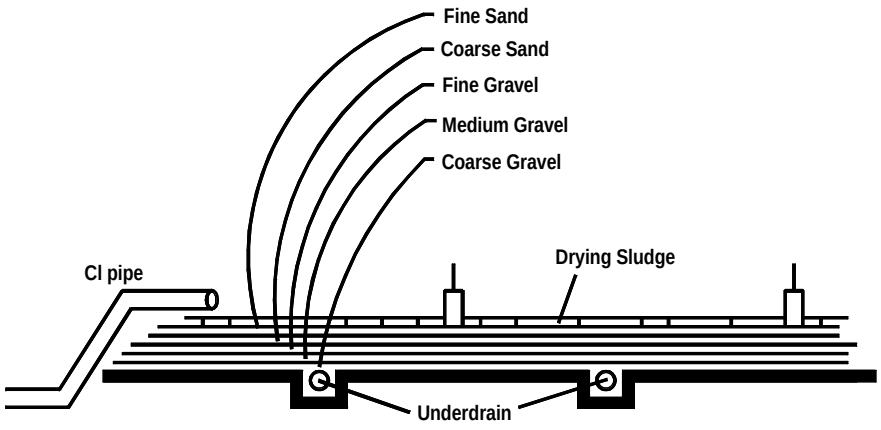


Figure 8-25: Drying Bed

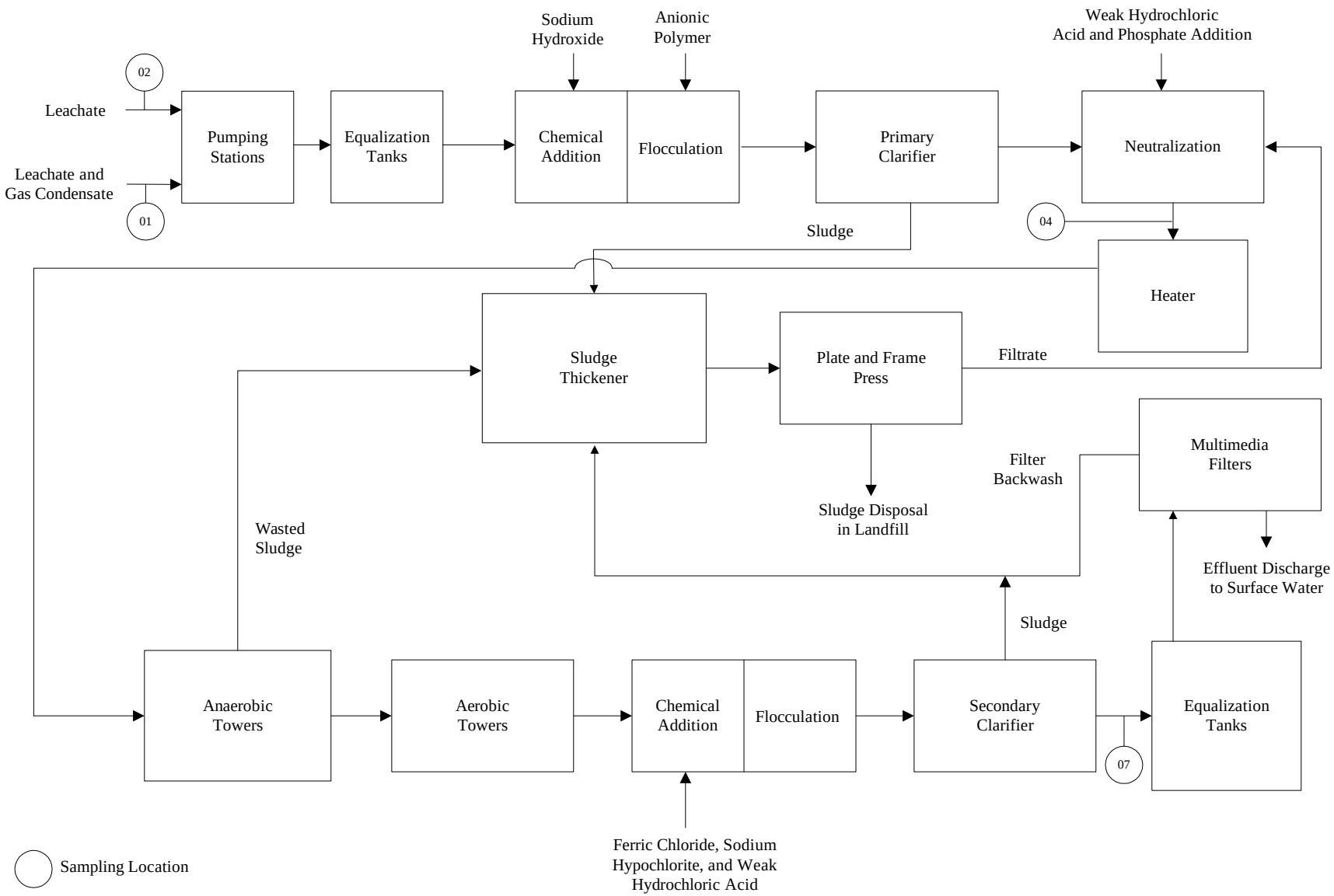


Figure 8-26: EPA Sampling Episode 4626 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

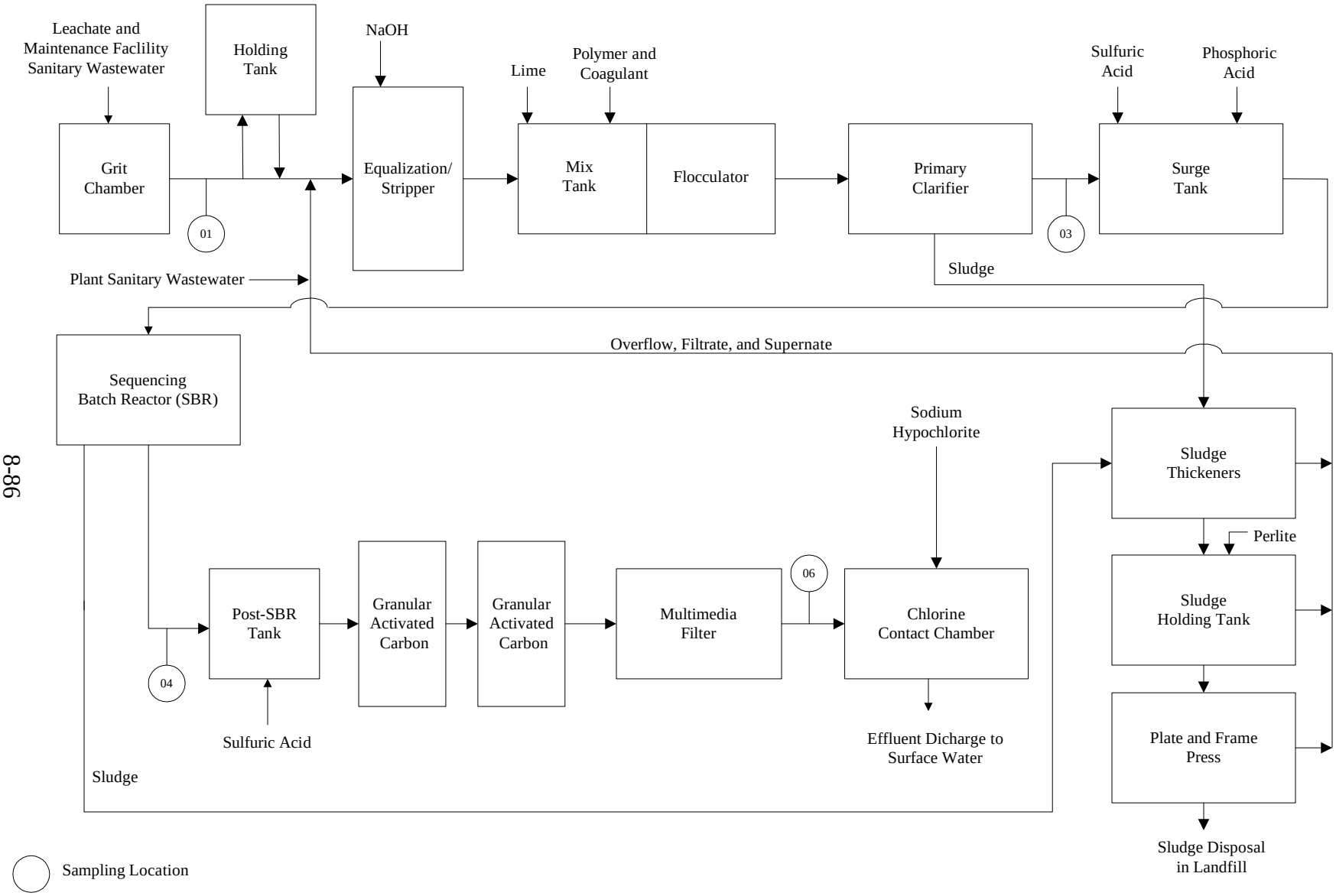


Figure 8-27: EPA Sampling Episode 4667 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

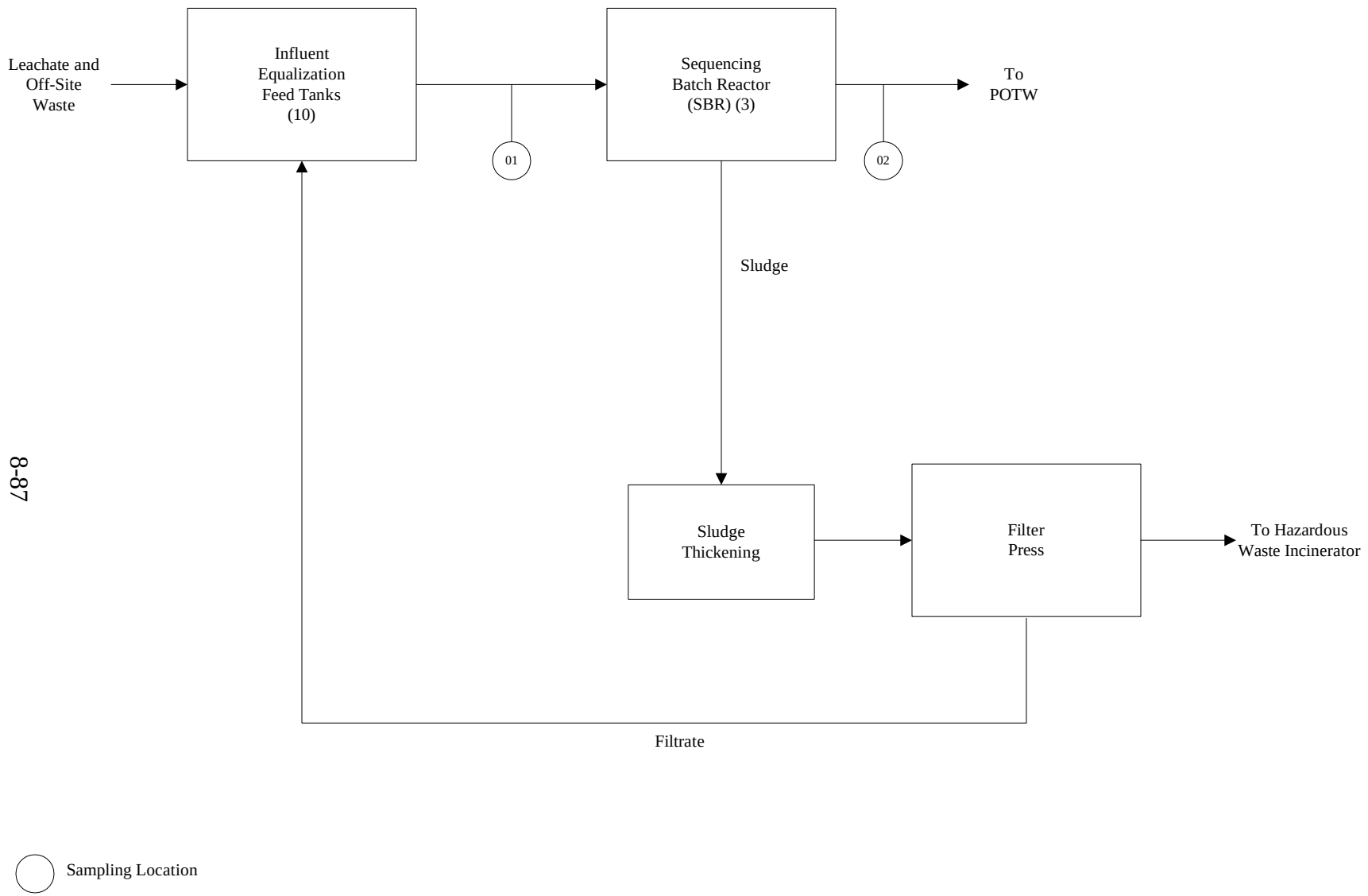


Figure 8-28: EPA Sampling Episode 4721 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

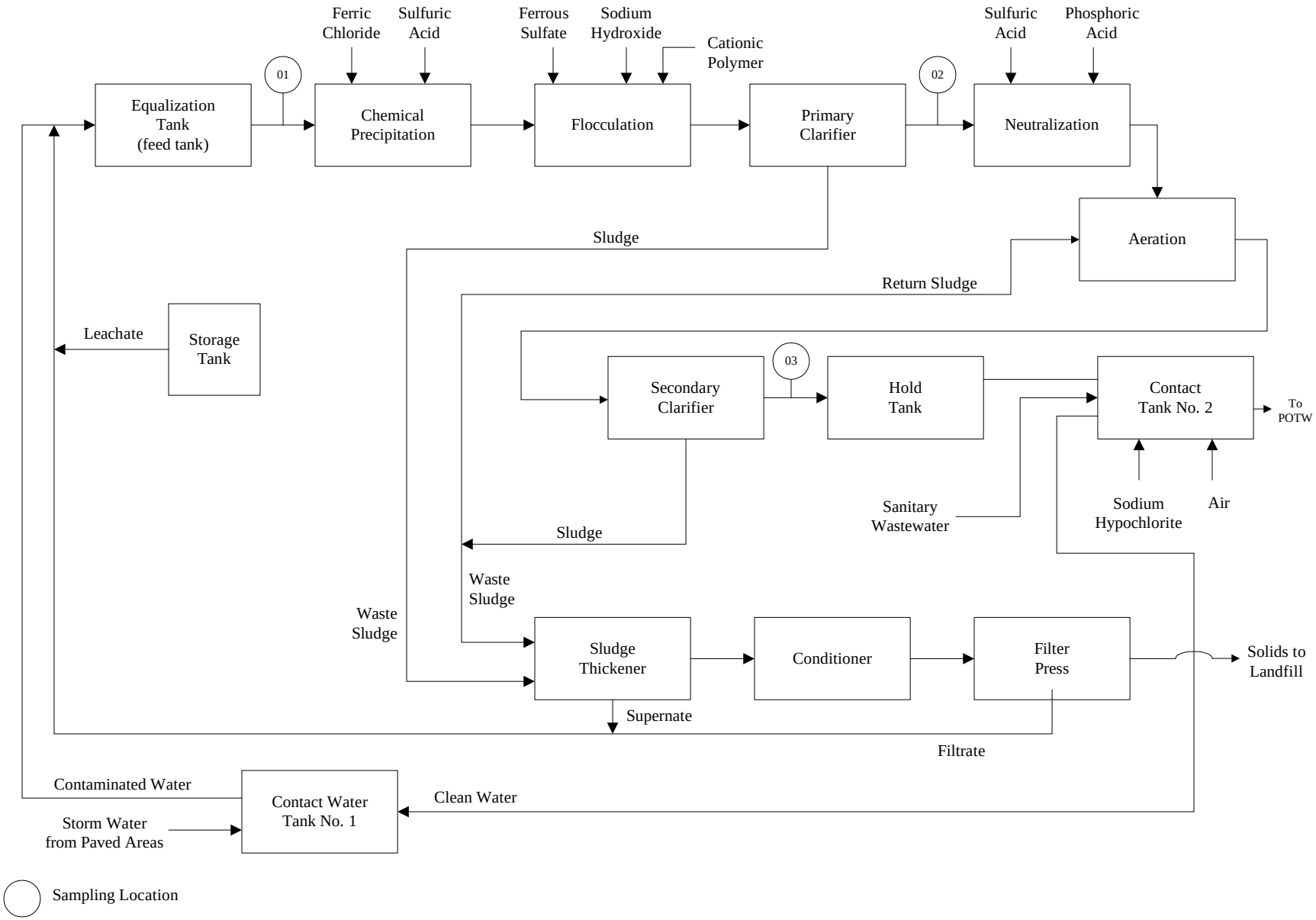


Figure 8-29: EPA Sampling Episode 4759 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

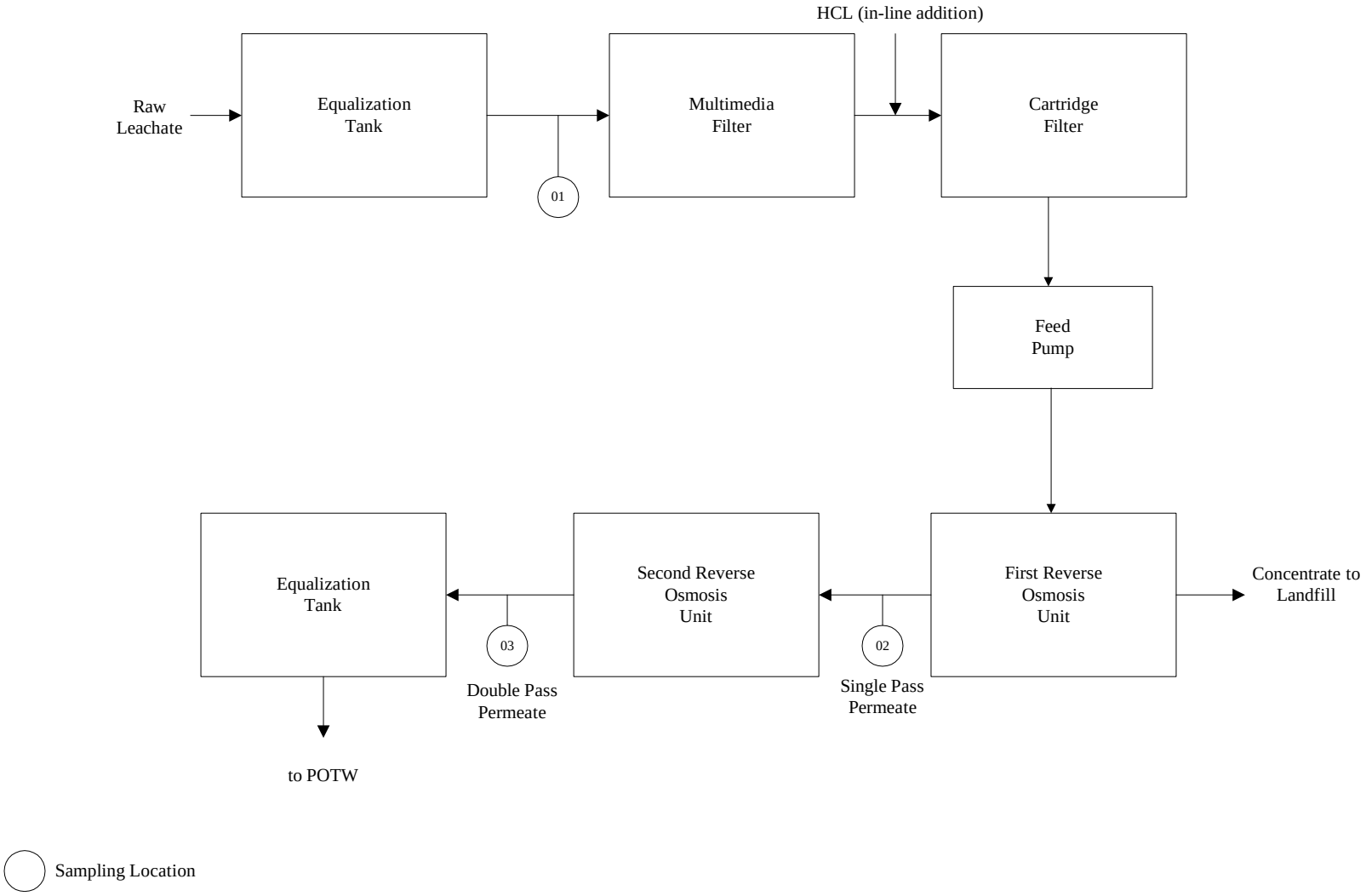


Figure 8-30: EPA Sampling Episode 4687 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

9.0 ENGINEERING COSTS

This chapter presents the costs estimated for compliance with the effluent limitations guidelines and standards for the Landfills industry. Section 9.1 provides a discussion of the cost-estimation methodologies considered by EPA including evaluation of two cost-estimation models. Section 9.2 presents a discussion of the types of cost estimates developed, while in Section 9.3, the development of capital costs, operating and maintenance (O&M) costs, and other related costs is described in detail. Section 9.4 summarizes the compliance costs for each regulatory option considered by EPA.

9.1 Evaluation of Cost-Estimation Techniques

This section presents a discussion of the cost-estimation techniques considered by EPA, including evaluation of two cost-estimation models. In this section, the Agency presents the criteria used to evaluate these techniques as well as the results of a benchmark analysis to compare the accuracy of these techniques. This section also presents the selected cost-estimation techniques.

9.1.1 Cost Models

EPA developed compliance-cost estimates for leachate treatment systems to determine the economic impact of the regulation. EPA has identified existing cost-estimation models to facilitate the development of compliance-cost estimates. In a mathematical cost model, various design and vendor data on a variety of treatment technologies are combined and cost equations that describe costs as a function of system parameters, such as flow, are developed for each treatment technology. Using these types of models allows for the generation of compliance-cost estimates for several regulatory options that are based on the iterative addition of treatment technologies and can assist EPA in the selection of options as the basis for the regulations.

EPA evaluated the following two well-known cost models for use in developing costs:

- Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET), developed by the U.S. Army Corps of Engineers.
- W/W Costs Program (WWC), Version 2.0, developed by CWC Engineering Software.

CAPDET is intended to provide planning level cost estimates to analyze alternatives in the design of wastewater treatment systems. Modules are used to develop cost estimates for a variety of physical, chemical, and biological treatment unit processes and can be linked together to represent entire treatment trains. Equations in each of these modules are based upon common engineering principles used for wastewater treatment system design. The CAPDET algorithm generates a design based on input parameters selected by the user, calculates cost estimates for various treatment trains, and ranks them based on present worth, capital, operating, or energy costs.

The WWC cost model was developed by Culp/Wesner/Culp from a variety of engineering sources, including vendor supplied data, actual plant construction data, unit takeoffs from actual and conceptual designs, and published data. The model calculates cost estimates for a variety of individual treatment technology units that can be combined together to develop compliance-cost estimates for the complete treatment systems. The WWC model does not design each treatment technology unit but rather prompts the user to provide design-input parameters that form the basis for the cost estimate. The WWC model includes a separate spreadsheet program that provides design criteria guidelines to assist in developing the input parameters to the cost-estimating program. The spreadsheet includes treatment component design equations and is supplied with default parameters that are based upon accepted design criteria used in wastewater treatment, to assist in the design of particular treatment units. The spreadsheet also is flexible enough to allow selected design parameters to be modified to estimate industry-specific factors accurately. Once design inputs are entered into the program, the WWC model calculates both construction and operation and maintenance (O&M) costs for the selected wastewater treatment system.

9.1.2 Vendor Data

For certain wastewater treatment technology units, the cost model was not considered the most accurate

estimate of costs. For these instances, EPA determined that reported equipment and operation and maintenance costs obtained directly from equipment vendors often can provide accurate cost estimates.

EPA provided information on landfill wastewater characteristics to vendors to determine the appropriate treatment unit and accurate sizing. Quotes obtained from vendors included equipment costs that EPA factored up to total capital costs to account for site preparation, mobilization costs, and engineering contingencies. EPA also obtained vendor quotes for operation and maintenance costs, including utility usage and cost. The Agency used vendor quotes to determine cost curves for equalization, multi-media filtration, granular activated carbon, breakpoint chlorination, and reverse osmosis. EPA based the cost curves used for these treatment technologies on direct vendor quotes, commercial costing guides, or cost information developed from vendor quotes as part of the Centralized Waste Treatment (CWT) effluent guidelines effort.

9.1.3 Other EPA Effluent Guideline Studies

EPA reviewed other EPA effluent studies, such as the Organic Chemicals and Plastics and Synthetic Fibers (OCPSF) industry effluent guidelines, to obtain additional costing background and supportive information. However, EPA did not use costs developed as part of other industrial effluent guidelines in costing for this industry, with the exception of the CWT effluent guideline data referenced in Section 9.1.2.

9.1.4 Benchmark Analysis and Evaluation Criteria

EPA performed benchmark analyses to evaluate the accuracy of each cost-estimation technique. This benchmark analysis used reported costs provided in the 308 Questionnaires and compared them to costs generated using each cost-estimation technique. EPA selected four landfill facilities (Questionnaire Identification numbers (QIDs) 16122, 16125, 16041, and 16087) with wastewater treatment systems for the benchmark analysis. The agency developed cost estimates for wastewater treatment units that make up the treatment systems at these landfill facilities using the WWC and CAPDET models and vendor quotes. Next, EPA compared these cost estimates to the reported component costs provided in the 308 Questionnaires to evaluate the accuracy of each methodology in estimating capital and operation and

maintenance costs. This cost comparison is presented in Table 9-1. Treatment technologies that EPA used in this benchmark analysis include the following:

- equalization,
- chemical precipitation,
- activated sludge,
- sedimentation, and
- multi-media filtration.

EPA also benchmarked cost estimates developed using these techniques against reported costs for wastewater treatment systems that included equalization, chemical precipitation, and multimedia filtration and were obtained from industrial waste combustor facilities as part of that effluent guidelines effort. EPA believes that the wastewater characteristics being treated by these treatment systems, i.e., inorganic contaminants and solids in an uncomplexed matrix, are similar for both landfills and industrial waste combustor facilities and that this additional comparison provides a more thorough evaluation of the Agency's cost-estimation methodologies. Table 9-2 presents a comparison of the capital and O&M costs obtained for the wastewater treatment systems at four industrial waste combustor facilities to the cost estimates obtained using each technique, i.e., the WWC and CAPDET models, and vendor quotes.

As shown in Tables 9-1 and 9-2, EPA has determined that, based on the results of the benchmark analyses for both data sources, the WWC model generated cost estimates that are considered more accurate than the CAPDET model when compared to reported treatment technology costs as provided in 308 Questionnaire responses. In all instances, the WWC model estimated the more accurate treatment system capital and O&M costs as compared to CAPDET and vendor costs. For several facilities, such as QIDs 16087, 16122, and 16125, the WWC model generated capital costs to within 32 percent of costs provided in the questionnaires. EPA estimated O&M costs for several facilities, including QIDs 16041, 16087, and 16122, to within 18 percent of costs provided in the 308 Questionnaires.

EPA used the following criteria to evaluate each cost-estimation technique and to select the appropriate option for developing a methodology for estimating compliance costs for the Landfills industry:

- Does the model contain costing modules representative of the various wastewater technologies in use or planned for use in the Landfills industry?
- Can the model produce costs in the expected flow range experienced in this industry?
- Can the model be adapted to cost entire treatment trains used in the Landfills industry?
- Is sufficient documentation available regarding the assumptions and sources of data so that costs are credible and defensible?
- Is the model capable of providing detailed capital and operation and maintenance costs with unit-costing breakdowns?
- Is the model capable of altering the default design criteria in order to accurately represent reported design criteria indicative of the Landfills industry?

9.1.5 Selection of Final Cost-Estimation Techniques

Based upon the results of the benchmark analysis, EPA selected the WWC model for estimating costs for the majority of the treatment technologies that form the basis for BPT/BAT/NSPS effluent limitations and standards. The Agency determined that the WWC model is capable of producing accurate capital and O&M costs for a wide range of treatment technologies. EPA found that the CAPDET model was not capable of generating cost estimates for many of the technologies that form the basis for BPT/BAT/NSPS effluent limitations and standards for the Landfills industry, and the Agency determined that it was not accurate in estimating technology costs for landfill facilities. Therefore, EPA decided not to use the CAPDET model for estimating compliance costs.

EPA has determined that the WWC model best satisfies the selection criteria. The program can estimate costs for a wide range of typical and innovative treatment technologies and can combine these costs of each technology to develop system costs. Since the WWC model is a computer based program, it readily allows for the iterative development of costs for a number of facilities and regulatory options. The program utilizes cost modules that can accommodate the range of flows and design-input parameters needed to develop cost estimates for landfill facilities. Cost estimates generated by this model are based upon a

number of sources, including actual construction and operation costs, along with published data, and are presented in a breakdown summary table that contains unit costs and totals. Finally, the WWC model can be adapted to estimate costs based upon specified design criteria and wastewater flow rates.

EPA notes that there were particular technologies for which the WWC model did not produce accurate cost estimates. These technologies included equalization, multimedia filtration, granular activated carbon, breakpoint chlorination, and reverse osmosis. In some low-flow situations, costs developed for these treatment technologies were excessively high as compared to industry provided costs in 308 Questionnaire responses. For these technologies, EPA determined that vendor quotes provided a more accurate estimate of compliance costs and would be used in the final engineering costing methodology for these technologies.

In addition, in a select few cases, EPA determined that it would be more economically feasible for some facilities to truck/pipe their wastewater off-site for treatment than to construct and maintain their own wastewater treatment system. These facilities had extremely low average daily flow rates (50 gallons or less); therefore, EPA substituted an off-site disposal cost for CWT treatment for BPT/BAT capital and O & M costs (see also 9.2.6).

9.2 Engineering Costing Methodology

This section presents the costing methodology used to develop treatment costs for BPT, BCT, and BAT options for the Landfills industry. This section also presents a description of additional costs, such as monitoring costs, that EPA developed. The following discussion presents a detailed summary of the technical approach used to estimate the compliance costs for each landfill facility. The Agency developed total capital and annual operation and maintenance costs for each facility in its database to upgrade its existing wastewater treatment system, or to install new treatment technologies, to comply with the long term averages for each regulatory option. Development of the long-term averages is discussed in Chapter 11 of this document and in the Statistical Support documents. EPA costed facilities primarily using the WWC model and, on occasion, from cost curves developed from vendor quotes. Table 9-3 presents a breakdown

of the cost-estimation method used for each treatment technology. EPA developed additional costs for monitoring, Resource Conservation and Recovery Act (RCRA) permit modifications, and residual disposal. The Agency developed total facility compliance costs under each BPT, BCT, and BAT option by adding treatment costs with these additional costs. EPA did not develop cost estimates for zero or alternative discharge facilities for any of the regulatory options (with the exception of some low flow facilities, see 9.2.5).

9.2.1 Treatment Costing Methodology

The methodology used to develop facility-specific BPT, BCT, and BAT option-compliance costs is presented graphically on the flow diagram in Figure 9-1. EPA costed facilities for an entire new treatment system, whether or not they had existing treatment at the facility, if the collected flow subject to this guideline was less than 85 percent of the total facility flow rate.

For each regulatory option, EPA evaluated each landfill facility in the Detailed Questionnaire database to determine if the facility would incur costs in order to comply with the regulations. EPA compared the current discharge concentrations of the facility's effluent with the long-term averages from each regulatory option. If the facility's current discharge concentration was less than the long-term average, EPA considered it to be in compliance. A facility considered to be in compliance was projected to incur costs only for additional monitoring requirements. If a facility was not in compliance but had treatment unit operations in-place capable of complying with the long-term averages, EPA costed the facility for system upgrades that would bring the facility into compliance.

For facilities that did not have BPT/BCT/BAT treatment systems or the equivalent, the Agency developed cost estimates for the additional unit operations and/or system upgrades necessary to meet each long term average. Facilities that were already close to compliance with the long-term averages only required an upgrade to achieve compliance with limitations for a regulatory option. EPA developed upgrade costs using the WWC model whenever possible and included either additional equipment to be installed as part

of an existing wastewater treatment system, expansion of existing equipment, or operational changes. Examples of upgrade costs include such items as new or expanded chemical feed systems and improved or expanded aeration systems. If a facility had no treatment system (or one that could not achieve desired levels with upgrades or minor additions) the Agency developed cost estimates for an entire BPT/BCT/BAT treatment system for that facility.

The first step in using the WWC model was to use the design-criteria guidelines spreadsheet to develop input parameters for the computer program. EPA used reported pollutant loadings from the facility whenever possible. If pollutant loadings were not available for a particular parameter, EPA used the estimates of pollutant concentrations in untreated landfill wastewater (see Chapter 6). The Agency also used the facility's baseline flow rate and the regulatory option long-term averages in the design of the unit operation. Certain parameters such as BOD_5, TSS, and ammonia are used directly in the WWC model and the design-criteria guideline spreadsheet to design the various treatment unit operations. EPA selected metals that were included as pollutants of interest to assist in the design of chemical precipitation systems. The metals to be treated typically control the type and amount of precipitating agents, which govern the chemical feed system design. A more detailed discussion of the design parameters and costs associated with individual treatment technologies is presented in Section 9.3.

The design parameters from the design-criteria spreadsheet then were input in the WWC model to generate installed capital and O&M costs. O&M costs for treatment chemicals, labor, materials, electricity, and fuel are included in the WWC model O&M costs. Treatment costs developed using the WWC model were corrected to 1992 dollars using the Engineering News Record published indexes. After EPA developed the installed capital and annual O&M costs for each facility, it applied selected cost factors, as shown in Table 9-4, to the results to develop total capital and O&M costs.

To complete the estimation of compliance costs for each regulatory option, EPA developed cost estimates for other than treatment component costs. The assessment must take into account other costs associated

with compliance with the effluent limitations guidelines and standards, including the following:

- land,
- residual disposal,
- RCRA permit modifications, and
- monitoring.

Each of these additional costs are further discussed and defined in the following sections.

The Agency developed final capital costs for each facility and then amortized them using a seven percent interest rate over 15 years. EPA the added this annualized capital cost to the annual O&M cost to develop a total annual cost for each regulatory option.

9.2.1.1 Retrofit Costs

EPA applied a retrofit cost factor when additional equipment or processes were required for existing systems. Retrofit costs cover the need for system modifications and components, such as piping, valves, controls, etc., that are necessary to connect new treatment units and processes to an existing treatment facility. EPA estimated retrofit costs at 20 percent of the installed capital cost of the equipment.

9.2.2 Land Costs

EPA did not include land costs in this analysis because it determined that landfills have adequate land to accommodate additional treatment systems. Typically, the size of the required treatment system is small when compared to the land area occupied by landfills. Landfills, as required by regulation and permit, have buffer zones around the fill areas. New treatment systems, or upgrades to an existing system, can be installed readily in this buffer zone or elsewhere at the landfill without the need to acquire new land.

9.2.3 Residual Disposal Costs

For each of the proposed treatment system additions or upgrades, EPA estimated a cost for residual disposal. The Agency used two approaches: the first addressed facilities with current sludge-handling

capabilities, while the second addressed facilities without current sludge handling capabilities. EPA prepared residual disposal costs on an annualized basis and added to the total O&M costs.

For facilities with sludge-handling capabilities, EPA evaluated the present solids treatment/dewatering system to determine if it was capable of handling the additional sludge expected to be produced under a particular regulatory option. For facilities with insufficient capacity to handle the additional solids loadings, EPA developed upgrade costs for sludge conditioning and dewatering to account for the additional solids. For facilities with sufficient solids treatment capability, the Agency did not provide additional sludge-treatment costs. For facilities without installed sludge conditioning and dewatering facilities, EPA developed cost estimates for a sludge conditioning and dewatering systems.

Dewatered sludge is assumed to be disposed of on-site in the landfill. EPA's cost estimate also includes the costs associated with the handling and transportation of the sludge to the on-site landfill.

9.2.4 Monitoring Costs

EPA developed costs for the monitoring of treatment system effluent for direct dischargers. The Agency based the costs upon the following assumptions:

- Monitoring costs are based on the number of outfalls through which leachate/ground water is discharged. The costs associated with a single outfall is multiplied by the total number of outfalls to arrive at the total cost for a facility. Monitoring costs estimated by EPA are incremental to the costs already incurred by the facility.

- The capital costs for flow-monitoring equipment are included in EPA's estimates.

- Sample-collection costs (equipment and labor) and sample shipment costs are not included in EPA's estimates because EPA assumes that the facility is already conducting these activities as part of its current permit requirements.

Based upon a review of current monitoring practices at landfills, many conventional and nonconventional parameters, as well as several metals, are already being monitored on a routine basis. EPA developed monitoring costs based upon BOD_5 and TSS monitoring 20 times per month and weekly monitoring of ammonia and other toxic and nonconventional pollutants. In general, these frequencies are higher than currently required. Table 9-5 presents the monitoring cost per sample for the landfill facilities.

9.2.5 Off-Site Disposal Costs

EPA evaluated whether it would be more cost effective for small-flow facilities to have their landfill wastewater hauled off site and treated at a centralized waste treatment facility, as opposed to on-site treatment. EPA compared total annual costs for new or upgraded wastewater treatment facilities to the costs for off-site treatment at a centralized waste treatment facility. Off-site disposal costs were estimated at $0.25 per gallon of wastewater treated. EPA added transportation costs to the off-site treatment costs at a rate of $3.00 per loaded mile using an average distance of 250 miles to the treatment facility. The Agency based transportation costs upon the use of a 5,000-gallon tanker truck load. Facilities that treat their wastewater off site are considered zero or alternative dischargers and, hence, do not incur ancillary costs such as residual disposal, monitoring and permit modifications. EPA then used the lower of the two costs for either on-site or off-site treatment. Table 9-6 presents the facilities that EPA costed using off-site treatment.

9.3 Development of Cost Estimates for Individual Treatment Technologies

In Chapter 8, EPA identified and described the wastewater control and treatment technologies used in the Landfills industry. The following sections describe how EPA developed cost estimates for each of the treatment technologies used in the regulatory options. Specific assumptions regarding the equipment used, flow ranges, input and design parameters, design, and cost calculations are discussed for each treatment technology. Table 9-3, previously referenced, presented the method used to estimate costs for each of treatment technologies used in the BPT, BCT, and BAT options. Table 9-7 presents a summary of the

cost-estimation techniques for each treatment technology for the BPT, BCT, and BAT regulatory options, including the WWC treatment module numbers.

To facilitate the costing of many facilities, EPA developed capital and O&M cost curves for specific technologies and system components. The Agency developed these curves, which represent cost as a function of flow rate or other system design parameters, using a commercial statistical software package (Slidewrite Plus Version 2.1). First, EPA developed costs using the WWC model for each technology or component using, as a design basis, five different flow rates or other system design parameters (depending upon the governing design-parameter). For instance, a technology costed on the basis of flow would have costs estimated using the WWC model at 0.01 million gallons per day (MGD), 0.05 MGD, 0.1 MGD, 0.5 MGD, and 1.0 MGD. EPA based the ranges for the five selected points upon a review of the flow- or technology-design parameters for landfill facilities and selected them to represent the range from low to high. Next, EPA entered these five data points (flow/design parameter and associated cost) into a commercial statistical software program. EPA developed cost curves to model the total capital and O&M costs by the program using curve fitting routines. EPA used a second-order natural-log equation format to develop all curves. All cost curves yielded total capital and O&M costs, unless otherwise noted.

9.3.1 Equalization

EPA conducted a review of questionnaire responses to determine the typical hydraulic detention time for equalization. Based upon of review of industry-furnished data, EPA selected a detention time of 48 hours.

EPA based equalization costs developed for each regulatory option on published price quotes for storage tanks. These costs were taken from the 1996 Environmental Restoration Unit Cost Book published by R.S. Means, Inc. EPA developed a cost curve as a function of flow from these tank quotes. The Agency based construction costs upon published data for an above-ground circular steel tank. EPA also included additional costs associated with a wastewater pumping system and diffused aeration to provide sufficient

mixing of tank contents to prohibit settling. The capital cost curve developed for equalization is presented as Equation 9-1 and is graphically presented in Figure 9-2.

Capital Costs

$$\ln(Y) = 15.177382 + 1.981547\ln(X) + 0.15768\ln(X)^2 \quad (9\text{-}1)$$

where:

X = Flow Rate (MGD), and

Y = Capital Cost (1992 $)

The O&M cost for the equation was taken as a function of the capital cost and is based upon 10 percent of the total capital cost per year.

9.3.2 Flocculation

EPA developed a cost curve for flocculation using WWC unit process 72. Costs for flocculation were a function of flow at a hydraulic detention time of 20 minutes. The capital and O&M cost curves developed for flocculation are presented below as Equations 9-2 and 9-3:

Capital Costs

$$\ln(Y) = 11.744579 + 0.633178\ln(X) - 0.015585\ln(X)^2 \quad (9\text{-}2)$$

O&M Costs

$$\ln(Y) = 8.817304 + 0.533382\ln(X) + 0.002427\ln(X)^2 \quad (9\text{-}3)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-3 and 9-4 graphically present the flocculation capital and O&M cost curves, respectively.

EPA based cost estimates for flocculation basins on rectangular-shaped, reinforced concrete structures with a depth of 12 feet and length-to-width ratio of 4:1. The Agency used common wall construction where the total basin volume exceeded 12,500 cubic feet. Vertical-turbine flocculators have higher structural costs than horizontal paddle flocculators because they require structural support above the basin. Horizontal paddles are less expensive and more efficient for use in larger basins, particularly when tapered flocculation is practiced. EPA based manufactured equipment costs on a G value 80 (G is the mean temporal velocity gradient that describes the degree of mixing; i.e., the greater the value of G the greater the degree of mixing). EPA based cost estimates for drive units on variable speed drives for maximum flexibility and, although common drives for two or more parallel basins are often utilized, EPA based the costs on individual drives for each basin.

Energy requirements are based on a G value 80 and an overall motor/mechanism efficiency of 60 percent. The Agency based labor requirements on routine operation and maintenance of 15 minutes/day/basin (maximum basin volume 12,500 cubic ft.) and a 4-hour oil change every 6 months.

9.3.3 Chemical Feed Systems

The following section presents the methodology used to calculate the chemical-addition feed rates used with each applicable regulatory option. Table 9-8 is a breakdown of the design process used for each type of chemical feed. Chemical costs were taken from the September 1992 Chemical Marketing Reporter and are presented in Table 9-9.

For facilities with existing chemical precipitation systems, EPA evaluated the system to determine if it was achieving the regulatory option long-term averages. If the existing system was achieving long-term averages, no additional chemical costs were necessary. However, if the facility was not achieving the long-term averages for an option, EPA estimated costs for an upgrade to the chemical precipitation system.

First, EPA determined the stoichiometric requirements to remove each metal pollutant of interest to the long-term average level. If the current feed rates were within the calculated feed rates, no additional costs were calculated. For facilities currently feeding less than the calculated amounts, EPA estimated costs for an upgrade to add additional precipitation chemicals, such as a coagulant, or expand their existing chemical feed system to accommodate larger dosage rates.

EPA costed facilities without an installed chemical precipitation system for an entire metals precipitation system. The Agency based the chemical feed rates used at a particular facility for either an upgrade or a new system upon stoichiometric requirements, pH adjustments, and the buffering ability of the raw influent.

In the CWT industry guideline, EPA determined that the stoichiometric requirements for chemical addition far outweighed the pH and buffer requirements. EPA determined that 150 percent of the stoichiometric requirement would sufficiently account for pH adjustment and buffering of the solution. The Agency included an additional 50 percent of the stoichiometric requirement to react with metals not on the pollutant of interest list. Finally, EPA added an additional 10 percent increase from the stoichiometric amount as excess. A total of 210 percent of the stoichiometric requirement was estimated when calculating costs for chemical addition systems.

<u>Sodium Hydroxide Feed Systems</u>

The stoichiometric requirement for either lime or hydroxide to remove a particular metal is based upon the following generic equation:

$$lb_{treatment\ chemical} = \left(\frac{lb_{M\ removed}}{year}\right)\left(\frac{valence_M}{MW_M}\right)\left(\frac{MW_{treatment\ chemical}}{valence_{Na/Ca}}\right)$$

where, M is the target metal and MW is the molecular weight.

The calculated amounts of sodium hydroxide to remove a pound of each of the selected metal pollutants of concern are presented in Table 9-10.

EPA developed sodium hydroxide chemical feed system costs for many facilities using the WWC model. The Agency used reported facility loadings to establish the sodium hydroxide dosage requirement. WWC unit process 45 was used to develop capital and O&M costs for sodium hydroxide feed systems. The capital and O&M cost curves developed for sodium hydroxide feed systems based upon the calculated dosage are presented as Equations 9-4 and 9-5, respectively.

<u>Capital Costs</u>

$$\ln(Y) = 10.653 - 0.184\ln(X) + 0.040\ln(X)^2 \qquad (9\text{-}4)$$

<u>O&M Costs</u>

$$\ln(Y) = 8.508 - 0.0464\ln(X) + 0.014\ln(X)^2 \qquad (9\text{-}5)$$

where:

X = Dosage Rate (lb/day), and

Y = Cost (1992 $)

Figures 9-5 and 9-6 graphically present the sodium hydroxide feed system capital and O&M cost curves, respectively.

EPA based cost estimates for a sodium hydroxide feed system on WWC unit process 45 for a sodium hydroxide feed rate of between 10 to 10,000 lb/day. EPA based costs on dry sodium hydroxide addition when rates were less than 200 lb/day and on liquid sodium hydroxide when feed rates were higher.

The WWC model assumes that dry sodium hydroxide (98.9 percent pure) is delivered in drums and mixed to a 10 percent solution on site. A volumetric feeder is used to feed sodium hydroxide to one of two tanks: one for mixing the 10 percent solution and one for feeding. Two tanks are necessary for this process because of the slow rate of sodium hydroxide addition due to the high heat of solution. Each tank is equipped with a mixer and a dual-head metering pump, used to convey the 10 percent solution to the point of application. Pipe and valving is required to convey water to the dry sodium hydroxide solution mixing tanks and between the metering pumps and the point of application.

A 50 percent sodium hydroxide solution is purchased premixed and delivered by bulk transport for feed rates greater than 200 lb/day. The 50 percent solution contains 6.38 pounds of sodium hydroxide per gallon and is stored for 15 days in fiberglass reinforced polyester (FRP) tanks. Dual-head metering pumps are used to convey the liquid solution to the point of application, and a standby metering pump is provided in all systems. The storage tanks are located indoors, since 50 percent sodium hydroxide begins to crystallize at temperatures below 54EF.

Phosphoric Acid Feed Systems

In the Subtitle C Hazardous subcategory, phosphoric acid is necessary to neutralize the waste stream and to provide phosphorus to biological treatment systems.

EPA costed the phosphoric acid feed system using the WWC unit process 46. EPA determined that the amount of phosphoric acid necessary to provide nutrient phosphorus was the controlling factor over the amount required for pH adjustment. EPA used a ratio of BOD_5 removed to the amount of phosphorus present in the influent waste stream (100 pounds BOD_5 removed to one pound phosphorus) to determine the amount of phosphoric acid to be added as a nutrient feed to a biological treatment system. To allow for solution buffering, 10 percent excess phosphoric acid was added. The capital and O&M cost curves developed for phosphoric acid feed systems based upon the calculated dosage are presented as Equations 9-6 and 9-7, respectively.

Capital Costs

$$\ln(Y) = 10.042 - 0.155\ln(X) + 0.049\ln(X)^2 \quad (9\text{-}6)$$

O&M Costs

$$\ln(Y) = 7.772 - 0.086\ln(X) + 0.041\ln(X)^2 \quad (9\text{-}7)$$

where:

X = Dosage Rate (gpd), and

Y = Cost (1992 $)

Figures 9-7 and 9-8 graphically present the phosphoric acid feed system capital and O&M cost curves, respectively.

EPA based costs on systems capable of metering 93 percent concentrated acid from a storage tank directly to the point of application. For feed rates up to 200 gpd, the concentrated acid is delivered in drums and stored indoors. At higher flow rates, the acid is delivered in bulk and stored outdoors in FRP tanks. Phosphoric acid is stored for 15 days and a standby metering pump is included for all installations.

Polymer Feed Systems

EPA used WWC unit process 34 to cost for polymer feed systems based upon a dosage rate of 2 mg/L. Although this module estimates costs for a liquid alum feed system, EPA determined that the costs generated by this module were more reasonable and accurate in developing polymer system costs than the WWC unit process 43 for polymer feed systems. The capital and O&M unloaded cost curves developed for polymer feed systems are presented as Equations 9-8 and 9-9, respectively.

Capital Costs

$$\ln(Y) = 10.539595 - 0.13771\ln(X) + 0.052403\ln(X)^2 \quad (9\text{-}8)$$

O&M Costs

$$\ln(Y) = 9.900596 + 0.99703\ln(X) + 0.00019\ln(X)^2 \quad (9\text{-}9)$$

where:

X = Dosage Rate (lb/hr), and

Y = Cost (1992 $)

Figures 9-9 and 9-10 graphically present the polymer feed system capital and O&M cost curves, respectively.

Polymer is stored for 15 days in fiberglass-reinforced polyester tanks. For smaller installations, the tanks are located indoors and left uncovered and, for larger installations, the tanks are covered and vented, with insulation and heating provided. Dual-head metering pumps deliver the polymer from the storage tank and meters the flow to the point of application. Feed costs include 150 feet of 316 stainless steel pipe, along with fittings and valves for each metering pump. A standby metering pump is included for each installation.

9.3.4 Primary Clarification

EPA developed cost curves for primary clarification using WWC unit process 118 for a rectangular basin with a 12 foot side wall depth. EPA based costs for primary clarification upon a function of flow at an overflow rate of 900 gallons per day per square feet tank size. The capital and O&M cost curves developed for primary clarification are presented as Equations 9-10 and 9-11, respectively.

Capital Costs

$$\ln(Y) = 12.517967 + 0.575652\ln(X) + 0.009396\ln(X)^2 \quad (9\text{-}10)$$

O&M Costs

$$\ln(Y) = 10.011664 + 0.268272\ln(X) + 0.00241\ln(X)^2 \quad (9\text{-}11)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-11 and 9-12 graphically present the primary clarification capital and O&M cost curves, respectively.

EPA based estimated costs on rectangular basins with a 12 feet side water depth (SWD) and chain-and-flight sludge collectors. Costs for the structure assumed multiple units with common wall construction and include the chain-and-flight collector, collector drive mechanism, weirs, the reinforced concrete structure complete with inlet and outlet troughs, a sludge sump, and sludge-withdrawal piping. Yard piping to and from the clarifier is not included in the cost estimates.

9.3.5 Activated Sludge Biological Treatment

EPA based costs for biological treatment systems using the activated sludge process using the WWC unit process 18 for a rectangular aeration basin with an 10 foot SWD. EPA determined basin size using a 24 hour hydraulic detention time using Equation 9-12.

$$X = ((24 \text{ Hours} \times 3600) \times (Z))/1{,}000 \qquad (9\text{-}12)$$

where:

X = Basin Volume (1,000 cu ft)

Z = Flow Rate (cfs)

The WWC model assumes zero O&M costs for the aeration basins only. The unloaded (without engineering cost factors applied) capital cost curve developed for aeration basins with an 10 foot SWD is presented as Equation 9-13.

$$\ln(Y) = -1.033901 + 3.722693\ln(X) - 0.197016\ln(X)^2 \quad (9\text{-}13)$$

where:

X = Basin Volume (in thousands of cubic feet), and

Y = Capital Cost (1992 $)

Figure 9-13 graphically presents the aeration basin capital cost curve.

Aeration using diffused air was costed for the basin using WWC unit process 26 and reported facility loading conditions. EPA calculated aeration requirements using the facility BOD_5 and ammonia loadings using Equation 9-14.

$$X = ((A + B)/0.075 \times C \times 0.232 \times 1440)/1{,}000 \quad (9\text{-}14)$$

where:

X = Air Requirement (1,000 standard cubic feet per minute [scfm])

A = BOD_5 to Aeration Basin (lb/day) based on 1.8 lb O_2 /lb BOD_5 influent

B = Ammonia to Aeration Basin (lb/day) based on 4.6 lb O_2/lb ammonia influent

C = Transfer Efficiency at 9 percent

The unloaded capital and O&M cost curves developed for air diffusion systems are presented as Equations 9-15 and 9-16, respectively.

<u>Capital Costs</u>

$$\ln(Y) = 11.034417 + 0.992985\ln(X) - 0.002521\ln(X)^2 \quad (9\text{-}15)$$

O&M Costs

$$\ln(Y) = 9.497546 + 0.549715\ln(X) - 0.004216\ln(X)^2 \quad (9\text{-}16)$$

where:

X = Air Requirement (1,000 scfm), and

Y = Cost (1992 $)

Figures 9-14 and 9-15 graphically present the air diffusion system capital and O&M cost curves, respectively.

The costs for aeration basins include all equipment, piping, electrical, and labor for installation. The air-supply system costs include piping from air source to aeration basin, blowers, controls, and housing. Aeration-basin cost estimates include excavation, concrete walkways, in-basin process piping, and handrails and attendant costs, but excludes the cost of aeration equipment, electrical and instrumentation work. EPA considered providing for heated aeration basins for facilities located in cold-weather climates. Based upon data collected by EPA, biological treatment of landfill generated wastewater was not adversely affected by climate conditions.

9.3.6 Secondary Clarification

EPA developed cost curves for secondary clarification using WWC unit process 118 for a rectangular basin with a 12 foot side wall depth with chain-and-flight collectors. EPA based costs for secondary clarification upon a function of flow, at an overflow rate of 900 gallons per day per square feet tank size. The capital and O&M cost curves developed for secondary clarification are presented as Equations 9-17 and 9-18, respectively.

Capital Costs

$$\ln(Y) = 12.834601 + 0.688675\ln(X) + 0.035432\ln(X)^2 \quad (9\text{-}17)$$

O&M Costs

$$\ln(Y) = 10.197762 + 0.339952\ln(X) + 0.015822\ln(X)^2 \quad (9\text{-}18)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-16 and 9-17 graphically present the secondary clarification capital and O&M cost curves, respectively.

Costs for the structure assumed multiple units with common wall construction, and include the chain-and-flight collector, collector drive mechanism, weirs, the reinforced concrete structure, complete with inlet and outlet troughs, a sludge sump, and sludge-withdrawal piping. Yard piping to and from the clarifier is not included in the cost estimates.

9.3.7 Multimedia Filtration

EPA developed cost curves as a function of flow rate for a multimedia filtration system using vendor-supplied quotes. The Agency developed cost curves as part of the CWT effluent guidelines effort. The capital and O&M cost curves developed for multimedia filtration are presented as Equations 9-19 and 9-20, respectively.

Capital Costs

$$\ln(Y) = 12.265 + 0.658\ln(X) + 0.036\ln(X)^2 \quad (9\text{-}19)$$

O&M Costs

$$\ln(Y) = 10.851 + 0.168\ln(X) + 0.018\ln(X)^2 \quad (9\text{-}20)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-18 and 9-19 graphically present the multimedia filtration capital and O&M cost curves, respectively.

The total capital costs for the multimedia filtration systems represent equipment and installation costs. The total construction cost includes the costs of the filter, instrumentation and controls, pumps, piping, and installation. The operation and maintenance costs include energy usage, maintenance, labor, and taxes and insurance. Energy costs include electricity to run the pumps, lighting, and instrumentation and controls. The labor requirement for the multimedia filtration system was four hours per day.

9.3.8 Reverse Osmosis

EPA developed capital and O&M cost curves as a function of flow rate for reverse osmosis treatment using vendor supplied quotes. EPA based costs on one single-pass system using disk tube module technology. The capital cost curve developed for reverse osmosis is presented as Equation 9-21.

$$\ln(Y) = 14.904 - 0.0142\ln(X) - 0.0687\ln(X)^2 \qquad (9\text{-}21)$$

where:

X = Flow Rate (MGD), and

Y = Capital Cost (1992 $)

Figure 9-20 graphically presents the reverse osmosis capital-cost curves. Based upon vendor supplied costs, O&M costs were taken at $0.02/gallon.

Costs for a standard reverse osmosis system generally include the following components: filter booster pump, sand or carbon filter, cartridge filter, high-pressure pump and control system, reverse osmosis module permeators, pure water deacidification filter, in-built closed circuit cleaning system, automatic pure water membrane flushing system, power and control system with microprocessor, full instrumentation and measurement equipment, comprehensive fail-safe system, fault indication, and modular skid frame construction. The costs did not take into account the following optional equipment: main raw-water supply pump, pure water tank and distribution pump, chlorine dosing system, ultra-violet disinfection system, containerized/mobile systems, self-contained power supply, and anti-magnetic systems.

9.3.9 Sludge Dewatering

EPA based costs estimated for sludge dewatering upon sludge-drying beds. EPA costed each facility separately using the WWC unit process 128. EPA based the required bed area upon influent characteristics at a loading of 15 gallons per day of sludge per square foot bed area. EPA calculated drying bed area using Equation 9-22.

$$X = (A \times 365)/B \qquad (9\text{-}22)$$

where:

X = Area (sq ft)

A = Total Dry Solids (lb/day) based on 0.8 lb solids/lb BOD_5 influent

B = 15 lb per year sludge/sq ft

The unloaded capital and O&M cost curves developed for sludge-drying beds are presented as Equations 9-23 and 9-24, respectively.

<u>Capital Costs</u>

$$\ln(Y) = 4.488639 + 0.716471\ln(X) + 0.000005311\ln(X)^2 \qquad (9\text{-}23)$$

O&M Costs

$$\ln(Y) = 6.95049 + 0.33155\ln(X) + 0.002882\ln(X)^2 \quad (9\text{-}24)$$

where:

X = Area (sq ft), and

Y = Cost (1992 $)

Figures 9-21 and 9-22 graphically present the sludge-drying bed capital and O&M cost curves, respectively.

Included in the costs are sludge-distribution piping, nine inches of sand media overlying nine inches of gravel media, two foot concrete dividers between beds, and an underdrain system to remove percolating water. EPA excluded land costs from the cost estimates.

Energy requirements are based on the following: a front-end loader to remove dried sludge from the beds and prepare the bed for the next sludge application, cleaning and preparation time of 3 hours for a 4,000 square foot bed, diesel fuel consumption of 4 gallons per hour, and 20 cleanings/bed/year.

9.3.10 Granular Activated Carbon

EPA developed cost curves as a function of flow rate for a granular activated carbon (GAC) system using vendor-supplied quotes. EPA estimated the capital and O&M costs for GAC using the "Power Plant Wastewater Treatment Technology Review Report", Electric Power Research Institute (EPRI), November 1996, Exhibits A3-1 and D3-1, respectively, and supplemented using "Technologies and Costs for Removal of Arsenic from Drinking Water", Office of Ground Water and Drinking Water, EPA, Draft July 1998. The capital and O&M cost curves developed for GAC adsorption are presented as Equations 9-25 and 9-26, respectively.

Capital Costs

$$\ln(Y) = 12.772 + 0.457\ln(X) - 0.025\ln(X)^2 \quad (9\text{-}25)$$

O&M Costs

$$\ln(Y) = 9.691 - 0.224\ln(X) - 0.041\ln(X)^2 \quad (9\text{-}26)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-23 and 9-24 graphically present the GAC adsorption capital and O&M cost curves, respectively.

The total capital costs for the GAC systems represent equipment and installation costs. The total construction cost includes the costs of the GAC, instrumentation and controls, pumps, piping, and installation. The operation and maintenance costs include carbon replacement/disposal, energy usage, maintenance, labor, and taxes and insurance. Energy costs include electricity to run the pumps, lighting, and instrumentation and controls. The labor requirement for the GAC system was four hours per day.

9.3.11 Breakpoint Chlorination

EPA developed cost curves as a function of flow rate for a breakpoint chlorination system using vendor-supplied quotes. EPA extrapolated cost estimates for breakpoint chlorination from data supplied by the EPA Office of Ground Water and Drinking Water report. The capital and O&M cost curves developed for a breakpoint chlorination system are presented as Equations 9-27 and 9-28, respectively.

Capital Costs

$$\ln(Y) = 12.219 + 0.051\ln(X) - 0.045\ln(X)^2 \quad (9\text{-}27)$$

O&M Costs

$$\ln(Y) = 12.881 + 0.923\ln(X) + 0.053\ln(X)^2 \quad (9\text{-}28)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-25 and 9-26 graphically present the breakpoint chlorination capital and O&M cost curves, respectively.

The total capital costs for the breakpoint chlorination systems represent equipment and installation costs. The total construction cost includes the costs of the chlorine addition unit, instrumentation and controls, pumps, piping, and installation. The operation and maintenance costs include chemical usage, energy usage, maintenance, labor, and taxes and insurance. Energy costs include electricity to run the pumps, lighting, and instrumentation and controls. The labor requirement for the breakpoint chlorination system was four hours per day.

9.4 Costs for Regulatory Options

The following sections present the costs estimated for compliance with the BPT/ BCT/BAT and NSPS effluent limitations guidelines and standards for the Subtitle D Non-Hazardous and Subtitle C Hazardous subcategories. Costs for each of the regulatory options are presented below for only the facilities in the 308 Questionnaire database, as well as for all of the facilities in the Landfills industry based on national estimates (see Chapter 3, Section 3.2.1 for an explanation of national estimates). All costs estimates in this section are expressed in terms of 1992 dollars, unless otherwise noted.

9.4.1 Facility Selection

EPA evaluated each of the 220 Detailed Questionnaires that were returned with sufficient technical and

economic data to determine if the facility would be subject to the final limitations and standards and would, therefore, incur costs as a result of the regulation. EPA determined that 94 of the 220 facilities would not incur costs because of the following reasons:

- 49 facilities indicated that they were zero or alternative discharge
- 40 facilities were operated in conjunction with other industrial or commercial operations and EPA determined that the rule was not applicable to these facilities
- 5 respondents did not generate in-scope wastewater.

EPA calculated costs for each of the remaining 126 facilities and then modeled the national population by using statistically-calculated survey weights. EPA projected the landfill industry costs (presented below) for several technology options based on costs developed for 123 Subtitle D and 3 Subtitle C facilities.

9.4.2 BPT Regulatory Costs

EPA developed preliminary cost-effectiveness analyses using interim costing-rounds to select BPT regulatory options. The BPT costs for each subcategory are presented below.

9.4.2.1 Subtitle D Non-Hazardous Subcategory BPT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle D Non-Hazardous subcategory, EPA evaluated two options,BPT Options I and II.

BPT Option I: Equalization and activated sludge biological treatment with secondary clarification, and sludge-dewatering. For the facilities in the 308 Questionnaire database, Table 9-11 presents the total capital ($2,737,104) and annual O&M costs ($838,579) for this option, as well as the total amortized annual cost for each facility. Based on national estimates, BPT Option I for the Subtitle D Non-Hazardous subcategory is estimated to have total annualized pre-tax costs of $7.30 million (based on 1998 dollars).

BPT Option II: Equalization, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. For the facilities in the 308 Questionnaire database, Table 9-12 presents the total capital ($3,252,453) and annual O&M ($1,027,788) costs for this option, as well as the total amortized annual cost for each facility. Based on national estimates, BPT Option II for the Subtitle D Non-Hazardous subcategory is estimated to have total annualized pre-tax and post-tax costs of $8.57 and $7.64 million (based on 1998 dollars), respectively.

9.4.2.2 Subtitle C Hazardous Subcategory BPT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one BPT option, BPT Option I.

BPT Option I: Equalization, chemical precipitation, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. Since EPA did not identify any direct discharge facilities in the Subtitle C Hazardous subcategory database, there are no costs associated with this option.

9.4.3 BCT Regulatory Costs

EPA developed preliminary cost-effectiveness analyses using interim costing-rounds to select BCT regulatory options. The BCT costs for each subcategory are presented below.

9.4.3.1 Subtitle D Non-Hazardous Subcategory BCT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle D Non-Hazardous subcategory, EPA evaluated two options, BCT Option I and II.

BCT Option I: Equalization and activated sludge biological treatment with secondary clarification, and sludge-dewatering. This option is equivalent to BPT Option I for the Non-Hazardous subcategory with costs previously provided in Section 9.4.2.1 above.

BCT Option II: Equalization, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. This option is equivalent to BPT Option II for the Non-Hazardous subcategory with costs previously provided in Section 9.4.2.1 above.

9.4.3.2 Subtitle C Hazardous Subcategory BCT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one option, BCT Option I.

BCT Option I: Equalization, chemical precipitation, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. This option is equivalent to BPT Option I for the Subtitle C Hazardous subcategory and, therefore, has no associated costs.

9.4.4 BAT Regulatory Costs

EPA developed preliminary cost-effectiveness analyses using interim costing-rounds to select BAT regulatory options. The BAT costs for each subcategory are presented below.

9.4.4.1 Subtitle D Non-Hazardous Subcategory BAT Costs

EPA costed three BAT options for the Subtitle D Non-Hazardous subcategory: BAT Options I, II and III.

BAT Option I: Equalization and activated sludge biological treatment with secondary clarification, and sludge-dewatering. This option is equivalent to BPT Option I for the Non-Hazardous subcategory with costs previously provided in Section 9.4.2.1 above.

BAT Option II: Equalization, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. This option is equivalent to BPT Option II for the Non-Hazardous subcategory with costs previously provided in Section 9.4.2.1 above.

BAT Option III: Equalization, activated sludge biological treatment, multimedia filtration, and reverse osmosis with sludge-dewatering. For facilities in the 308 Questionnaire database, Table 9-13 presents the total capital ($34,518,089) and annual O&M ($5,896,531) costs for this option as well as the total amortized annual cost for each facility. Based on national estimates, BAT Option III for the Subtitle D Non-Hazardous subcategory is estimated to have a total annualized pre-tax cost of $45.95 million (based on 1998 dollars).

9.4.4.2 Subtitle C Hazardous Subcategory BAT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one BAT option, BPT Option I.

BAT Option I: Equalization, chemical precipitation, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. This option is equivalent to BPT Option I for the Hazardous subcategory and, therefore, has no associated costs.

9.4.5 NSPS Regulatory Costs

EPA developed preliminary cost-effectiveness analyses using interim costing-rounds to select NSPS regulatory options. The NSPS costs for each subcategory are presented below.

9.4.5.1 Subtitle D Non-Hazardous Subcategory NSPS Costs

EPA is establishing NSPS for the Subtitle D Non-Hazardous subcategory to be equivalent to the limitations established for BPT Option II for this subcategory, which also is the basis for BCT and BAT.

NSPS: Equalization, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. The total NSPS annual cost for the Non-Hazardous subcategory is $52,755 assuming an average facility flow of 10,000 gpd.

9.4.5.2 Subtitle C Hazardous Subcategory NSPS Costs

EPA is establishing NSPS for the Subtitle C Hazardous subcategory to be equivalent to the limitations established for BPT Option I for this subcategory, which also is the basis for BCT and BAT.

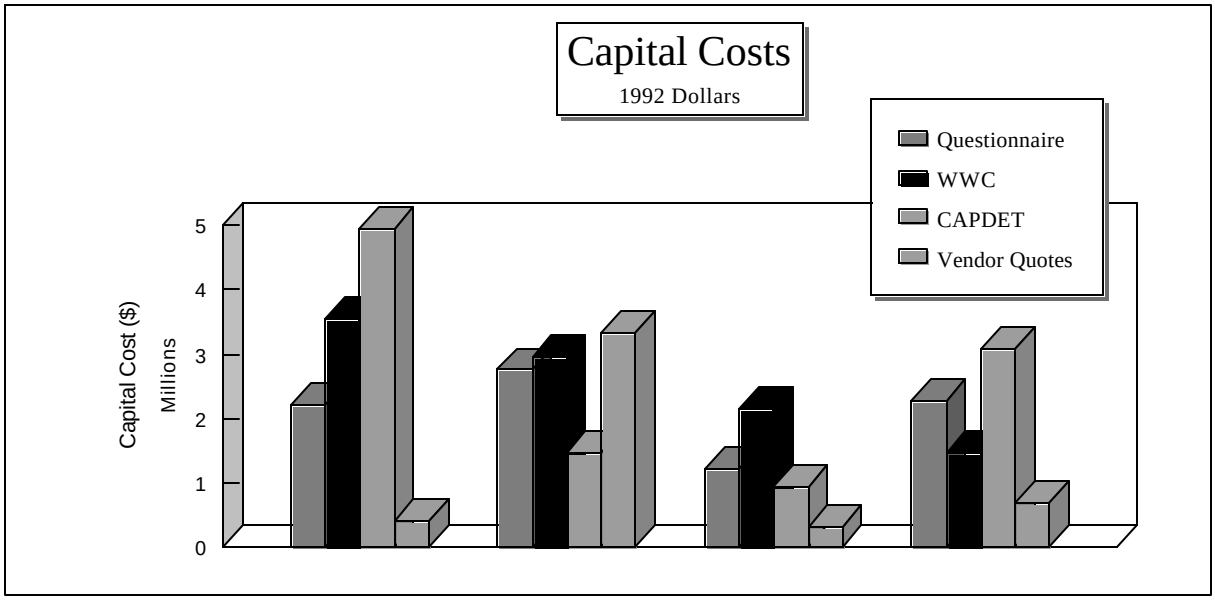
NSPS: Equalization, chemical precipitation, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. The total NSPS annual cost for the Hazardous subcategory is $132,031 assuming an average facility flow of 10,000 gpd.

Table 9-1: Cost Comparison

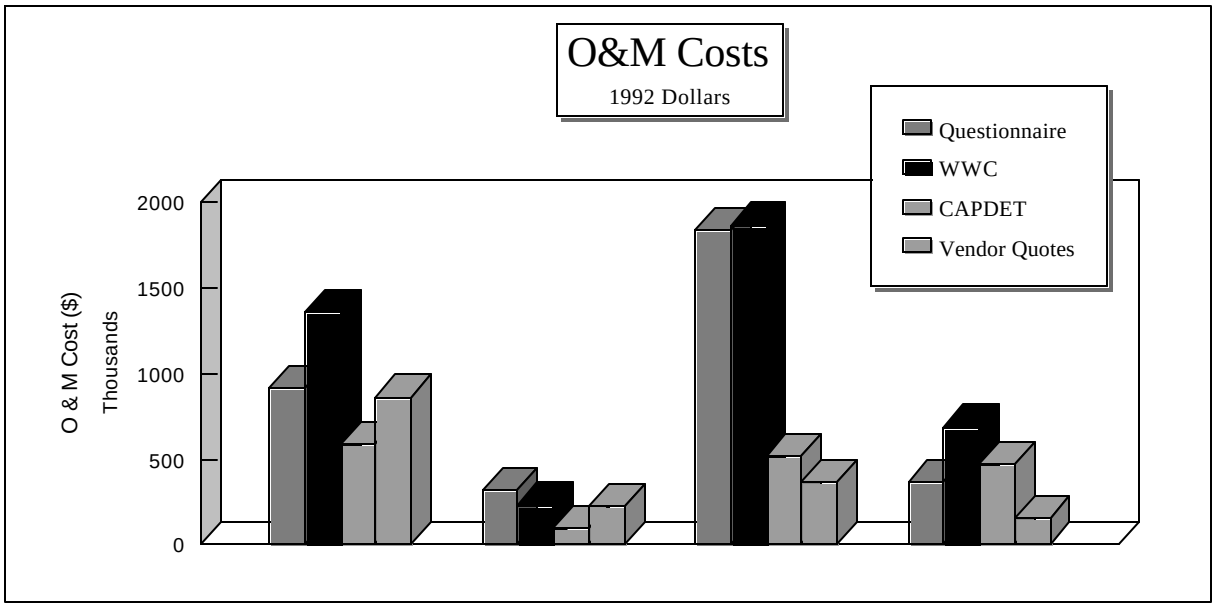
Facility QID	Treatment Train	CAPDET Computer Run		WWC Engineering Software		Vendor Quotes		Questionnaire Responses	
		Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs
16122	Chemical Precipitation	$232,366	$178,773	$190,308	$41,883	$177,504	$163,397	NA	$22,858
	Above+Anaerobic&Aerobic Bio	$1,217,370	$353,181	$836,433	$79,898	$794,343	$305,669	NA	$133,314
	Above+2nd Chemical Precipitation	$1,449,732	$587,637	$908,201	$91,295	$971,847	$469,066	NA	$133,872
	Above+Equalization+Multimedia Filter	$1,517,811	$715,088	$1,573,621	$91,295	$1,553,010	$543,840	NA	$133,872
	Equalization	$58,478	$69,475	$692,252	$1,997	$526,532	$36,442	NA	$3,388
	Entire Treatment Train	$1,576,289	$784,563	$2,782,188	$317,747	$2,154,117	$586,240	$4,113,628	$311,400
16125	Equalization+Air Stripping	$57,717	$61,556	$394,570	$20,718	$243,800	$54,147	$588,714	$8,247
	Chemical Precipitation+SBR	$282,073	$255,294	$1,928,245	$103,100	(a)	(a)	$2,067,188	$31,534
	Above+Carbon+Multimedia Filter	$478,266	$460,622	$2,492,431	$145,949	(b)	(b)	$2,534,242	$34,883
16087	Entire Treatment Train	NA	NA	$2,519,307	$816,351	(c)	(c)	$2,423,057	$992,578
16041	SBR+Sludge Equipment	$159,908	$115,066	$2,378,898	$436,879	NA	NA	$6,293,919	$460,050

NA: Not Available
(a): Capital O&M costs without the SBR are $82,675 and $56,972, respectively
(b): Capital O&M costs without the SBR are $140,078 and $106,642, respectively
(c): Capital O&M costs without the activated sludge system and chlorine addition are $189,120 and $100,849, respectively

Table 9-2: Costing Source Comparison



	Chem Precip	Chem Precip and Filtration	Chem Precip	2-stage Chem Precip
Questionnaire	2,206,980	2,751,204	1,214,563	2,265,009
WWC	3,543,264	2,950,035	2,144,446	1,476,821
CAPDET	4,948,779	1,475,480	942,216	3,072,253
Vendor Quotes	399,878	3,314,930	319,206	670,158



	Chem Precip	Chem Precip and Filtration	Chem Precip	2-stage Chem Precip
Questionnaire	910,000	315,000	1,837,000	363,000
WWC	1,355,505	231,728	1,864,219	686,360
CAPDET	585,855	99,036	515,859	466,848
Vendor Quotes	860,867	222,135	361,623	151,889

Table 9-3: Breakdown of Costing Method by Treatment Technology

Treatment Technology	Cost Using WWC Program	Cost Using Vendor Quotes	Key Design Parameter(s)
Equalization		X(a)	Flow rate
Flocculation	X		Flow rate
Chemical Feed System	X		Flow rate & Pollutant of Interest Metals
Primary & Secondary Clarification	X		Flow rate
Activated Sludge	X		Flow rate, BOD_5, & Ammonia
Reverse Osmosis		X	Flow rate
Multimedia Filtration		X(b)	Flow rate
Activated Carbon		X(c)	Flow rate
Breakpoint Chlor.		X(d)	Flow rate
Sludge-Drying Beds	X		Flow rate, TSS & BOD_5

(a) Based upon costs provided in Environmental Restoration Unit Cost Book
(b) Cost curves developed using vendor quotes in the CWT guideline effort
(c) Based upon costs provided in "Power Plant Wastewater Treatment Technology Review Report", Electric Power Research Institute (EPRI), November 1996, Exhibits A3-1 and D3-1, respectively, and supplemented using "Technologies and Costs for Removal of Arsenic from Drinking Water", Office of Ground Water and Drinking Water, EPA, Draft July 1998
(d) Costs were extrapolated from data supplied by the EPA Office of Ground Water and Drinking Water report

Table 9-4: Additional Cost Factors

Type	Factor	Percent of Capital Cost
Capital	Site Work & Interface Piping	18
	General Contractor Overhead	10
	Engineering	12
	Instrumentation & Controls	13
	Buildings	6
	Site Improvements	10
	Legal, Fiscal, & Administrative	2
	Interest During Construction	9
	Contingency	8
	Retrofit (if necessary)	20
O&M	Taxes & Insurance	2[1]

(1) 2 percent of total capital costs, which includes WWC costs and capital costs listed above.

Table 9-5: Analytical Monitoring Costs

Pollutants	Cost/Sample ($)[1]
Subtitle D Non-Hazardous	
Ammonia as N	18.00
BOD_5	15.00
TSS	6.00
Metals & Organics	105.00
Subtitle C Hazardous	
Ammonia as N	18.00
BOD_5	15.00
TSS	6.00
Metals & Volatile/Semi-Volatile Organics	1600.00

(1) Cost based on 1995 analytical laboratory costs adjusted to 1992 dollars.

Table 9-6: Subtitle D Non-Hazardous Facilities Costed for Off-Site Disposal

Facility QID	Flow (gpd)	Off-Site Disposal Cost ($/yr)
16048	5	730
16055	8	1168
16062	50	7300
16139	50	7300
16148	77	11242
16160	137	20002
16250	200	29200

Table 9-7: Unit Process Breakdown by Regulatory Option

Treatment Technology Description	Subcategory		WWC Unit Process #*	WWC Unit Process # Description
	Non-Hazardous	Hazardous		
Equalization & activated sludge	BPT/BCT/BAT Option I		NA 18 26 118 128	equalization aeration basin aeration system secondary clarification sludge dewatering
Equalization, activated sludge & multimedia filtration	BPT/BCT/BAT Option II NSPS		NA 18 26 118 NA 128	equalization aeration basin aeration system secondary clarification multimedia filtration sludge dewatering
Equalization, activated sludge, multimedia filtration & single-stage reverse osmosis	BAT Option III		NA 18 26 118 NA NA 128	equalization aeration basin aeration system secondary clarification multimedia filtration single-stage reverse osmosis sludge dewatering
Equalization, chemical precipitation, activated sludge & multimedia filtration		BPT/BCT/BAT Option I NSPS	NA 72 45 34 118 46 18 26 118 NA 128	equalization flocculation tank sodium hydroxide feed system polymer feed system primary clarification phosphoric acid feed system aeration basin aeration system secondary clarification multimedia filtration sludge dewatering

*NA=Not Applicable-Vendor Quotes Used

Table 9-8: Chemical Addition Design Method

Chemical	Basis for Design	
	Stoichiometry	Reference[1] (mg/L)
Sodium Hydroxide	X	
Polymer		2.0
Phosphoric Acid	X	

(1) From: Industrial Water Pollution Control, 2nd Edition.

Table 9-9: Treatment Chemical Costs

Treatment Chemical	Cost
Sodium Hydroxide	$350/ton
Polymer	$2.25/lb
Phosphoric Acid	$300/ton

Table 9-10: Sodium Hydroxide Requirements for Chemical Precipitation

Pollutant	Dosage Rate Sodium Hydroxide (lb/lb metal removed)
Cadmium	0.71
Chromium, total	2.31
Iron	2.15
Nickel	2.04
Zinc	1.22
Phosphorus	6.46

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory

		CAPITAL COSTS ($)						AMORTIZED	O&M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O&M	ANNUAL COST ($/YR)(b)
16001	0.0793	153,015	2,004	31,004	0	0	186,023	20,424	19,637	4,078	11,540	35,255	55,679
16003	0.00472	0	0	0	0	0	0	0	0	0	0	0	0
16008	0	0	0	0	0	0	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0	0	0	0	0	0
16012	0.00221	0	0	0	0	0	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16016	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16020	0.04581	0	0	0	0	0	0	0	0	0	0	0	0
16023	0.05734	0	0	0	0	0	0	0	0	0	0	0	0
16024	0.00592	0	0	0	0	0	0	0	0	0	0	0	0
16025	0	0	0	0	0	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0	0	0	0	0	0
16038	0.00822	0	0	0	0	0	0	0	0	0	0	0	0
16039	0.00178	0	0	0	0	0	0	0	0	0	0	0	0
16043	0.00218	0	0	0	0	0	0	0	0	0	0	0	0
16044	0	0	0	0	0	0	0	0	0	0	0	0	0
16046	0	0	0	0	0	0	0	0	0	0	0	0	0
16047	0.00115	38,175	2,004	0	0	0	40,179	4,411	8,760	1,917	11,540	22,217	26,628
16048	5E-06	0	0	0	0	0	0	0	0	0	0	0	730
16049	0.0017	35,037	2,004	7,408	0	0	44,449	4,880	8,302	2,208	11,540	22,050	26,930
16050	0.01	58,533	2,004	0	0	0	60,537	6,647	11,672	1,917	11,540	25,129	31,776
16052	0.0546	217,678	5,563	44,648	0	0	267,889	29,413	17,799	6,897	11,072	35,768	65,180
16053	0.00124	39,625	2,004	0	0	0	41,629	4,571	9,002	1,917	11,540	22,459	27,030
16054	0.00075	16,544	2,004	3,710	0	0	22,258	2,444	5,276	1,917	11,357	18,550	20,994
16055	8E-06	0	0	0	0	0	0	0	0	0	0	0	1,168
16056	0.00137	40,636	2,004	0	0	0	42,640	4,682	8,921	1,917	11,540	22,378	27,060
16058	0.003	44,348	2,004	9,270	0	0	55,622	6,107	8,936	1,917	0	10,853	16,960
16059	0.0011	38,017	2,004	0	0	0	40,021	4,394	8,730	1,917	11,540	22,187	26,581
16060	0.0018	43,919	2,004	0	0	0	45,923	5,042	9,178	2,208	11,540	22,926	27,968

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16061	0	0	0	0	0	0	0	0	0	0	0	0	0
16062	0.00005	0	0	0	0	0	0	0	0	0	0	0	7,300
16063	0.0067	75,309	2,004	0	0	0	77,313	8,489	11,152	3,562	11,540	26,254	34,742
16064	0.01197	62,083	2,004	0	0	0	64,087	7,036	12,127	3,931	11,540	27,598	34,634
16065	0.008	71,448	2,004	14,690	0	0	88,143	9,678	10,481	3,231	11,090	24,802	34,480
16068	0	0	0	0	0	0	0	0	0	0	0	0	0
16070	0.00133	0	0	0	0	0	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0	0	0	0	0	0
16072	0	0	0	0	0	0	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0	0	0	0	0	0
16075	0.01021	0	0	0	0	0	0	0	0	0	0	0	0
16076	0	0	0	0	0	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0	0	0	0	0	0
16079	0.11247	344,770	0	68,954	0	0	413,724	45,425	23,219	0	11,180	34,399	79,824
16083	0.001	29,000	2,004	6,201	0	0	37,205	4,085	7,835	1,735	11,540	21,110	25,195
16084	0.00643	0	0	0	0	0	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0	0	0	0	0	0
16090	0.00393	0	0	0	0	0	0	0	0	0	0	0	0
16091	0.2321	0	0	0	0	0	0	0	0	0	0	0	0
16092	0.00668	0	0	0	0	0	0	0	0	0	0	0	0
16093	0.08158	222,598	0	44,520	0	0	267,118	29,328	30,361	0	11,180	41,541	70,869
16097	0.019	0	0	0	0	0	0	0	0	0	10,520	10,520	10,520
16098	0	0	0	0	0	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0	0	0	0	0	0
16102	0.01394	110,824	0	22,165	0	0	132,989	14,602	13,163	0	11,540	24,703	39,304
16103	0.03756	0	0	0	0	0	0	0	0	0	0	0	0
16107	0.00129	0	0	0	0	0	0	0	0	0	0	0	0
16109	0.05056	0	0	0	0	0	0	0	0	0	0	0	0
16111	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16113	0	0	0	0	0	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0	0	0	0	0	0
16115	0.00407	0	0	0	0	0	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0	0	0	0	0	0
16117	0.04	0	0	0	0	0	0	0	0	0	9,908	9,908	9,908

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16118	0.0288	0	0	0	0	0	0	0	0	0	0	0	0
16119	0.00729	13,151	2,004	3,031	0	0	18,186	1,997	2,577	1,948	11,117	15,642	17,639
16120	0.04278	0	0	0	0	0	0	0	0	0	9,200	9,200	9,200
16121	0.08028	0	0	0	0	0	0	0	0	0	0	0	0
16122	0.0255	0	0	0	0	0	0	0	0	0	9,948	9,948	9,948
16123	0.04608	206,903	8,080	42,997	0	0	257,980	28,325	19,430	8,365	11,540	39,335	67,660
16124	0.01666	0	0	0	0	0	0	0	0	0	0	0	0
16125	0.01419	0	0	0	0	0	0	0	0	0	10,712	10,712	10,712
16127	0.00363	48,545	2,004	10,110	0	0	60,659	6,660	9,190	2,756	11,540	23,486	30,146
16128	0.00396	0	0	0	0	0	0	0	0	0	0	0	0
16129	0.00469	0	0	0	0	0	0	0	0	0	11,540	11,540	11,540
16130	0.0003	4,400	2,004	1,281	0	0	7,685	844	10,400	4,078	11,540	26,018	26,862
16131	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16135	0.01149	0	0	0	0	0	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0	0	0	0	0	0
16140	0	0	0	0	0	0	0	0	0	0	0	0	0
16143	0	0	0	0	0	0	0	0	0	0	0	0	0
16144	0	0	0	0	0	0	0	0	0	0	0	0	0
16146	0	0	0	0	0	0	0	0	0	0	0	0	0
16148	0.00008	0	0	0	0	0	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0	0	0	0	0	0
16150	0.04578	0	0	0	0	0	0	0	0	0	0	0	0
16151	0.00205	0	0	0	0	0	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0	0	0	0	0	0
16154	0.01022	0	0	0	0	0	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0	0	0	0	0	0
16158	0.01428	0	0	0	0	0	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0	0	0	0	0	0
16160	0.00014	0	0	0	0	0	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16165	0.03022	0	0	0	0	0	0	0	0	0	0	0	0
16166	0.00342	0	0	0	0	0	0	0	0	0	0	0	0
16169	0	0	0	0	0	0	0	0	0	0	0	0	0
16170	0.0048	55,201	2,004	11,441	0	0	68,647	7,537	9,594	4,078	11,235	24,907	32,444
16171	0.024	0	0	0	0	0	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0	0	0	0	0	0
16176	0.03727	0	0	0	0	0	0	0	0	0	0	0	0
16177	0	0	0	0	0	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0	0	0	0	0	0
16184	0	0	0	0	0	0	0	0	0	0	0	0	0
16185	0	0	0	0	0	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0	0	0	0	0	0
16190	0	0	0	0	0	0	0	0	0	0	0	0	0
16191	0	0	0	0	0	0	0	0	0	0	0	0	0
16193	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16196	0.01223	108,110	11,645	0	0	0	119,755	13,148	14,487	10,115	11,540	36,142	49,290
16197	0	0	0	0	0	0	0	0	0	0	0	0	0
16199	0.0008	0	0	0	0	0	0	0	0	0	0	0	0
16200	0.01142	0	0	0	0	0	0	0	0	0	0	0	0
16201	0.00188	0	0	0	0	0	0	0	0	0	0	0	0
16202	0.01301	0	0	0	0	0	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0	0	0	0	0	0
16206	0.05739	0	0	0	0	0	0	0	0	0	0	0	0
16208	0.00334	0	0	0	0	0	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0	0	0	0	0	0
16212	0.0007	15,300	2,004	0	0	0	17,304	1,900	18,800	1,516	10,500	30,816	32,716
16215	0	0	0	0	0	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0	0	0	0	0	0
16219	0.02544	0	0	0	0	0	0	0	0	0	0	0	0
16220	0.03041	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($) Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	AMORTIZED TOTAL CAPITAL(a) ($/YR)	O & M COSTS ($/YR) Equipment	Solids Handling	Monitoring	Total O & M	TOTAL ANNUAL COST ($/YR)(b)
16221	0.00662	0	0	0	0	0	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0	0	0	0	0	0
16222	0	0	0	0	0	0	0	0	0	0	0	0	0
16223	0.02904	153,000	2,004	0	0	0	155,004	17,019	51,200	4,078	10,500	65,778	82,797
16224	0	0	0	0	0	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0	0	0	0	0	0
16228	0.00072	0	0	0	0	0	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0	0	0	0	0	0
16231	0	0	0	0	0	0	0	0	0	0	0	0	0
16232	0	0	0	0	0	0	0	0	0	0	0	0	0
16233	0.0097	94,269	9,868	0	0	0	104,137	11,434	13,366	9,277	11,540	34,183	45,617
16234	0.03083	0	0	0	0	0	0	0	0	0	0	0	0
16236	0.00595	0	0	0	0	0	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0.0056	0	0	0	0	0	0	0	0	0	0	0	0
16241	0	0	0	0	0	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16243	0	0	0	0	0	0	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0	0	0	0	0	0
16246	0.00135	0	0	0	0	0	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0	0	0	0	0	0
16253	0.01776	0	0	0	0	0	0	0	0	0	11,068	11,068	11,068
TOTALS	2.694	2,340,439	75,236	321,429	0	0	2,737,104	300,519	373,594	87,480	368,307	829,381	1,139,098

(a) Amortization assuming 7% interest over 15 year period.

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

Table 9-12: BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16001	0.0793	203,456	2,004	41,092	0	0	246,552	27,070	44,857	4,078	11,540	60,475	87,545
16003	0.00472	0	0	0	0	0	0	0	0	0	0	0	0
16008	0	0	0	0	0	0	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0	0	0	0	0	0
16012	0.00221	0	0	0	0	0	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16016	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16020	0.04581	0	0	0	0	0	0	0	0	0	0	0	0
16023	0.05734	0	0	0	0	0	0	0	0	0	0	0	0
16024	0.00592	0	0	0	0	0	0	0	0	0	0	0	0
16025	0	0	0	0	0	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0	0	0	0	0	0
16038	0.00822	0	0	0	0	0	0	0	0	0	0	0	0
16039	0.00178	0	0	0	0	0	0	0	0	0	0	0	0
16043	0.00218	0	0	0	0	0	0	0	0	0	0	0	0
16044	0	0	0	0	0	0	0	0	0	0	0	0	0
16046	0	0	0	0	0	0	0	0	0	0	0	0	0
16047	0.00115	51,650	2,004	0	0	0	53,654	5,891	15,497	1,917	11,540	28,954	34,845
16048	5E-06	0	0	0	0	0	0	0	0	0	0	0	730
16049	0.0017	48,843	2,004	10,169	0	0	61,017	6,699	15,205	2,208	11,540	28,953	35,653
16050	0.01	58,533	2,004	0	0	0	60,537	6,647	11,672	1,917	11,540	25,129	31,776
16052	0.0546	217,678	5,563	44,648	0	0	267,889	29,413	17,799	6,897	11,072	35,768	65,180
16053	0.00124	39,625	2,004	0	0	0	41,629	4,571	9,002	1,917	11,540	22,459	27,030
16054	0.00075	30,019	2,004	6,405	0	0	38,427	4,219	12,013	1,917	11,357	25,287	29,506
16055	8E-06	0	0	0	0	0	0	0	0	0	0	0	1,168
16056	0.00137	54,111	2,004	0	0	0	56,115	6,161	15,659	1,917	11,540	29,116	35,277
16058	0.003	44,348	2,004	9,270	0	0	55,622	6,107	8,936	1,917	0	10,853	16,960
16059	0.0011	51,492	2,004	0	0	0	53,496	5,874	15,468	1,917	11,540	28,925	34,798
16060	0.0018	57,885	2,004	0	0	0	59,889	6,575	16,161	2,208	11,540	29,909	36,484
16061	0	0	0	0	0	0	0	0	0	0	0	0	0
16062	0.00005	0	0	0	0	0	0	0	0	0	0	0	7,300
16063	0.0067	94,714	2,004	0	0	0	96,718	10,619	20,855	3,562	11,540	35,957	46,576
16064	0.01197	62,083	2,004	0	0	0	64,087	7,036	12,127	3,931	11,540	27,598	34,634

Table 9-12: BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16065	0.008	91,929	2,004	18,787	0	0	112,719	12,376	20,721	3,231	11,090	35,042	47,418
16068	0	0	0	0	0	0	0	0	0	0	0	0	0
16070	0.00133	0	0	0	0	0	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0	0	0	0	0	0
16072	0	0	0	0	0	0	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0	0	0	0	0	0
16075	0.01021	0	0	0	0	0	0	0	0	0	0	0	0
16076	0	0	0	0	0	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0	0	0	0	0	0
16079	0.11247	356,066	0	71,213	0	0	427,279	46,913	27,018	0	11,180	38,198	85,111
16083	0.001	42,475	2,004	8,896	0	0	53,374	5,860	14,573	1,735	11,540	27,848	33,708
16084	0.00643	0	0	0	0	0	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0	0	0	0	0	0
16090	0.00393	0	0	0	0	0	0	0	0	0	0	0	0
16091	0.2321	0	0	0	0	0	0	0	0	0	0	0	0
16092	0.00668	0	0	0	0	0	0	0	0	0	0	0	0
16093	0.08158	222,598	0	44,520	0	0	267,118	29,328	30,361	0	11,180	41,541	70,869
16097	0.019	72,380	0	14,476	0	0	86,856	9,536	3,597	0	10,520	14,117	23,653
16098	0	0	0	0	0	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0	0	0	0	0	0
16102	0.01394	135,429	0	27,086	0	0	162,514	17,843	25,465	0	11,540	37,005	54,848
16103	0.03756	0	0	0	0	0	0	0	0	0	0	0	0
16107	0.00129	0	0	0	0	0	0	0	0	0	0	0	0
16109	0.05056	0	0	0	0	0	0	0	0	0	0	0	0
16111	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16113	0	0	0	0	0	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0	0	0	0	0	0
16115	0.00407	0	0	0	0	0	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0	0	0	0	0	0
16117	0.04	37,048	0	7,410	0	0	44,458	4,881	18,524	0	9,908	28,432	33,313
16118	0.0288	0	0	0	0	0	0	0	0	0	0	0	0
16119	0.00729	13,151	2,004	3,031	0	0	18,186	1,997	2,577	1,948	11,117	15,642	17,639
16120	0.04278	0	0	0	0	0	0	0	0	0	9,200	9,200	9,200
16121	0.08028	0	0	0	0	0	0	0	0	0	0	0	0
16122	0.0255	0	0	0	0	0	0	0	0	0	9,948	9,948	9,948
16123	0.04608	246,283	8,080	50,873	0	0	305,236	33,513	39,120	8,365	11,540	59,025	92,538
16124	0.01666	0	0	0	0	0	0	0	0	0	0	0	0
16125	0.01419	0	0	0	0	0	0	0	0	0	10,712	10,712	10,712

Table 9-12: BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O&M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O&M	ANNUAL COST ($/YR)(b)
16127	0.00363	55,540	2,004	11,509	0	0	69,053	7,582	11,684	2,756	11,540	25,980	33,562
16128	0.00396	0	0	0	0	0	0	0	0	0	0	0	0
16129	0.00469	0	0	0	0	0	0	0	0	0	11,540	11,540	11,540
16130	0.0003	4,400	2,004	1,281	0	0	7,685	844	10,400	4,078	11,540	26,018	26,862
16131	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16135	0.01149	0	0	0	0	0	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0	0	0	0	0	0
16140	0	0	0	0	0	0	0	0	0	0	0	0	0
16143	0	0	0	0	0	0	0	0	0	0	0	0	0
16144	0	0	0	0	0	0	0	0	0	0	0	0	0
16146	0	0	0	0	0	0	0	0	0	0	0	0	0
16148	0.00008	0	0	0	0	0	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0	0	0	0	0	0
16150	0.04578	0	0	0	0	0	0	0	0	0	0	0	0
16151	0.00205	0	0	0	0	0	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0	0	0	0	0	0
16154	0.01022	0	0	0	0	0	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0	0	0	0	0	0
16158	0.01428	0	0	0	0	0	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0	0	0	0	0	0
16160	0.00014	0	0	0	0	0	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16165	0.03022	0	0	0	0	0	0	0	0	0	0	0	0
16166	0.00342	0	0	0	0	0	0	0	0	0	0	0	0
16169	0	0	0	0	0	0	0	0	0	0	0	0	0
16170	0.0048	55,201	2,004	11,441	0	0	68,647	7,537	9,594	4,078	11,235	24,907	32,444
16171	0.024	0	0	0	0	0	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0	0	0	0	0	0
16176	0.03727	0	0	0	0	0	0	0	0	0	0	0	0
16177	0	0	0	0	0	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0	0	0	0	0	0
16184	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-12: BCT/BPT/BAT Option II Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O&M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O&M	ANNUAL COST ($/YR)(b)
16185	0	0	0	0	0	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0	0	0	0	0	0
16190	0	0	0	0	0	0	0	0	0	0	0	0	0
16191	0	0	0	0	0	0	0	0	0	0	0	0	0
16193	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16196	0.01223	131,628	11,645	0	0	0	143,273	15,731	26,246	10,115	11,540	47,901	63,632
16197	0	0	0	0	0	0	0	0	0	0	0	0	0
16199	0.0008	0	0	0	0	0	0	0	0	0	0	0	0
16200	0.01142	0	0	0	0	0	0	0	0	0	0	0	0
16201	0.00188	0	0	0	0	0	0	0	0	0	0	0	0
16202	0.01301	0	0	0	0	0	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0	0	0	0	0	0
16206	0.05739	0	0	0	0	0	0	0	0	0	0	0	0
16208	0.00334	0	0	0	0	0	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0	0	0	0	0	0
16212	0.0007	15,300	2,004	0	0	0	17,304	1,900	18,800	1,516	10,500	30,816	32,716
16215	0	0	0	0	0	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0	0	0	0	0	0
16219	0.02544	0	0	0	0	0	0	0	0	0	0	0	0
16220	0.03041	0	0	0	0	0	0	0	0	0	0	0	0
16221	0.00662	0	0	0	0	0	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0	0	0	0	0	0
16222	0	0	0	0	0	0	0	0	0	0	0	0	0
16223	0.02904	153,000	2,004	0	0	0	155,004	17,019	51,200	4,078	10,500	65,778	82,797
16224	0	0	0	0	0	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0	0	0	0	0	0
16228	0.00072	0	0	0	0	0	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0	0	0	0	0	0
16231	0	0	0	0	0	0	0	0	0	0	0	0	0
16232	0	0	0	0	0	0	0	0	0	0	0	0	0
16233	0.0097	116,040	9,868	0	0	0	125,908	13,824	24,252	9,277	11,540	45,069	58,893
16234	0.03083	0	0	0	0	0	0	0	0	0	0	0	0
16236	0.00595	0	0	0	0	0	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0.0056	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-12: BCT/BPT/BAT Option II Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($) Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	AMORTIZED TOTAL CAPITAL(a) ($/YR)	O&M COSTS ($/YR) Equipment	Solids Handling	Monitoring	Total O&M	TOTAL ANNUAL COST ($/YR)(b)
16241	0	0	0	0	0	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16243	0	0	0	0	0	0	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0	0	0	0	0	0
16246	0.00135	0	0	0	0	0	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0	0	0	0	0	0
16253	0.01776	26,840	0	5,368	0	0	32,208	3,536	13,420	0	11,068	24,488	28,024
TOTALS	2.694	2,789,743	75,236	387,473	0	0	3,252,453	357,102	562,803	87,480	368,307	1,018,590	1,384,890

(a) Amortization assuming 7% interest over 15 year period.

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory

ID#	Flow (MGD)	CAPITAL COSTS ($) Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	AMORTIZED TOTAL CAPITAL(a) ($/YR)	O & M COSTS ($/YR) Equipment	Solids Handling	Monitoring	Total O & M	TOTAL ANNUAL COST ($/YR)(b)
16001	0.0793	2,183,593	2,004	437,119	0	0	2,622,716	287,960	623,747	4,078	11,540	639,365	927,325
16003	0.00472	0	0	0	0	0	0	0	0	0	0	0	0
16008	0	0	0	0	0	0	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0	0	0	0	0	0
16012	0.00221	0	0	0	0	0	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16016	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16020	0.04581	0	0	0	0	0	0	0	0	0	0	0	0
16023	0.05734	0	0	0	0	0	0	0	0	0	0	0	0
16024	0.00592	0	0	0	0	0	0	0	0	0	0	0	0
16025	0	0	0	0	0	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0	0	0	0	0	0
16038	0.00822	0	0	0	0	0	0	0	0	0	0	0	0
16039	0.00178	0	0	0	0	0	0	0	0	0	0	0	0
16043	0.00218	0	0	0	0	0	0	0	0	0	0	0	0
16044	0	0	0	0	0	0	0	0	0	0	0	0	0
16046	0	0	0	0	0	0	0	0	0	0	0	0	0
16047	0.00115	191,967	2,004	0	0	0	193,971	21,297	23,878	1,917	11,540	37,335	58,632
16048	5E-06	46,193	0	0	0	0	46,193	5,072	14,452	0	0	14,452	20,254
16049	0.0017	247,768	2,004	49,954	0	0	299,726	32,908	27,615	2,208	11,540	41,363	74,272
16050	0.01	797,074	2,004	0	0	0	799,078	87,734	84,672	1,917	11,540	98,129	185,864
16052	0.0546	1,949,079	5,563	390,928	0	0	2,345,571	257,531	416,379	6,897	11,072	434,348	691,879
16053	0.00124	190,146	2,004	0	0	0	192,150	21,097	18,054	1,917	11,540	31,511	52,609
16054	0.00075	123,852	2,004	25,171	0	0	151,028	16,582	17,488	1,917	11,357	30,762	47,344
16055	8E-06	32,864	0	0	0	0	32,864	3,608	7,737	0	0	7,737	12,513
16056	0.00137	218,417	2,004	0	0	0	220,421	24,201	25,638	1,917	11,540	39,095	63,296
16058	0.003	361,815	2,004	72,764	0	0	436,583	47,934	30,836	1,917	0	32,753	80,688
16059	0.0011	186,408	2,004	0	0	0	188,412	20,687	23,498	1,917	11,540	36,955	57,641
16060	0.0018	266,809	2,004	0	0	0	268,813	29,514	29,301	2,208	11,540	43,049	72,563
16061	0	0	0	0	0	0	0	0	0	0	0	0	0
16062	0.00005	36,642	0	0	0	0	36,642	4,023	8,043	0	0	8,043	19,366
16063	0.0067	664,889	2,004	0	0	0	666,893	73,221	69,765	3,562	11,540	84,867	158,088

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O&M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O&M	ANNUAL COST ($/YR)(b)
16064	0.01197	885,558	2,004	0	0	0	887,562	97,450	99,486	3,931	11,540	114,957	212,406
16065	0.008	733,057	2,004	147,012	0	0	882,073	96,847	79,121	3,231	11,090	93,442	190,289
16068	0	0	0	0	0	0	0	0	0	0	0	0	0
16070	0.00133	0	0	0	0	0	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0	0	0	0	0	0
16072	0	0	0	0	0	0	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0	0	0	0	0	0
16075	0.01021	0	0	0	0	0	0	0	0	0	0	0	0
16076	0	0	0	0	0	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0	0	0	0	0	0
16079	0.11247	2,562,809	0	512,562	0	0	3,075,371	337,659	848,079	0	11,180	859,259	1,196,918
16083	0.001	165,966	2,004	33,594	0	0	201,564	22,131	21,873	1,735	11,540	35,148	57,279
16084	0.00643	0	0	0	0	0	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0	0	0	0	0	0
16090	0.00393	0	0	0	0	0	0	0	0	0	0	0	0
16091	0.2321	0	0	0	0	0	0	0	0	0	0	0	0
16092	0.00668	0	0	0	0	0	0	0	0	0	0	0	0
16093	0.08158	2,221,423	0	444,285	0	0	2,665,708	292,680	625,858	0	11,180	637,038	929,719
16097	0.019	1,067,839	0	213,568	0	0	1,281,407	140,692	138,700	0	10,520	149,220	289,912
16098	0	0	0	0	0	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0	0	0	0	0	0
16102	0.01394	1,035,581	0	207,116	0	0	1,242,698	136,442	127,227	0	11,540	138,767	275,208
16103	0.03756	0	0	0	0	0	0	0	0	0	0	0	0
16107	0.00129	0	0	0	0	0	0	0	0	0	0	0	0
16109	0.05056	0	0	0	0	0	0	0	0	0	0	0	0
16111	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16113	0	0	0	0	0	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0	0	0	0	0	0
16115	0.00407	0	0	0	0	0	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0	0	0	0	0	0
16117	0.04	1,562,645	0	312,529	0	0	1,875,174	205,884	310,524	0	9,908	320,432	526,316
16118	0.0288	0	0	0	0	0	0	0	0	0	0	0	0
16119	0.00729	603,122	0	120,624	0	0	723,746	79,463	53,202	0	11,117	64,319	143,783
16120	0.04278	1,569,551	0	313,910	0	0	1,883,461	206,794	312,258	0	9,200	321,458	528,251
16121	0.08028	0	0	0	0	0	0	0	0	0	0	0	0
16122	0.0255	1,240,783	0	248,157	0	0	1,488,939	163,478	186,150	0	9,948	196,098	359,576
16123	0.04608	1,864,917	8,080	374,599	0	0	2,247,596	246,774	375,504	8,365	11,540	395,409	642,183

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($) Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	AMORTIZED TOTAL CAPITAL(a) ($/YR)	O & M COSTS ($/YR) Equipment	Solids Handling	Monitoring	Total O & M	TOTAL ANNUAL COST ($/YR)(b)
16124	0.01666	0	0	0	0	0	0	0	0	0	0	0	0
16125	0.01419	909,456	0	181,891	0	0	1,091,347	119,824	103,609	0	10,712	114,321	234,145
16127	0.00363	423,029	2,004	85,007	0	0	510,040	56,000	38,161	2,756	11,540	52,457	108,457
16128	0.00396	0	0	0	0	0	0	0	0	0	0	0	0
16129	0.00469	444,502	0	88,900	0	0	533,403	58,565	34,237	0	11,540	45,777	104,342
16130	0.0003	36,269	0	7,254	0	0	43,523	4,779	2,190	0	11,540	13,730	18,509
16131	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16135	0.01149	0	0	0	0	0	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0	0	0	0	0	0
16140	0	0	0	0	0	0	0	0	0	0	0	0	0
16143	0	0	0	0	0	0	0	0	0	0	0	0	0
16144	0	0	0	0	0	0	0	0	0	0	0	0	0
16146	0	0	0	0	0	0	0	0	0	0	0	0	0
16148	0.00008	0	0	0	0	0	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0	0	0	0	0	0
16150	0.04578	0	0	0	0	0	0	0	0	0	0	0	0
16151	0.00205	0	0	0	0	0	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0	0	0	0	0	0
16154	0.01022	0	0	0	0	0	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0	0	0	0	0	0
16158	0.01428	0	0	0	0	0	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0	0	0	0	0	0
16160	0.00014	0	0	0	0	0	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16165	0.03022	0	0	0	0	0	0	0	0	0	0	0	0
16166	0.00342	0	0	0	0	0	0	0	0	0	0	0	0
16169	0	0	0	0	0	0	0	0	0	0	0	0	0
16170	0.0048	507,196	2,004	101,840	0	0	611,040	67,089	44,634	4,078	11,235	59,947	127,036
16171	0.024	0	0	0	0	0	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0	0	0	0	0	0
16176	0.03727	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16177	0	0	0	0	0	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0	0	0	0	0	0
16184	0	0	0	0	0	0	0	0	0	0	0	0	0
16185	0	0	0	0	0	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0	0	0	0	0	0
16190	0	0	0	0	0	0	0	0	0	0	0	0	0
16191	0	0	0	0	0	0	0	0	0	0	0	0	0
16193	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16196	0.01223	965,897	11,645	0	0	0	977,542	107,329	115,547	10,115	11,540	137,202	244,531
16197	0	0	0	0	0	0	0	0	0	0	0	0	0
16199	0.0008	0	0	0	0	0	0	0	0	0	0	0	0
16200	0.01142	0	0	0	0	0	0	0	0	0	0	0	0
16201	0.00188	0	0	0	0	0	0	0	0	0	0	0	0
16202	0.01301	0	0	0	0	0	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0	0	0	0	0	0
16206	0.05739	0	0	0	0	0	0	0	0	0	0	0	0
16208	0.00334	0	0	0	0	0	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0	0	0	0	0	0
16212	0.0007	134,753	2,004	0	0	0	136,757	15,015	20,233	1,516	10,500	32,249	47,264
16215	0	0	0	0	0	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0	0	0	0	0	0
16219	0.02544	0	0	0	0	0	0	0	0	0	0	0	0
16220	0.03041	0	0	0	0	0	0	0	0	0	0	0	0
16221	0.00662	0	0	0	0	0	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0	0	0	0	0	0
16222	0	0	0	0	0	0	0	0	0	0	0	0	0
16223	0.02904	1,531,517	7,768	0	0	0	1,539,285	169,005	246,811	8,212	10,500	265,523	434,528
16224	0	0	0	0	0	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0	0	0	0	0	0
16228	0.00072	0	0	0	0	0	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0	0	0	0	0	0
16231	0	0	0	0	0	0	0	0	0	0	0	0	0
16232	0	0	0	0	0	0	0	0	0	0	0	0	0
16233	0.0097	840,751	9,868	0	0	0	850,619	93,393	95,062	9,277	11,540	115,879	209,272
16234	0.03083	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($) Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	AMORTIZED TOTAL CAPITAL(a) ($/YR)	O & M COSTS ($/YR) Equipment	Solids Handling	Monitoring	Total O & M	TOTAL ANNUAL COST ($/YR)(b)
16236	0.00595	0	0	0	0	0	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0.0056	0	0	0	0	0	0	0	0	0	0	0	0
16241	0	0	0	0	0	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16243	0	0	0	0	0	0	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0	0	0	0	0	0
16246	0.00135	0	0	0	0	0	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0	0	0	0	0	0
16253	0.01776	1,056,810	0	211,362	0	0	1,268,173	139,239	143,068	0	11,068	154,136	293,374
TOTALS	2.694	29,860,948	76,992	4,580,148	0	0	34,518,089	3,789,901	5,442,636	85,588	368,307	5,896,531	9,695,630

(a) Amortization assuming 7% interest over 15 year period.

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

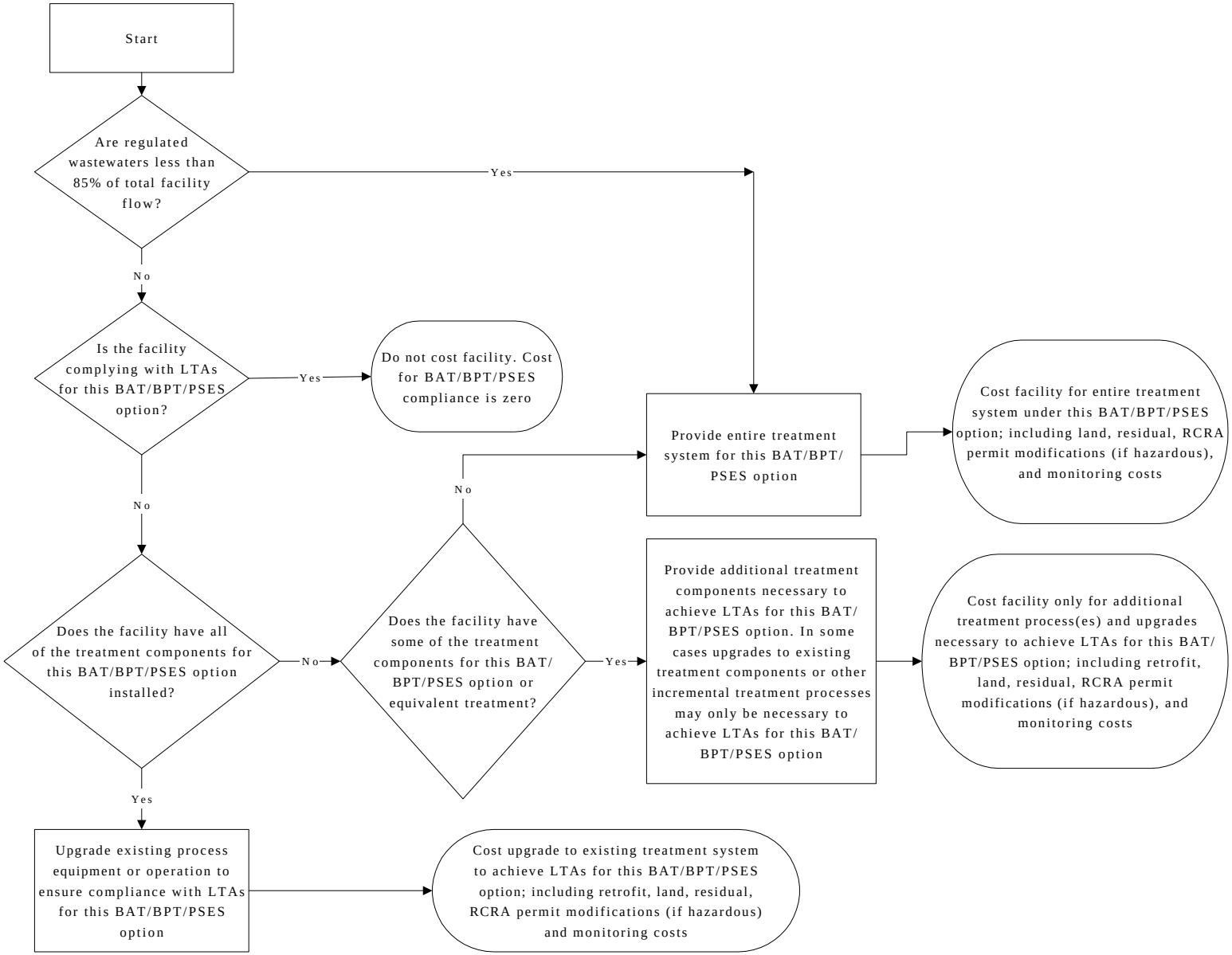


Figure 9-1: Option-Specific Costing Logic Flow Diagram

Figure 9-2
Equalization Capital Cost Curve

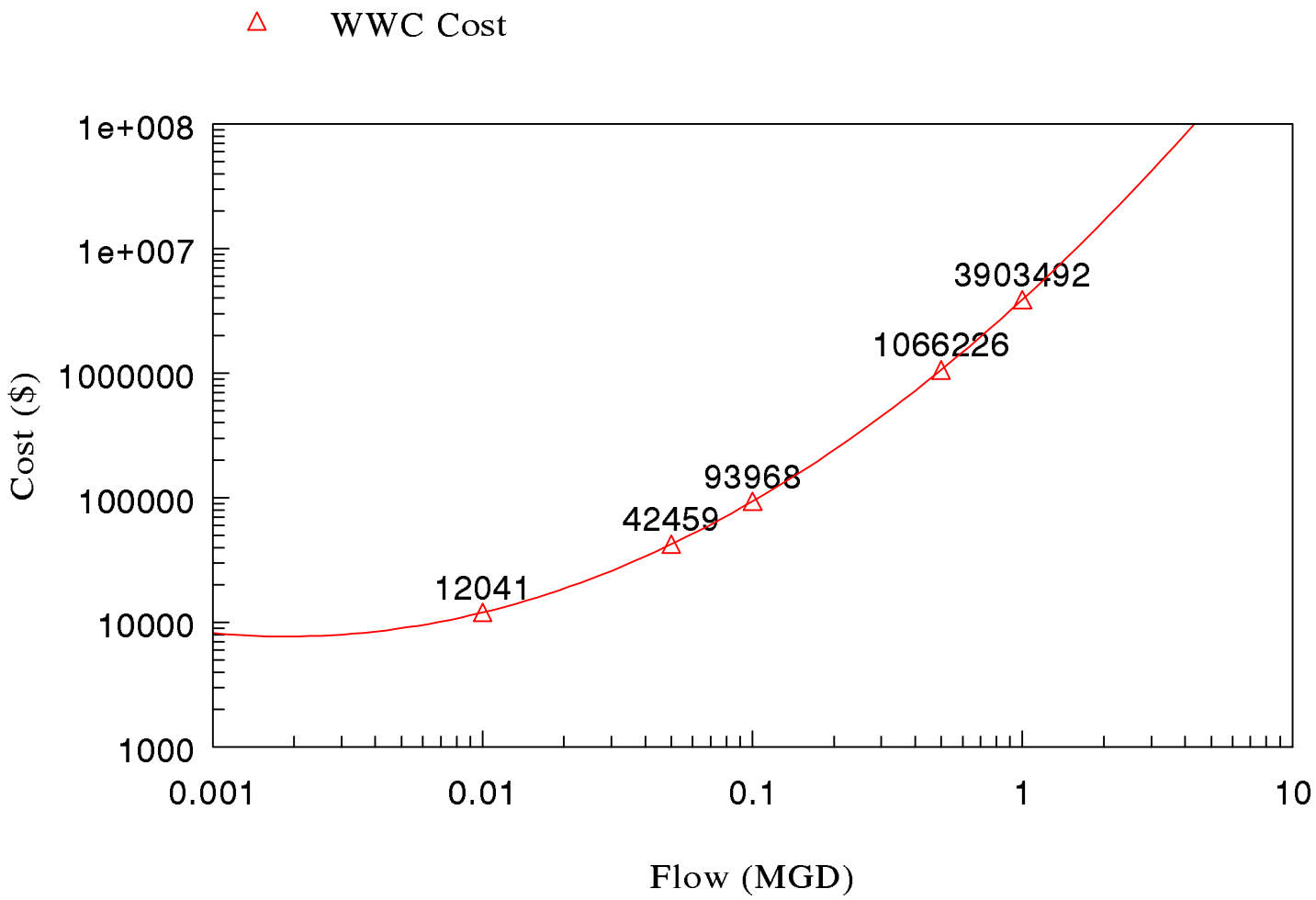


Figure 9-3
Flocculation Capital Cost Curve

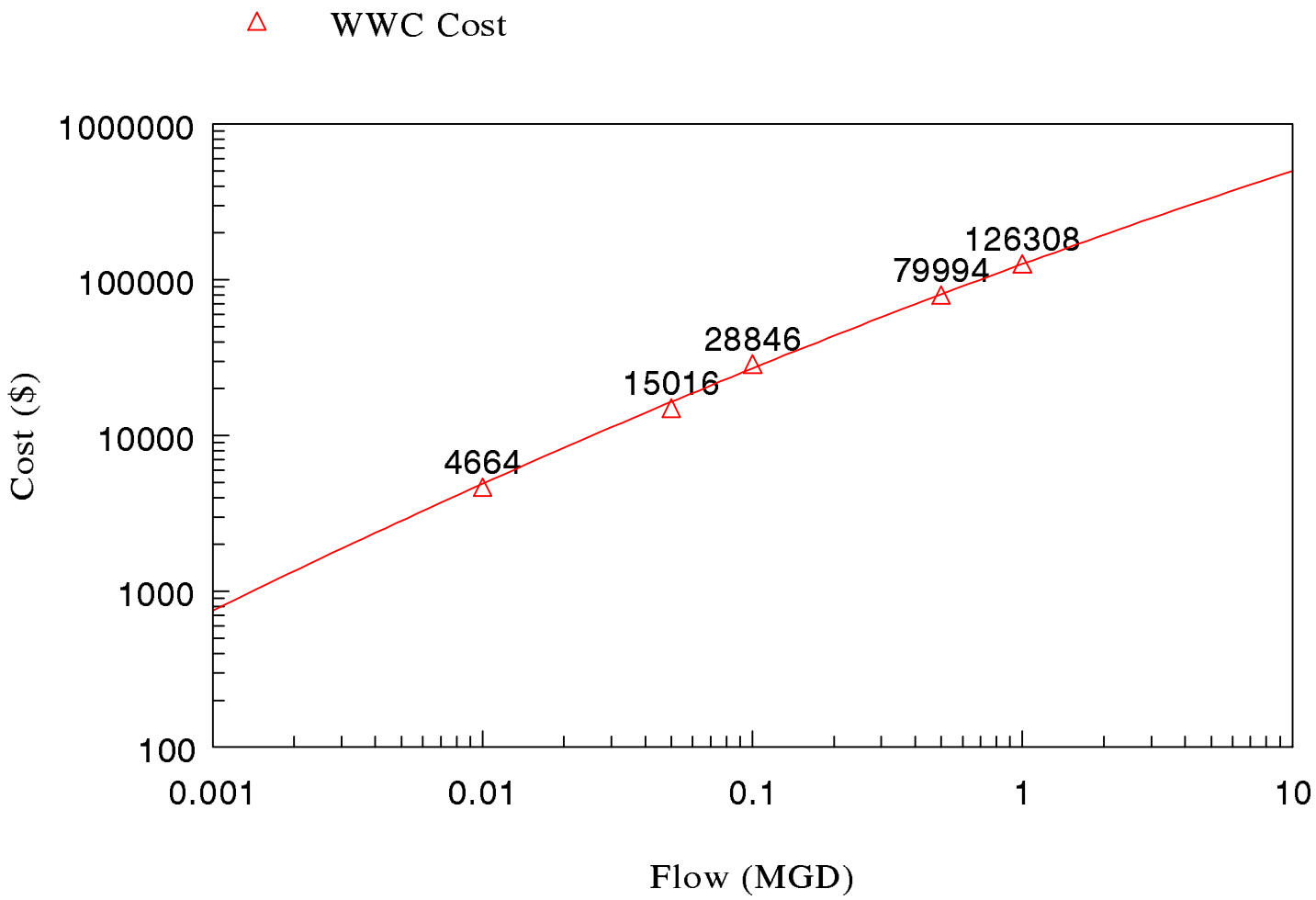


Figure 9-4
Flocculation O&M Cost Curve

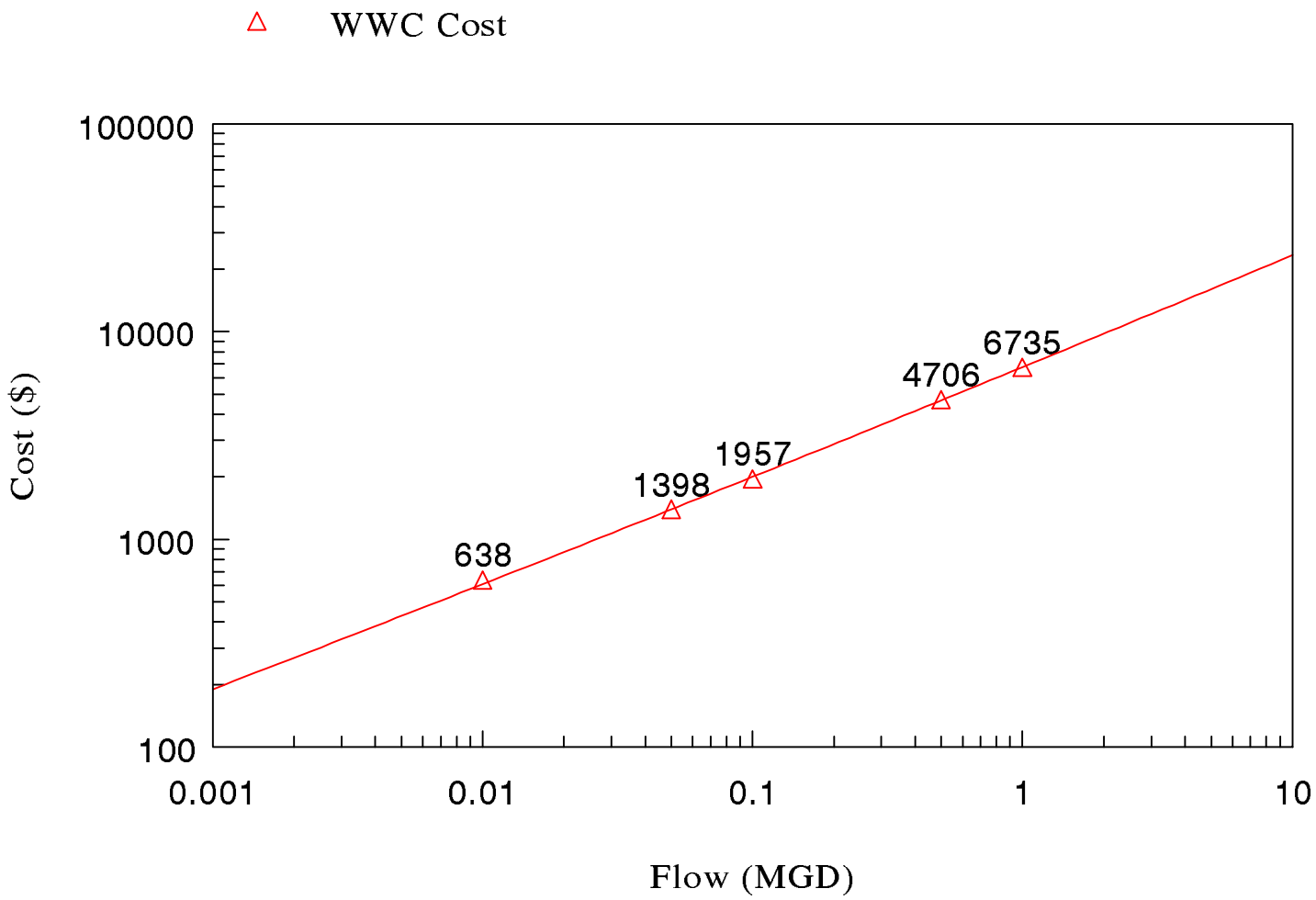


Figure 9-5

Sodium Hydroxide Capital Cost Curve

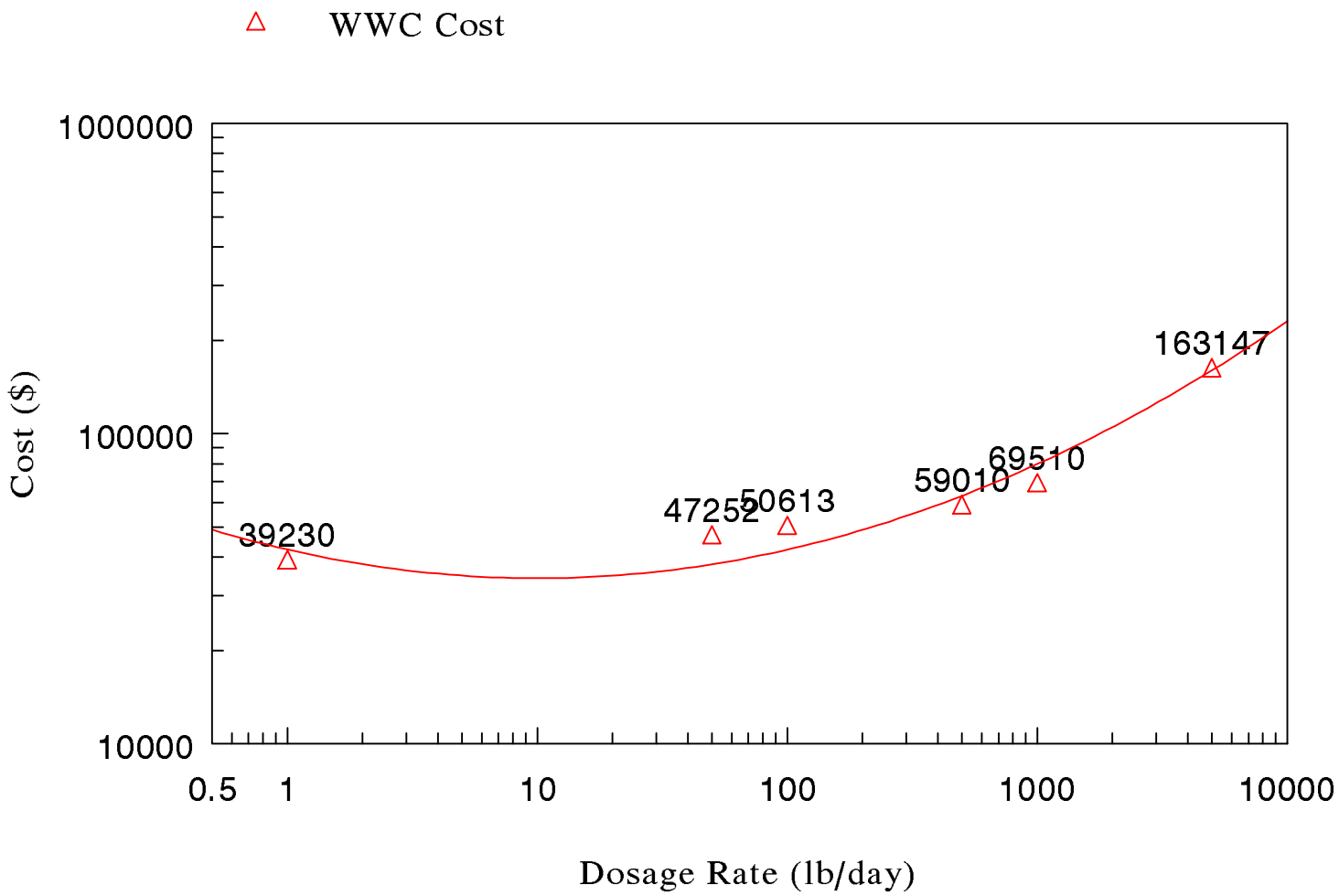


Figure 9-6
Sodium Hydroxide O&M Cost Curve

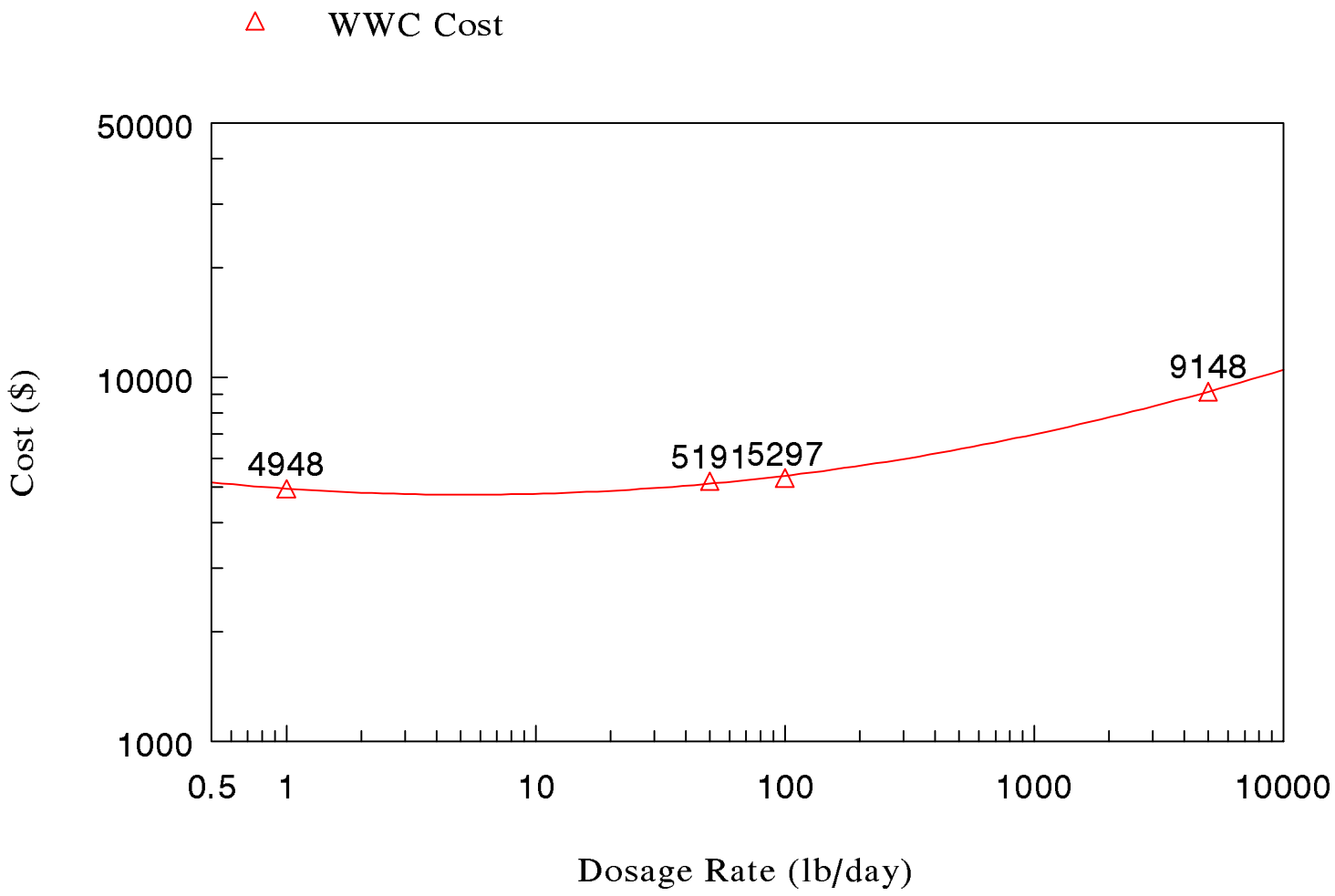


Figure 9-7
Phosphoric Acid Feed Capital Cost Curve

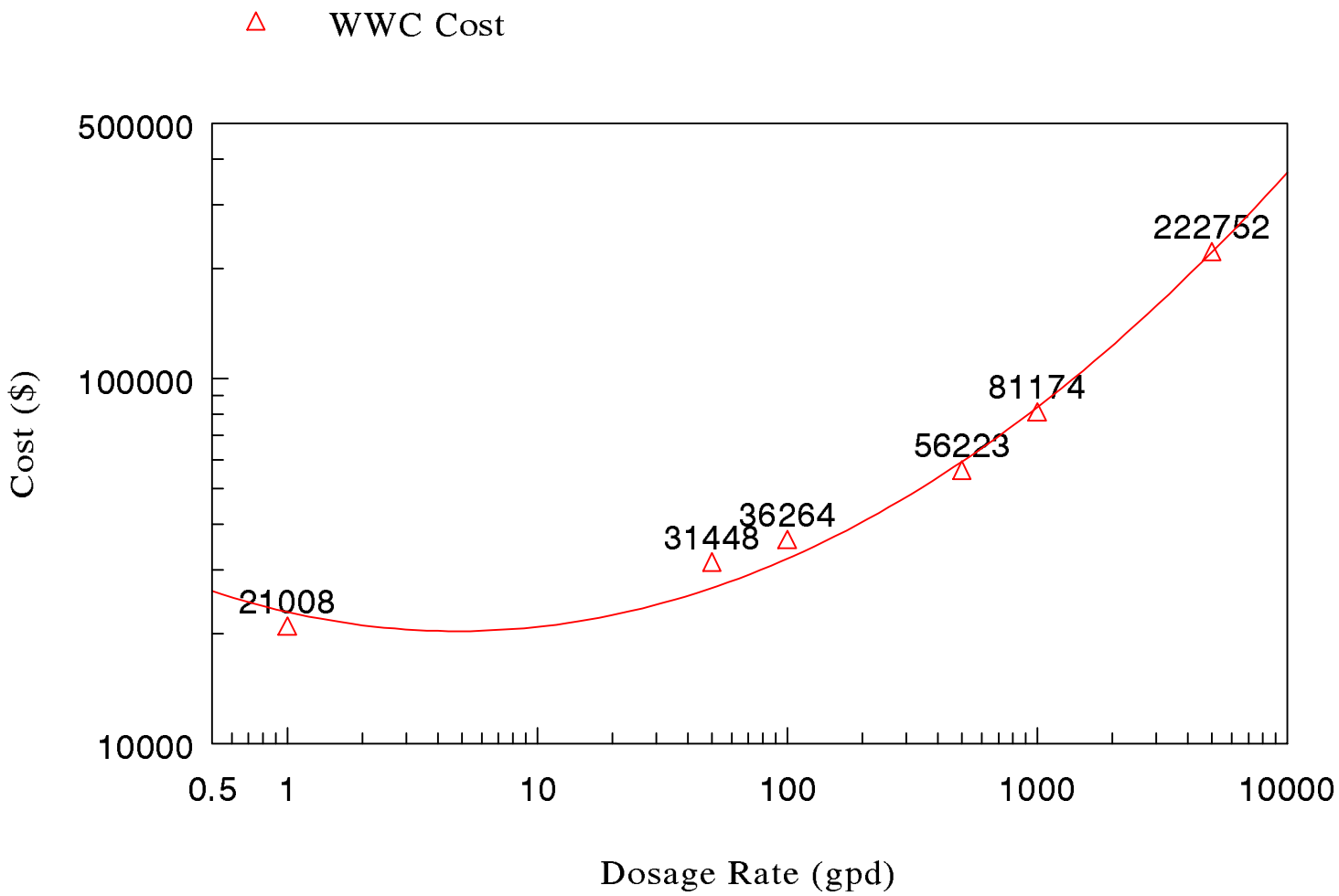


Figure 9-8
Phosphoric Acid Feed O&M Cost Curve

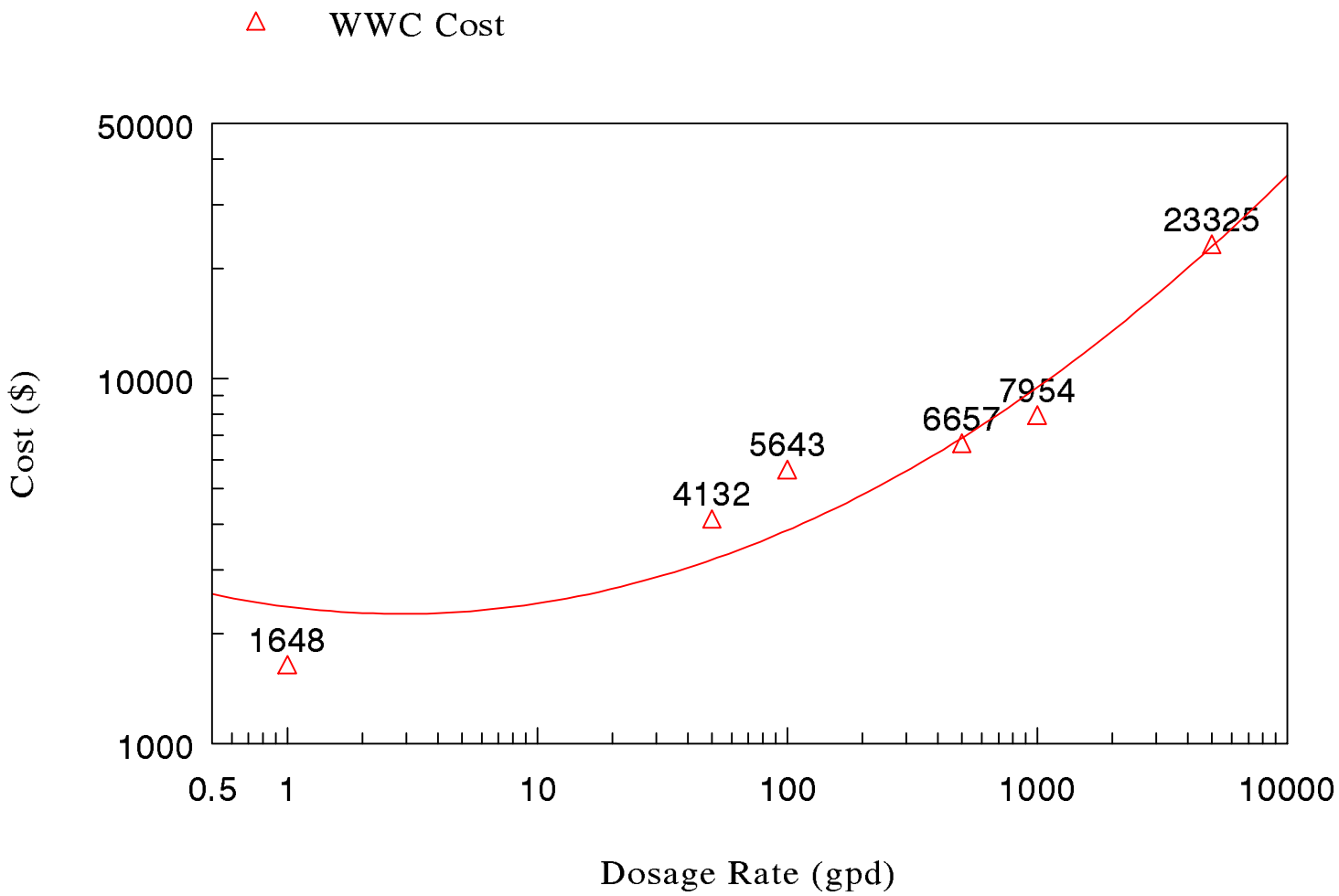


Figure 9-9
Polymer Feed Capital Cost Curve

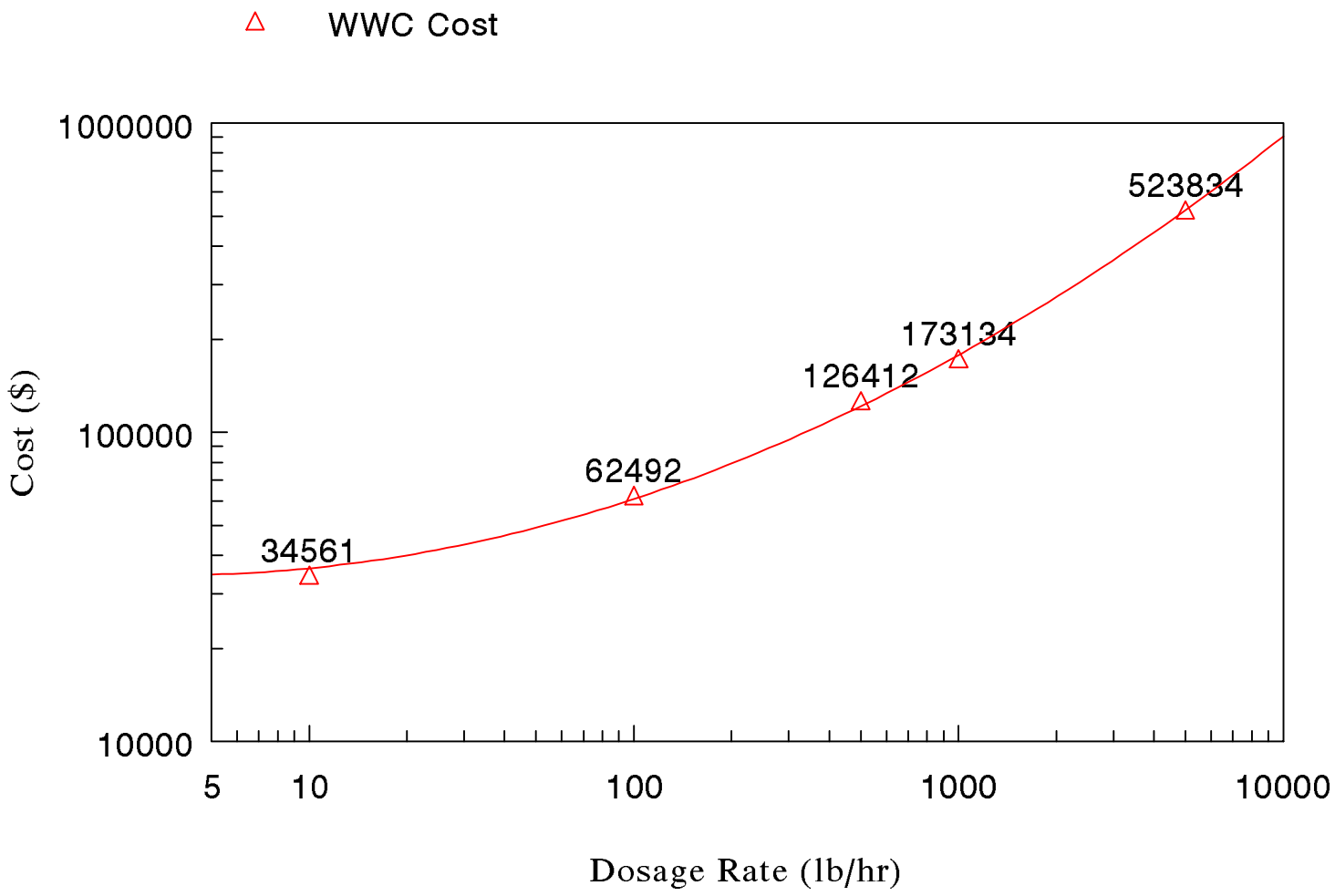


Figure 9-10
Polymer Feed O&M Cost Curve

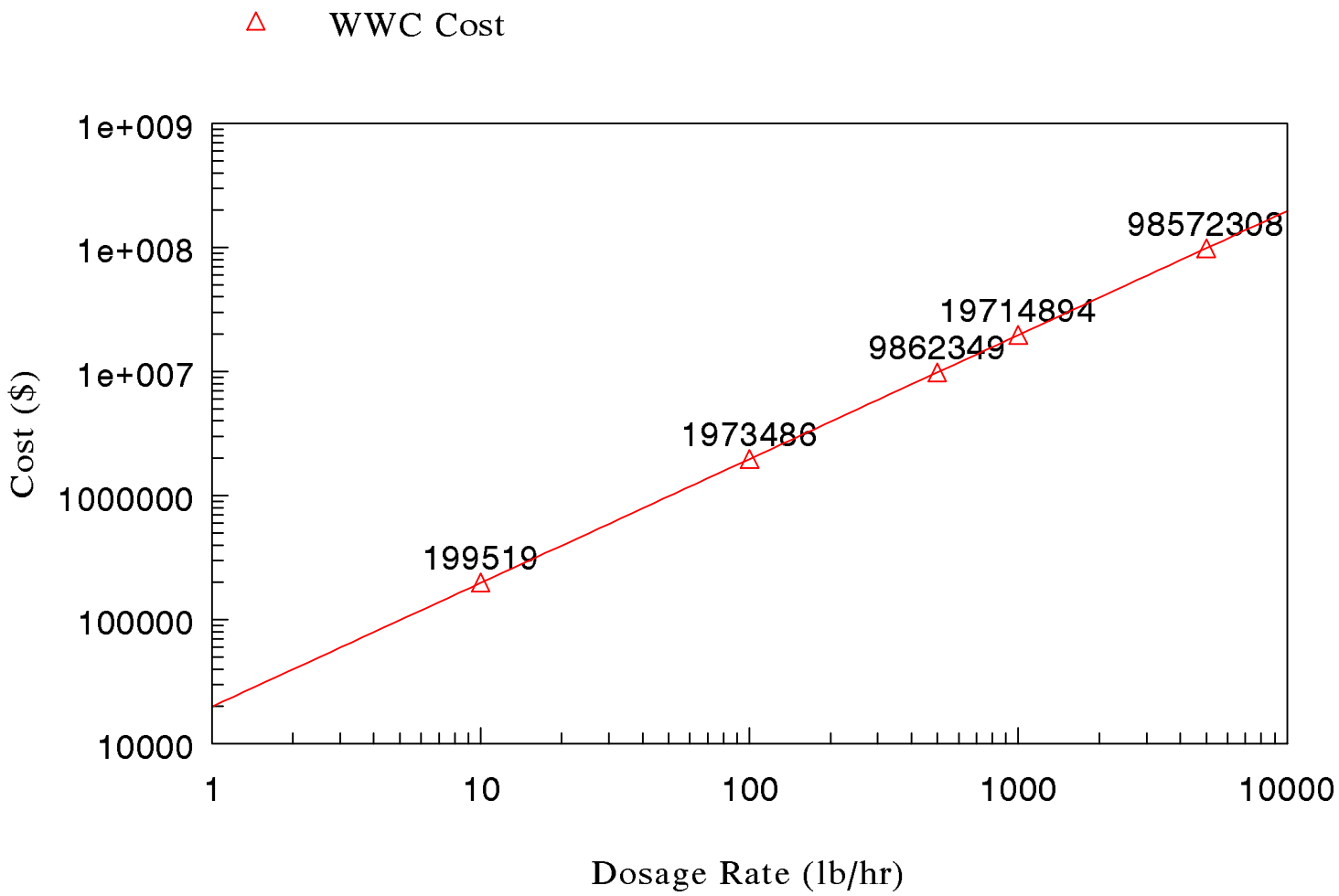


Figure 9-11
Primary Clarifier Capital Cost Curve

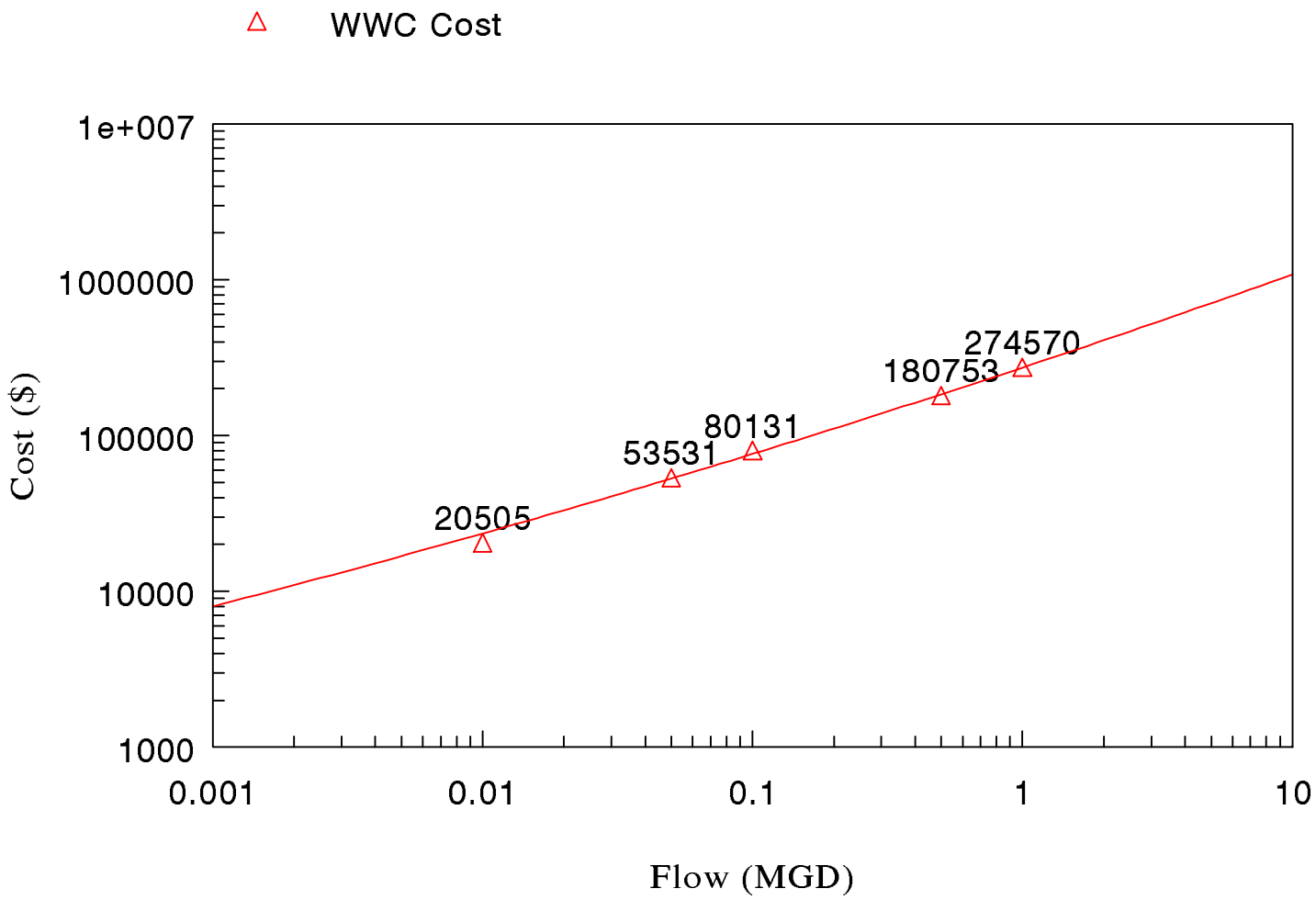


Figure 9-12
Primary Clarifier O&M Cost Curve

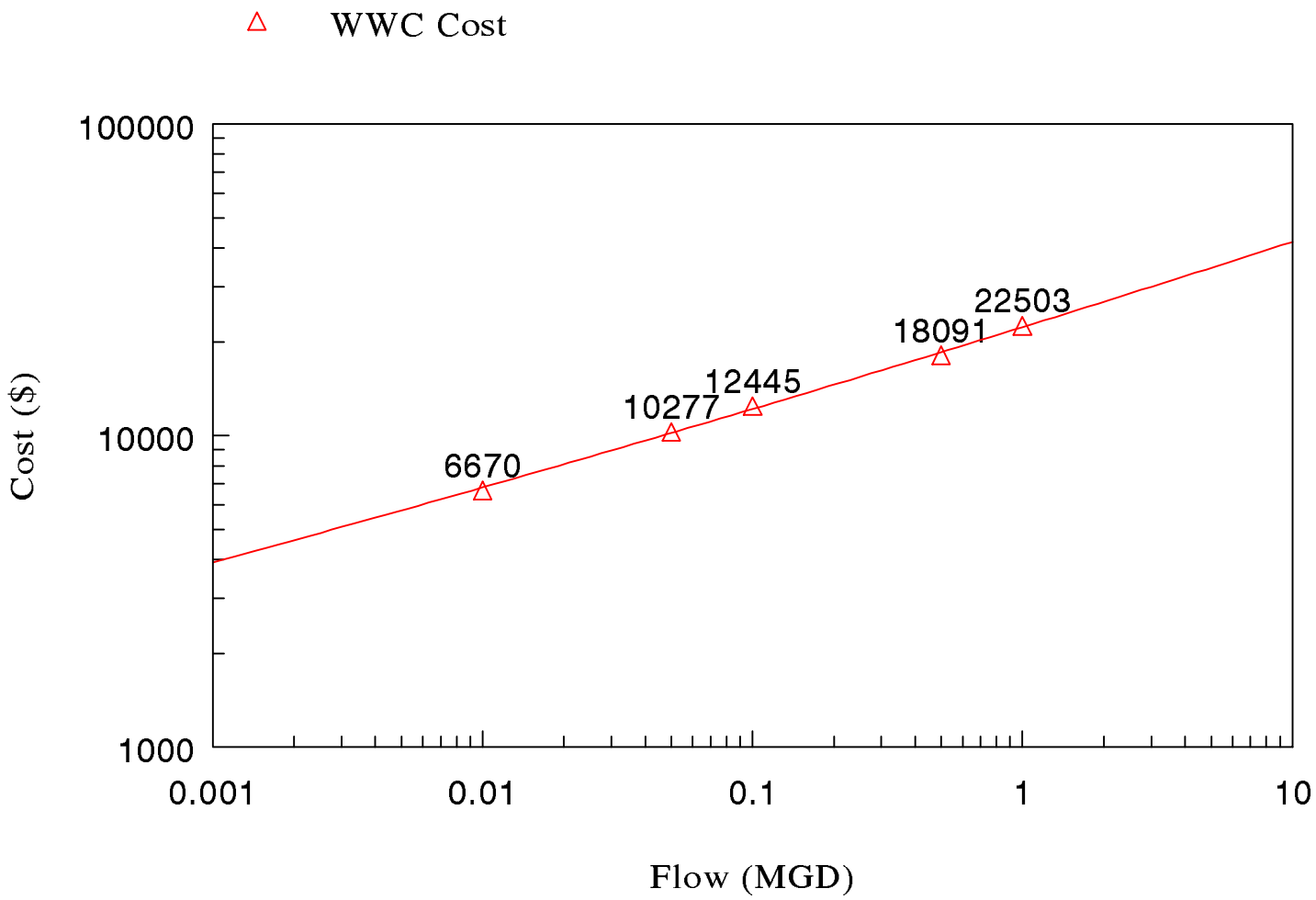


Figure 9-13
Aeration Basin Capital Cost Curve

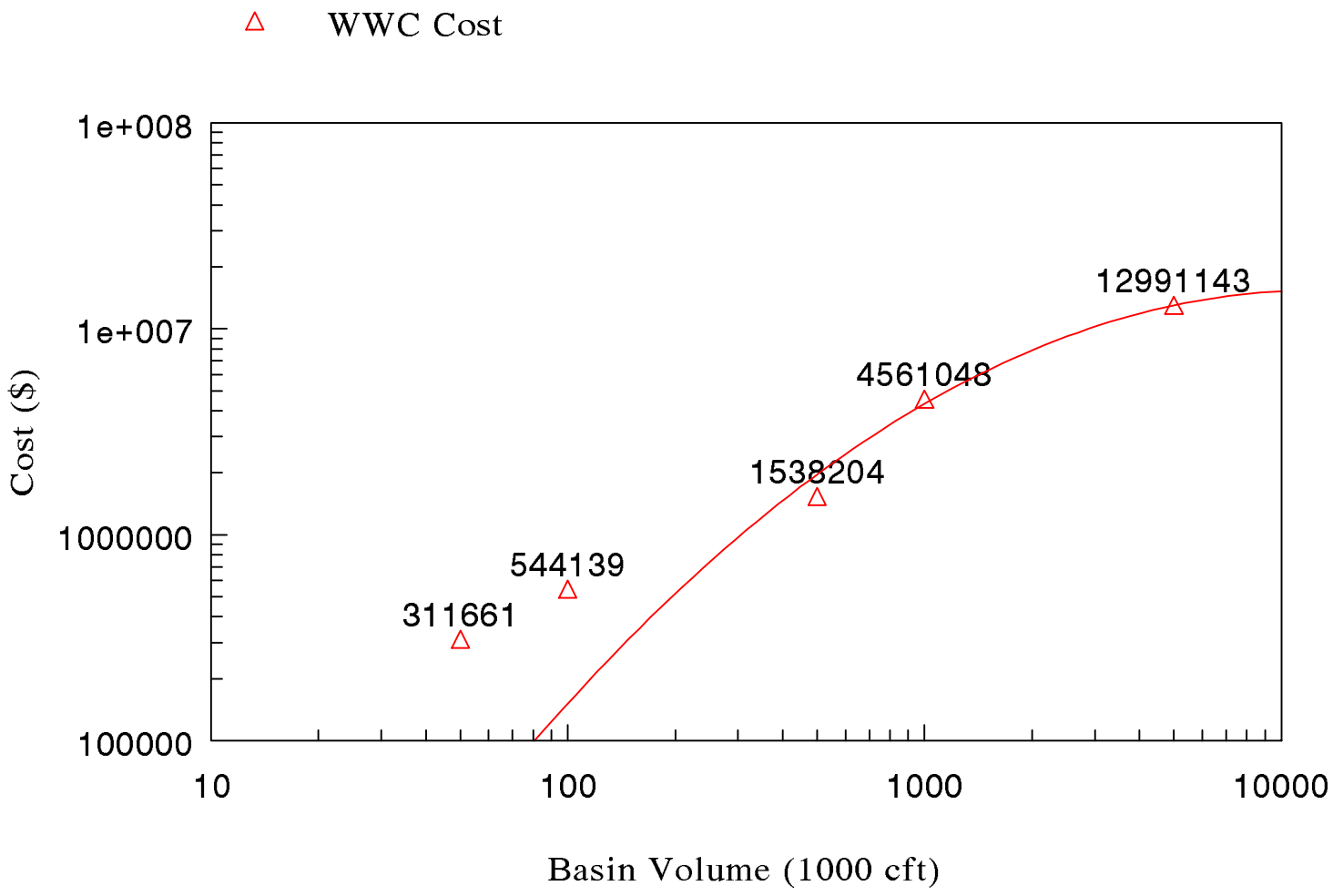


Figure 9-14
Air Diffusion System Capital Cost Curve

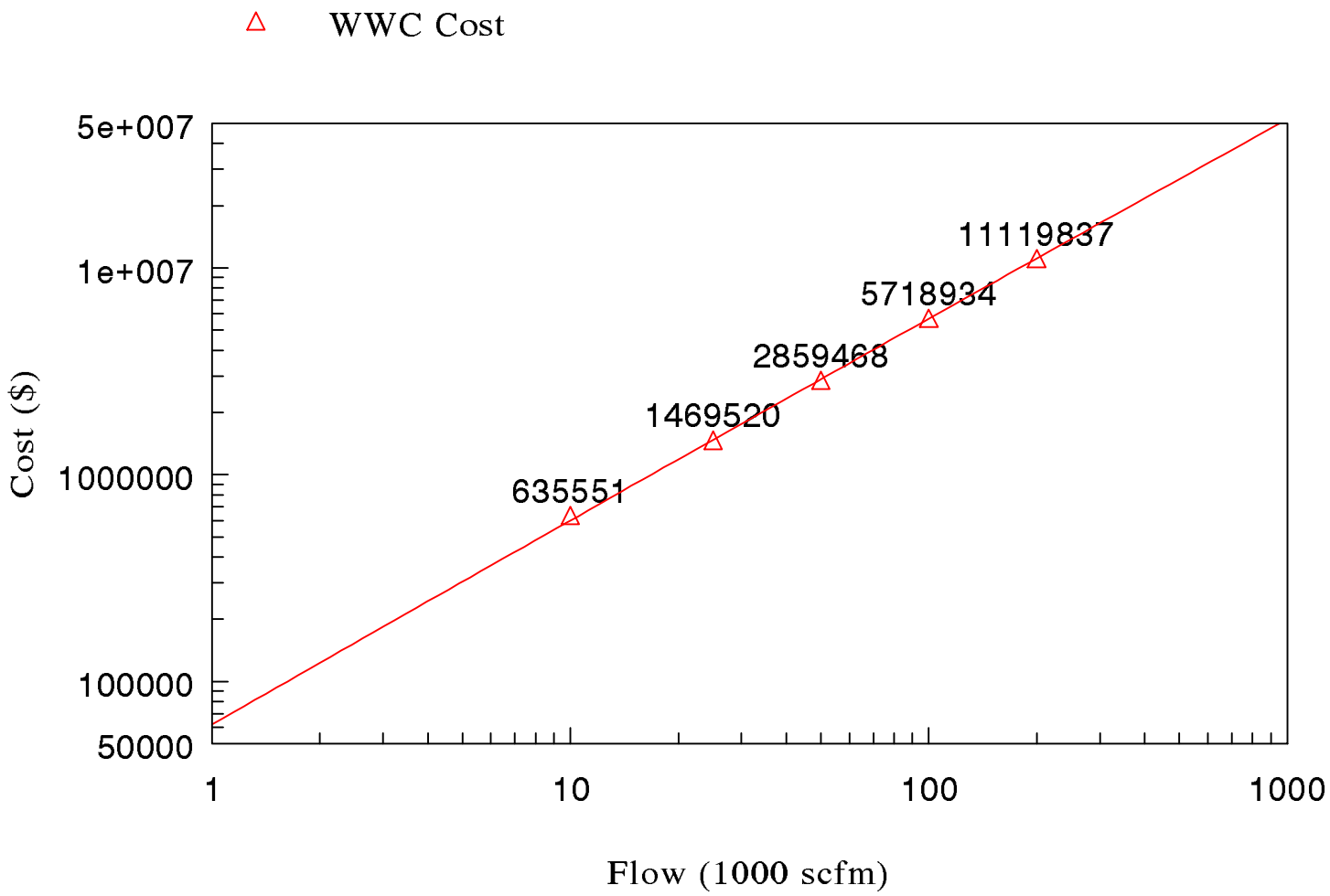


Figure 9-15
Air Diffusion System O&M Cost Curve

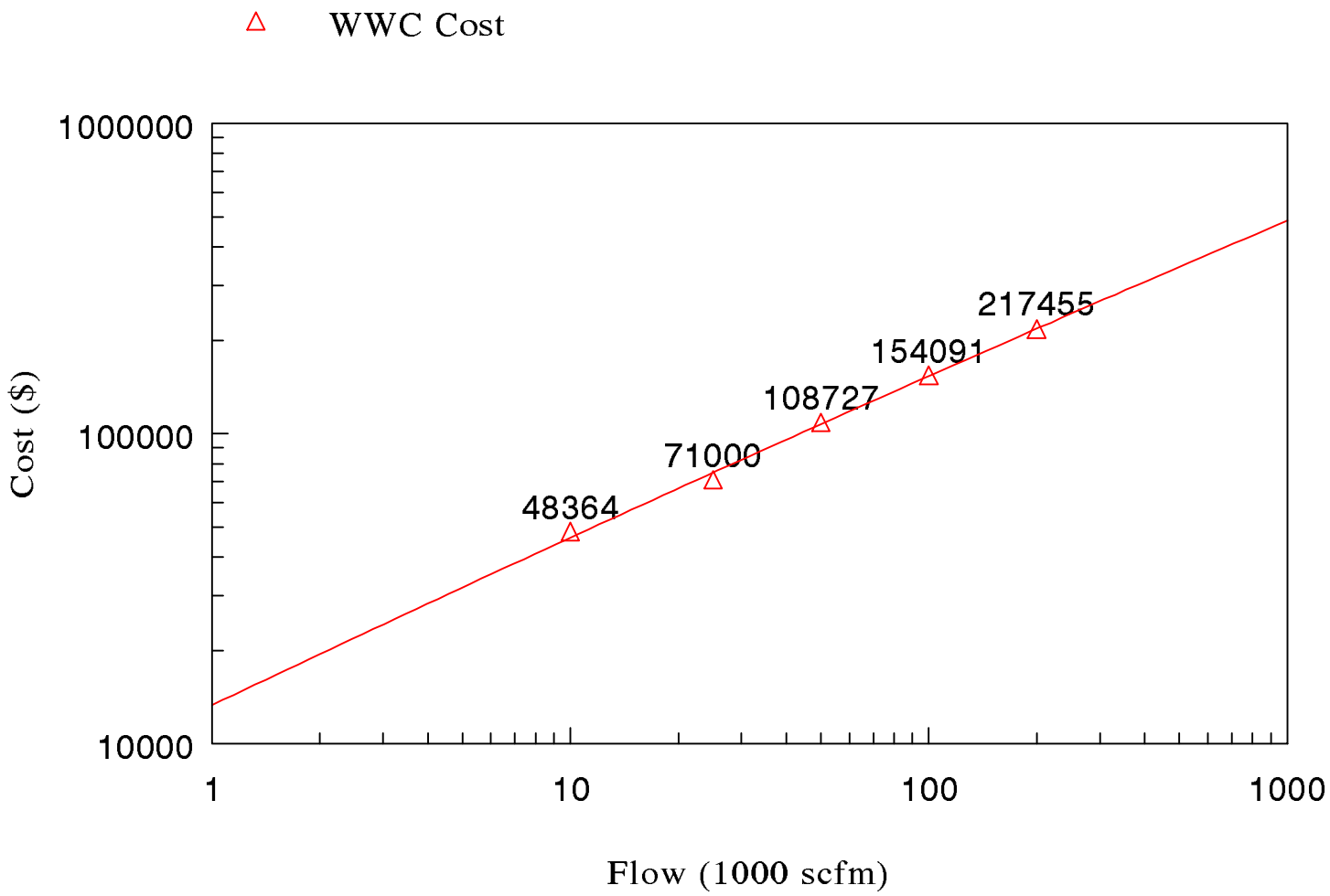


Figure 9-16
Secondary Clarifier Capital Cost Curve

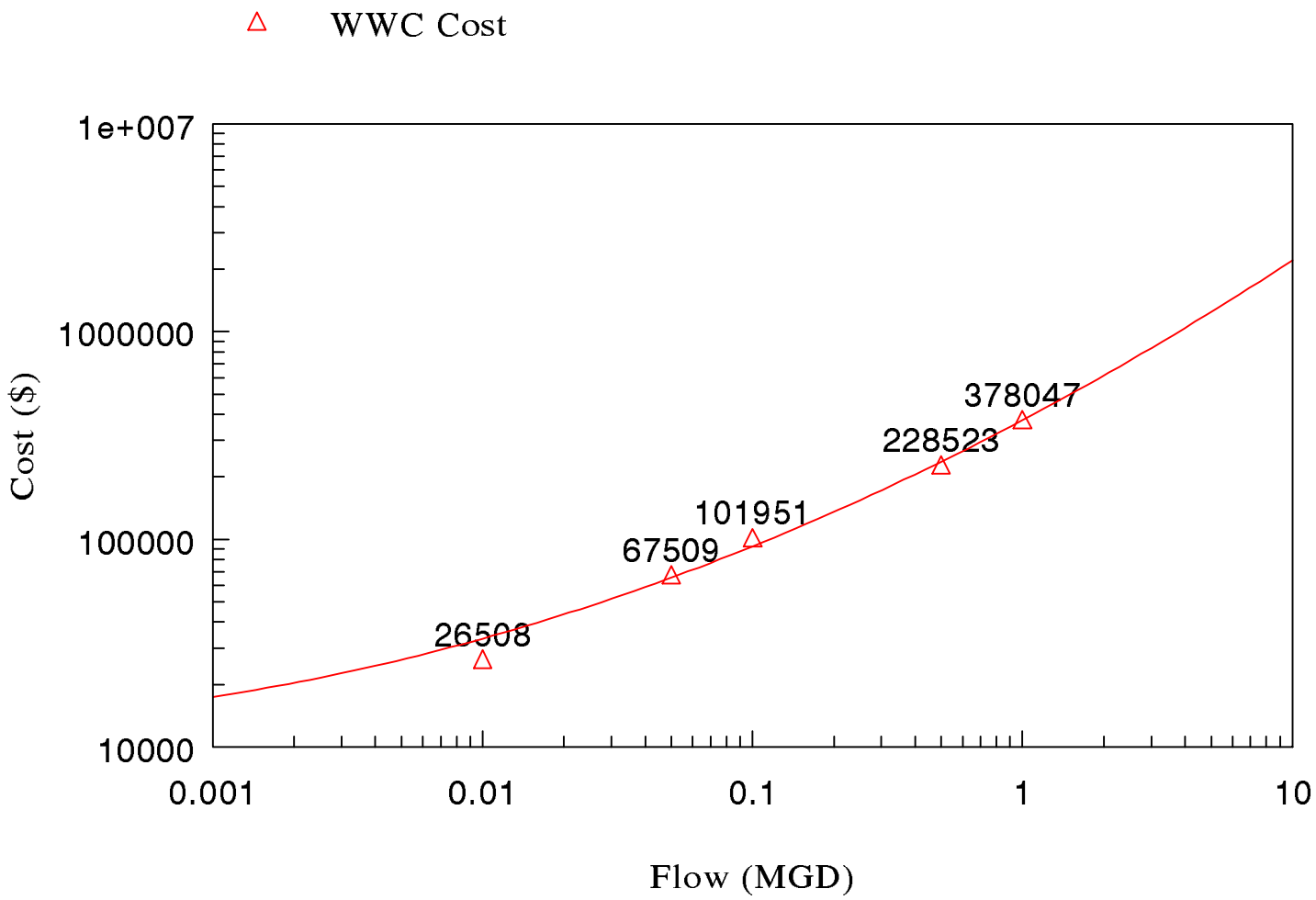


Figure 9-17
Secondary Clarifier O&M Cost Curve

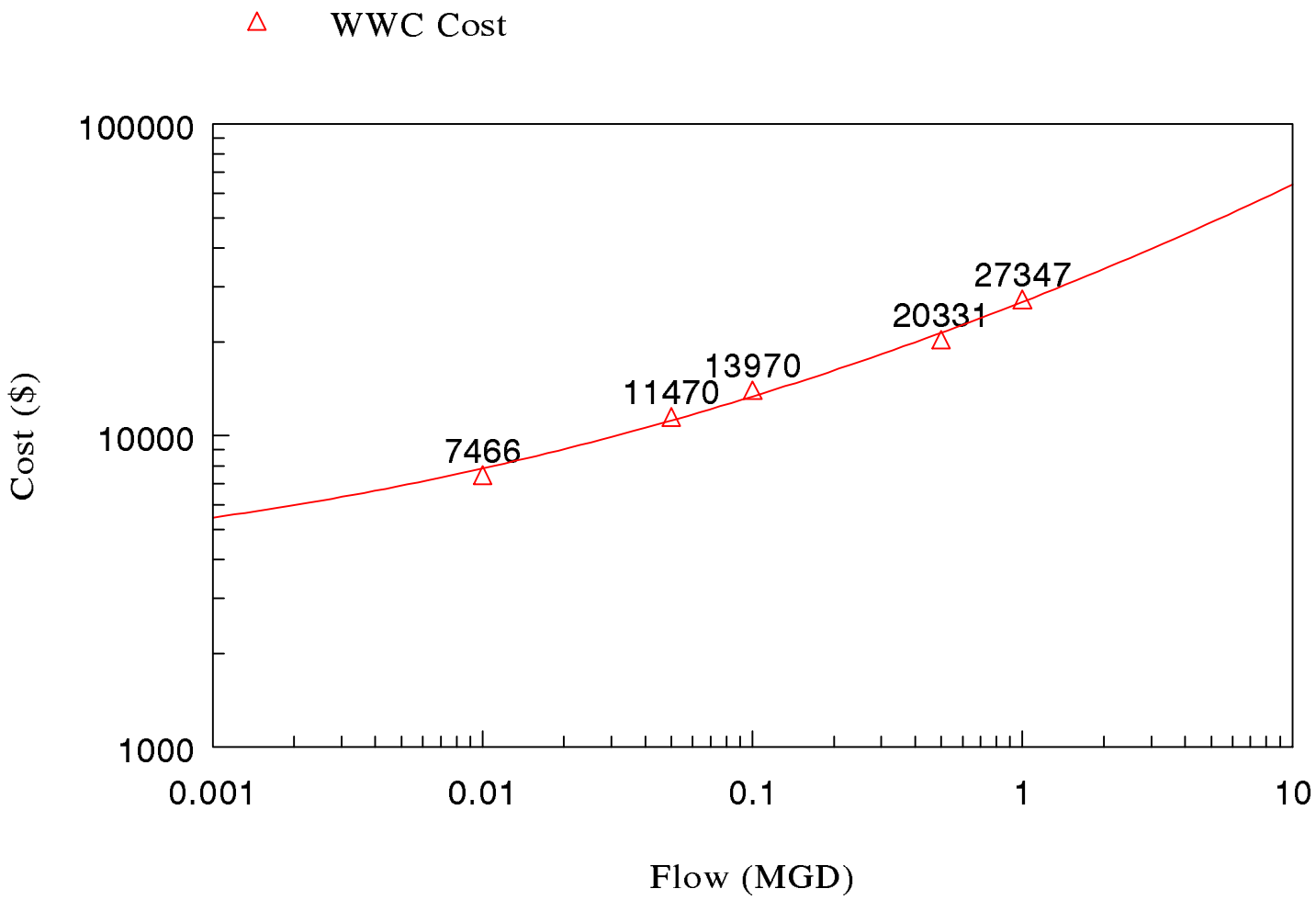


Figure 9-18
Multimedia Filtration Capital Cost Curve

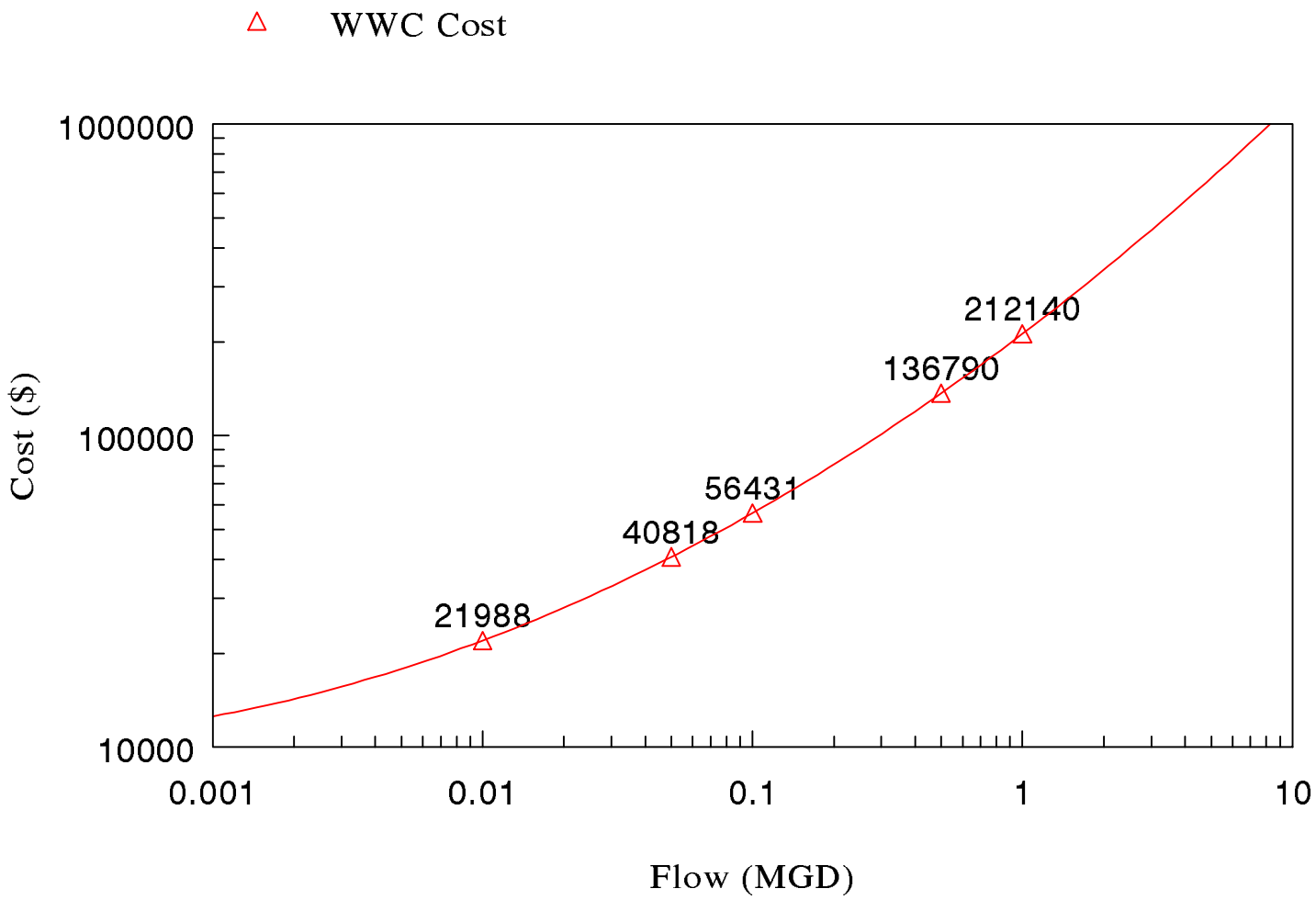


Figure 9-19
Multimedia Filtration O&M Cost Curve

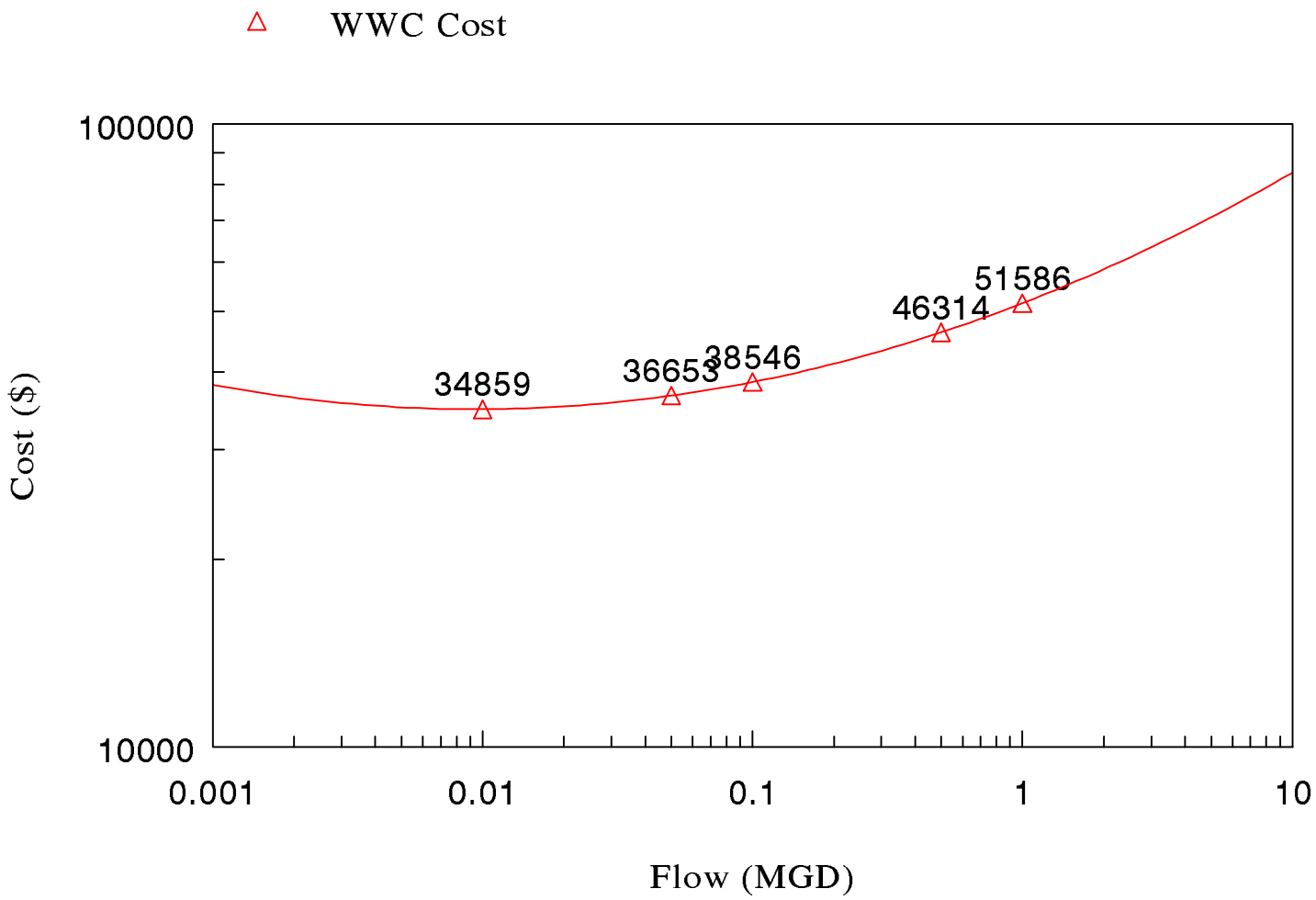


Figure 9-20
Reverse Osmosis Capital Cost Curve

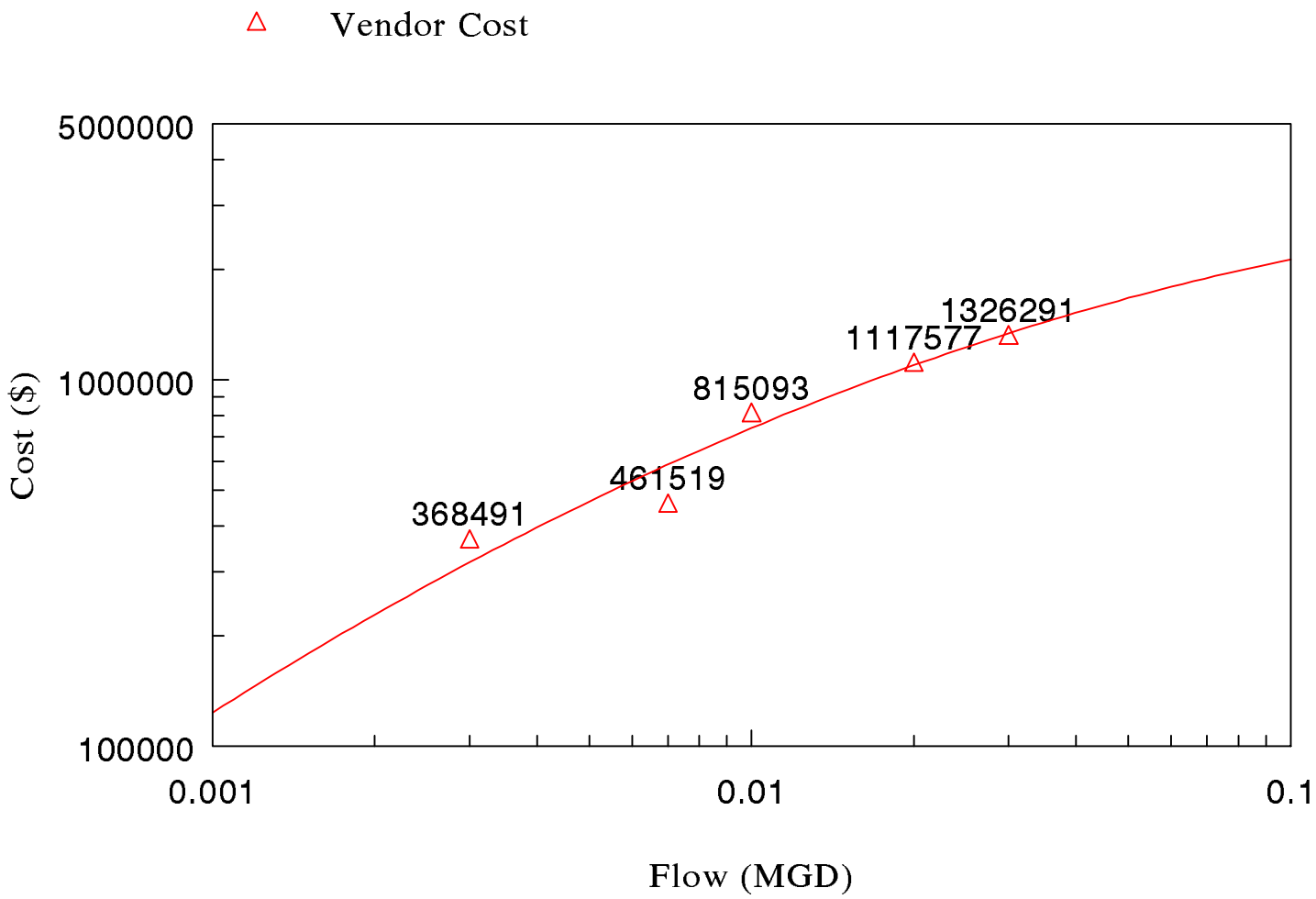


Figure 9-21
Sludge Drying Beds Capital Cost Curve

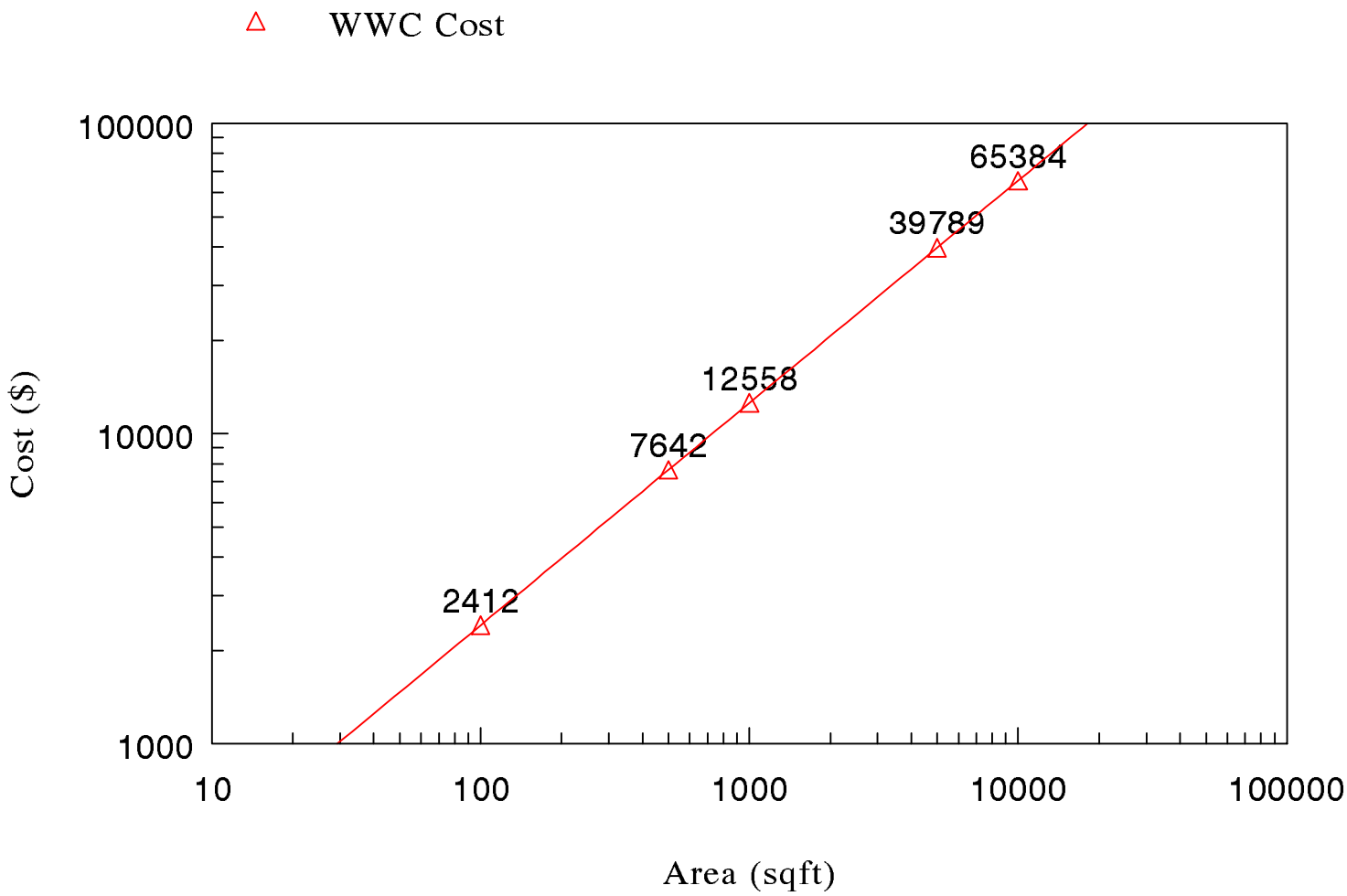


Figure 9-22
Sludge Drying Beds O&M Cost Curve

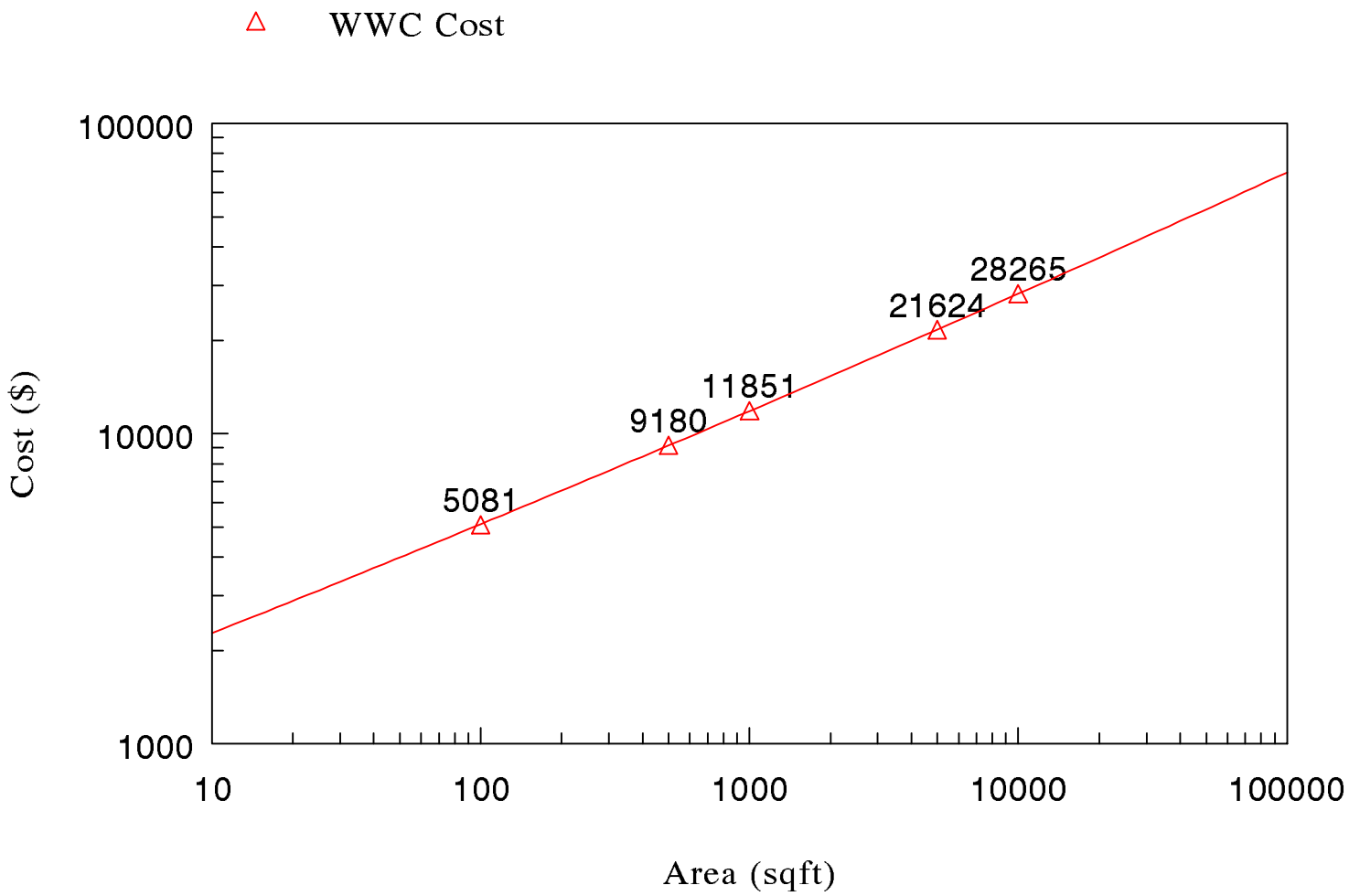


Figure 9-23
GAC Capital Cost Curve

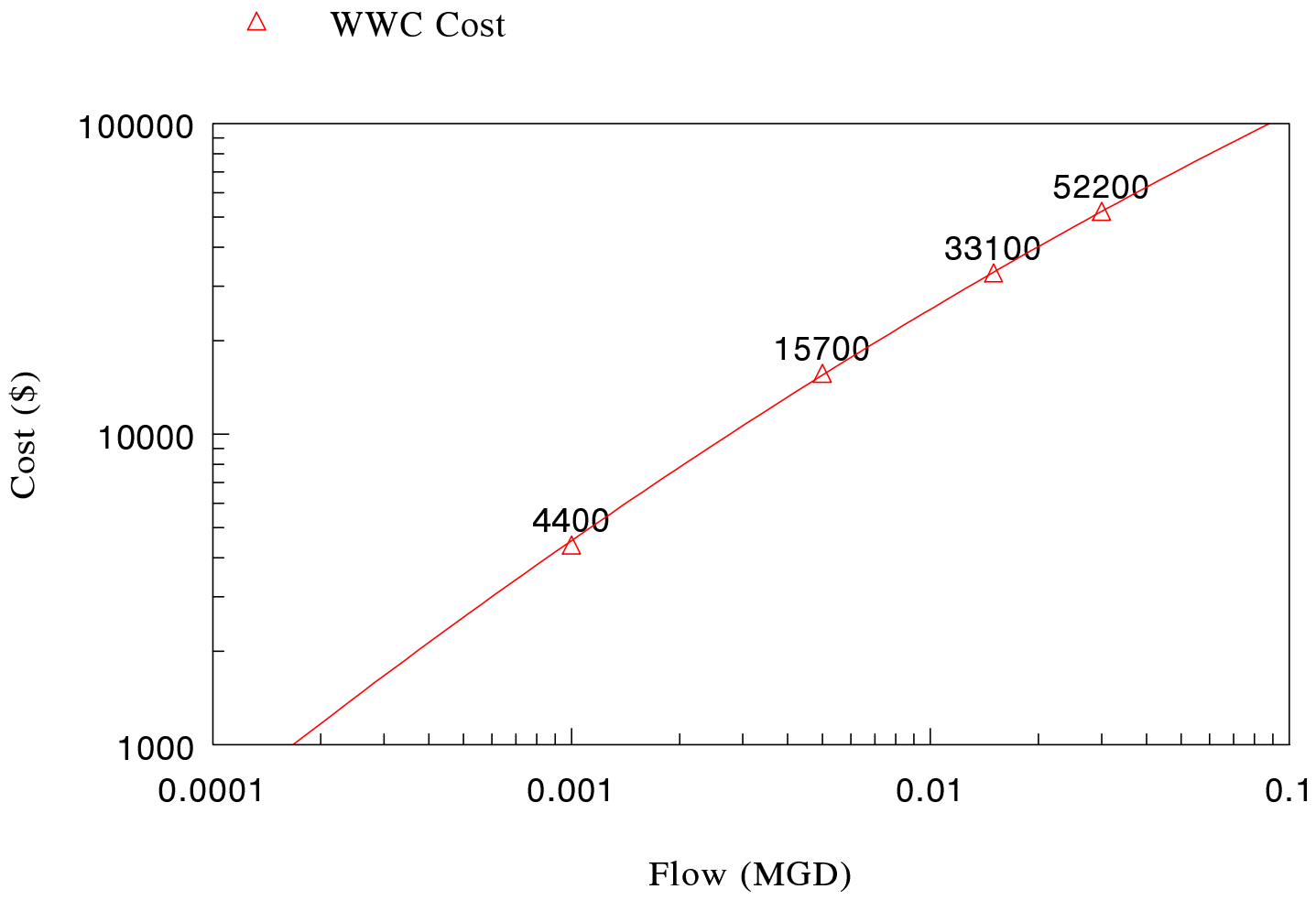


Figure 9-24
GAC O&M Cost Curve

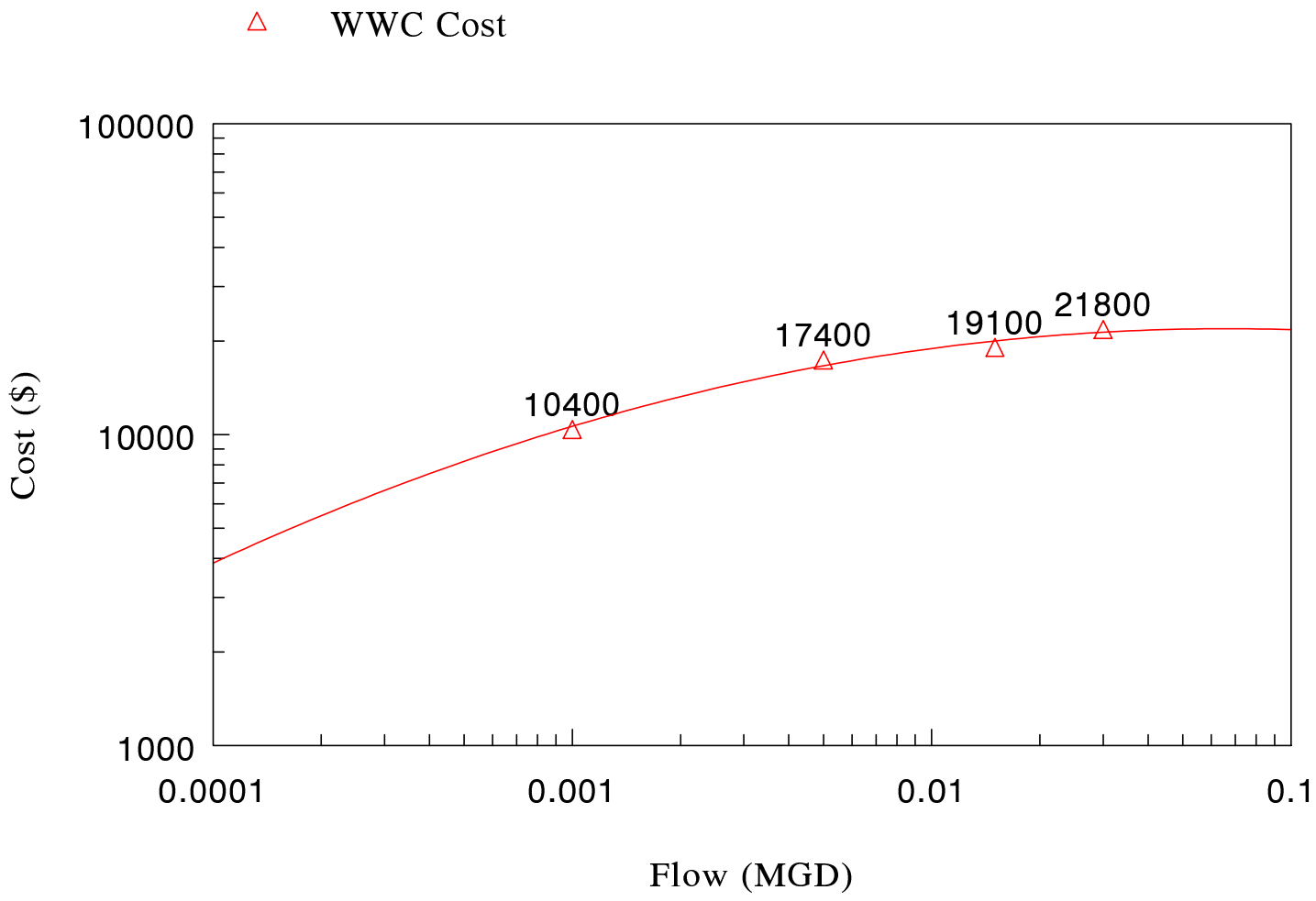


Figure 9-25
Brkpnt Chlorination Capital Cost Curve

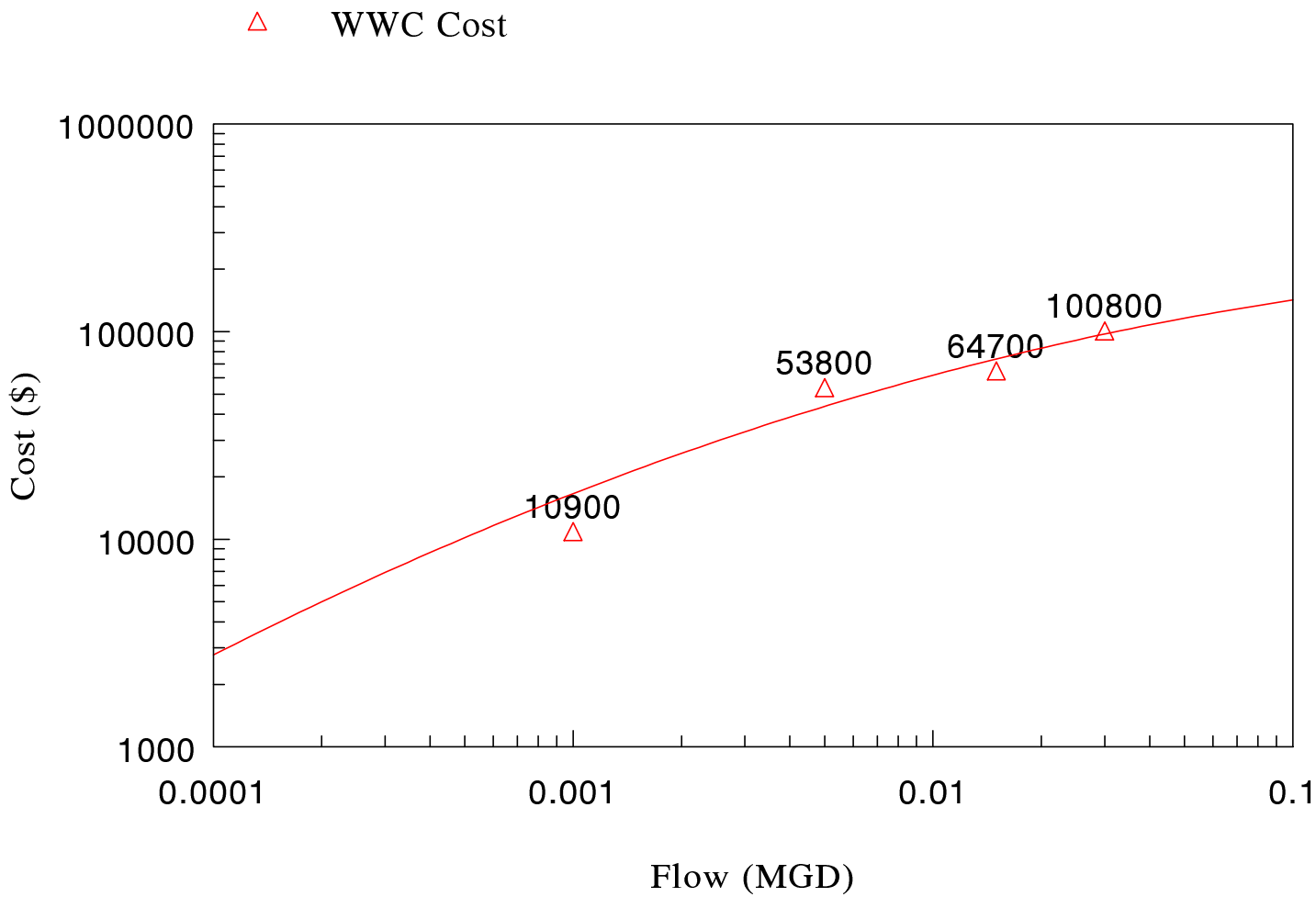
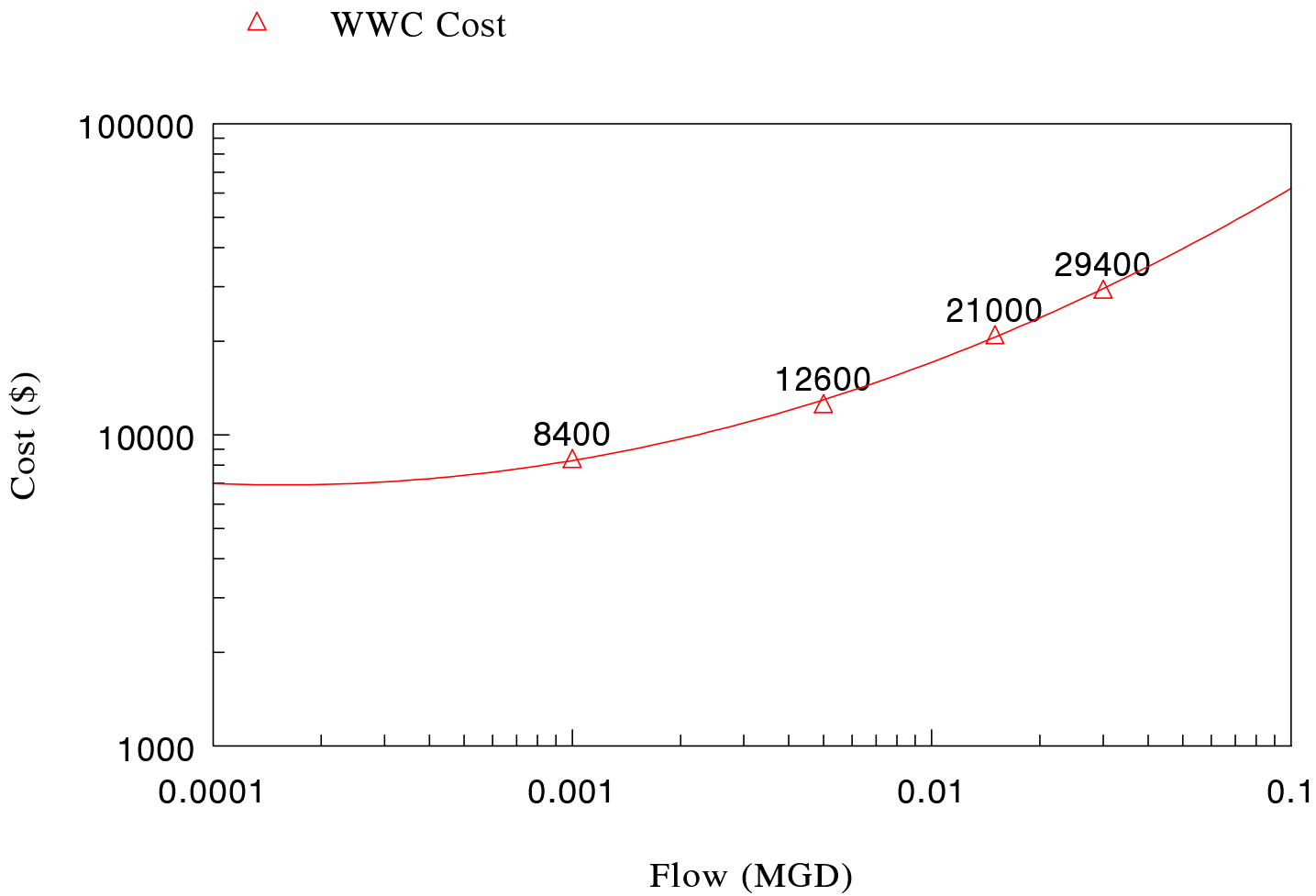


Figure 9-26
Breakpoint Chlorination O&M Cost Curve



10.0 NON-WATER QUALITY IMPACTS

The operation of wastewater treatment systems may have ancillary environmental effects by generating solid and hazardous residuals and air emissions, and by consuming energy in treatment.

The elimination or reduction of one form of pollution may create or aggravate other environmental problems. Therefore, Sections 304(b) and 306 of the Clean Water Act (CWA) require EPA to consider the non-water quality environmental impacts and energy requirements of effluent limitations guidelines and standards. In fulfillment of these requirements, EPA has considered the effect of promulgating the BPT, BCT, BAT, and NSPS regulations for the Landfills industry on the creation of additional air pollution, solid and hazardous waste, and energy consumption.

While it is difficult to balance environmental impacts across all media and energy use, the Agency determined that the impacts identified below do not outweigh the benefits associated with compliance with the limitations and standards.

10.1 Air Pollution

The primary source of air pollution from landfills results from the microbial breakdown of organic wastes from within the landfill. Landfills are known to be major sources of greenhouse gas emissions such as methane and carbon dioxide. These emissions are now regulated under the Clean Air Act (CAA) as a result of the municipal solid waste landfill Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources, promulgated by the EPA on March 12, 1996 (Federal Register: Volume 61, Number 49) and codified in 40 CFR 60 Subpart CC-Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills and Subpart WWW-Standards of Performance for Municipal Solid Waste Landfills. Many non-hazardous solid waste landfills are required to collect and combust the gases generated in the landfill. Wastewater collected from within the landfill contains organic compounds which include volatile organic compounds (VOC) and hazardous air pollutants (HAP). This

wastewater must be collected, treated and stored in units which are often open to the atmosphere and may result in the volatilization of certain compounds. Organic pollutants volatilize in reaching an equilibrium with the vapor phase above the wastewater. These volatile organic compounds are emitted to the ambient air surrounding the collection and treatment units. The magnitude of volatile organic compound emissions is dependent on factors such as the physical properties of the pollutants, the temperature of the wastewater, and the design of the individual collection and treatment units.

The landfill effluent guidelines limitations are based on the performance of an aerated biological system. Wastewater aeration may increase the volatilization of certain organic compounds, a potential environmental concern. However, indications are that the potential increase in air emissions due to the final landfill effluent guideline will be minimal. VOCs in hazardous waste landfill leachate are being steadily minimized due to the Resource Conservation and Recovery Act (RCRA) land disposal restriction rules, which typically require aggressive destructive treatment of organics in hazardous wastes before the waste can be landfilled (see 40 CFR 268.40 and 268.48).[1] VOC levels in historic landfill leachate (from both hazardous and non-hazardous waste landfills dating from the 1930s to the mid-1990s) are also at levels which are low enough as not to call into question EPA's determination to base these rules on the performance of aerated biological systems. Tables 6-9, 6-10, and 6-13 in Chapter 6 show the concentrations of VOCs found in landfill wastewater.

Furthermore, EPA's Office of Air and Radiation is currently evaluating the air emissions from wastewater generated at municipal solid waste landfills, and intends to take this rule into account in determining whether further controls under section 112 of the Clean Air Act (which requires technology-based standards for hazardous air pollutants emitted by major sources of emissions of those pollutants) are justified.

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[1] There are certain exceptions to these treatment requirements for hazardous wastewater which is disposed in surface impoundments. RCRA section 3005 (j) (11). However, if this wastewater contains VOCs above a designated concentration level, then the impoundments are subject to rules requiring control of the resulting air emissions. 40 CFR 264.1085 and 263.1086.

(Preliminary indications are that hazardous air pollutant emissions from aeration would be a minor fraction of those from other landfill emission sources such as landfill gas emissions.)

In addition, EPA is addressing emissions of volatile organic compounds from industrial wastewater through a Control Techniques Guideline (CTG) under Section 110 of the CAA. CAA amendments require that State implementation plans for certain ozone nonattainment areas be revised to require the implementation of reasonably available control technology (RACT) for control of volatile organic compound emissions from sources for which EPA has prepared CTGs. In September, 1992, EPA published a draft CTG document entitled "Control of Volatile Organic Compound Emissions from Industrial Wastewater." (EPA-453/0-93-056). This document addresses various industries, including the hazardous waste treatment, storage, and disposal facilities (TSDF) industry, and outlines volatile organic compound emissions expected from their wastewater treatment systems and methods for controlling them. For CTG guideline purposes, EPA has included Subtitle C and D landfills with leachate collection systems in the TSDF industry. EPA estimates that nearly all landfills affected by the Landfills effluent guideline will be subject to this CTG for volatile emissions from their wastewater treatment systems. It was estimated in the CTG draft document that 43 percent of the facilities in the TSDF industry are located in areas of ozone nonattainment. In 1994, the draft CTGs were revised to reflect changes that were made in the wastewater provisions of the Hazardous Organic National Emission Standards for Hazardous Air Pollutants promulgated by the EPA on April 22, 1994 (Federal Register: Volume 59, Number 19). EPA published these changes to the CTGs in a document entitled "Industrial Wastewater Alternative Control Technology".

10.2 Solid and Other Aqueous Waste

Several of the wastewater treatment technologies available to comply with the landfills regulation will generate solid and other aqueous waste. The costs for the disposal of these other waste residuals were included in the compliance cost estimates prepared for the regulatory options. Solid wastes generated by a number of the BPT, BCT, and BAT wastewater treatment technologies include sludge from clarifiers

associated with biological treatment and chemical precipitation systems and backwash waters from filtration systems.

In surveying both subcategories of this industry, EPA determined that it is common practice to dispose of the sludges generated by the on-site wastewater treatment systems directly back into the landfills. This practice eliminates the need for, and the costs associated with, off-site disposal. Analysis of sludge data collected as part of this study also indicates that sludges generated by wastewater treatment systems at landfills in the Subtitle D Non-Hazardous subcategory are non-hazardous, allowing them to be disposed of at the landfill sites from which they are generated.

Waste sludge generated by wastewater treatment facilities at landfills in the Subtitle C Hazardous subcategory may be a hazardous waste, depending upon factors such as the characteristics of the waste deposited in the landfill and the design and operation of the wastewater treatment system. If listed hazardous wastes, as per 40 CFR 261 Subpart D, are disposed of into the landfill, the resultant sludges from the treatment of landfill generated wastewater will be considered a hazardous waste. Based upon the "derived-from" rule found in 40 CFR 261.3(c)(2), the sludge will have the same RCRA waste code as the waste in the landfill for monofills. For hazardous waste landfills which dispose of more than one type of listed hazardous waste and generate a multi-source leachate, the sludge from treatment of the leachate will have the F039 RCRA waste code. Sludges from a treated leachate at a landfill which handles only characteristic wastes, as per 40 CFR 261 Subpart C, will need to be analyzed to determine whether it exhibits any of the characteristics of a hazardous waste as per 40 CFR 261 Subpart C. EPA has developed land disposal restrictions as found in 40 CFR 268. This regulation places restrictions on the land disposal of wastes and specifies treatment standards that must be met before wastes can be land disposed. For purposes of this regulation, EPA has assumed that dried sludges from facilities in the Subtitle C Hazardous subcategory will be returned to the on-site landfill for disposal. Similarly, EPA has assumed dried sludges from Subtitle D non-hazardous facilities will be returned to the on-site landfill for disposal.

Listed or characteristically hazardous waste sludges are to meet applicable treatment standards prior to disposal.

The increased amount of sludge created due to this regulation will be negligible in comparison to the daily volumes of waste processed and disposed in a typical landfill, whether non-hazardous or hazardous. As a result, the practice of on-site disposal has a minimal impact on landfill capacity. For example, based on national estimates, the Subtitle D Non-Hazardous subcategory processed approximately 5,300 million tons of waste in 1992. The BPT/BCT/BAT wastewater treatment options will generate approximately 0.0044 million tons per year of waste solids or only 8.3×10^{-5} percent of the volume of waste disposed into the landfill. For the Subtitle C Hazardous subcategory, the BPT/BCT/BAT option will generate approximately 194 tons per year of solids, as compared to the national estimate of 550 million tons of waste processed, which equates to 3.5×10^{-5} percent.

Filtration backwash waters are generally recycled to the beginning of the wastewater treatment system for reprocessing. This practice eliminates the generation of a waste stream needing disposal.

10.3 Energy Requirements

The operation of wastewater treatment equipment results in the consumption of energy. EPA estimates that the attainment of the BPT, BCT, and BAT standards will increase energy consumption by a very small increment over present industry use. The treatment technologies that are the basis for the limitations and standards are not energy-intensive, and the projected increase in energy consumption is primarily due to the incorporation of components such as power pumps, mixers, blowers, power lighting and controls, and heating devices. The associated energy costs are included in EPA's estimated operating costs for compliance with the guideline presented in Chapter 9. For example, the BPT/BCT/BAT Option 2 for the Subtitle D Non-Hazardous subcategory is estimated to consume 3,300 megawatt-hour per year (Mwhr/year). This is equivalent to approximately 1,800 barrels per year of No.2 fuel oil, as compared to the 1992 rate of consumption in the United States of 40.6 million barrels per year. The additional energy

demand imposed by this regulatory option will represent an insignificant increase in the production or importation of fuel oil. For the Subtitle C Hazardous subcategory, the regulatory option is estimated to consume 37.3 Mwhr/yr or an equivalent 21 barrels per year of No.2 fuel oil.

11.0 DEVELOPMENT OF EFFLUENT LIMITATIONS AND STANDARDS

This chapter presents the final effluent limitations guidelines and standards for the landfills point source category. EPA bases the final effluent limitations upon the performance of selected wastewater treatment systems at landfill facilities and develops limitations expressed as monthly-average and daily-maximum concentrations. The following sections discuss the development of the numerical, technology-based limitations:

- Development of Long-Term Averages, Variability Factors, and Effluent Limitations
- Best Practicable Control Technology Currently Available (BPT)
- Best Conventional Pollutant Control Technology (BCT)
- Best Available Technology Economically Achievable (BAT)
- New Source Performance Standards (NSPS)
- Pretreatment Standards for Existing Sources (PSES)
- Pretreatment Standards for New Sources (PSNS)

11.1 Development of Long-Term Averages, Variability Factors, and Effluent Limitations

The section below presents a summary of the statistical methodology used in the calculation of effluent limitations. (As explained in section 11.6, et.seq., EPA decided not to establish pretreatment standards for landfills). A more detailed explanation can be found in the "Statistical Support Document for the Final Effluent Limitations Guidelines and Standards for the Landfills Point Source Category" (EPA-821-B-99-007).

EPA bases effluent limitations for each subcategory on a combination of long-term average effluent concentrations and variability factors that account for variation in treatment performance within a treatment system over time. The Agency developed variability factors and long-term averages from a database

composed of individual daily measurements of treated effluent at landfills. EPA collected technology performance data from field sampling efforts and from industry-supplied data provided in the Detailed Monitoring Questionnaire. In Chapter 4, EPA presents a detailed description of each data source. While EPA sampling data typically reflects the daily performance of a system over a 5-day period, industry-supplied data for this guideline (collected through the Detailed Monitoring Questionnaire) reflected up to three years of data. The monitoring data obtained through the Detailed Monitoring Questionnaire is unique to each facility in terms of the number of parameters analyzed and the monitoring frequency. Several facilities provided information for dozens of pollutants, while others provided data for only a few parameters. Additionally, monitoring may have been performed weekly, monthly, or quarterly. Wherever possible, when calculating effluent limitations, EPA used a combination of industry-supplied data and EPA sampling data to better account for the variability of the treatment of landfill leachate over time.

EPA used these data to develop long-term average concentrations and variability factors, by pollutant and technology option, for each subcategory. The Agency calculated the final limitations by multiplying long-term average concentrations by the appropriate variability factors. The following paragraphs briefly describe how EPA determined each of these values. As mentioned above, EPA presents the detailed methodology and data in the Statistical Support Document.

11.1.1 Calculation of Long-Term Averages

For each pollutant selected for regulation (see Chapter 7), EPA calculated long-term average effluent concentrations for each regulatory option and subcategory. The first step was to select representative facilities from the EPA database for each option. In Section 11.2, EPA explains the criteria used in facility selection. After selecting the facilities that best represented a technology option, EPA reviewed the influent and effluent data supplied for each of the regulated pollutants. In calculating limitations, the Agency used effluent data from EPA sampling episodes and Detailed Monitoring Questionnaires, but it did not use effluent data from the Detailed Questionnaire. The pollutant data submitted in the Detailed Questionnaire contained the average concentration, the minimum and maximum concentrations, and the number of

samples, whereas EPA sampling data and the Detailed Monitoring Questionnaire consisted of individual daily data. In developing limits, EPA calculated the long-term averages and variability factors using individual daily data. Furthermore, summary data (like the data submitted in the Detailed Questionnaire) may obscure the minimum detection levels used in the sampling data. The use of daily data (like the Detailed Monitoring Questionnaire and EPA sampling data) in developing limitations allows EPA to account for concentration values reported at or below the detection limits. EPA set observations below the sample-specific detection level equal to the detection level for the purposes of calculating a facility-level long-term average. In addition, in many cases, EPA considered reported averages from the Detailed Questionnaires redundant because many facilities also reported the daily data from the Detailed Monitoring Questionnaire for the same time period in 1992 and, therefore, EPA would not have used the data in the calculation of limits. However, in determining whether a pollutant was present at treatable levels, EPA relied on data from any of the three pollutant data sources: Detailed Questionnaire, Detailed Monitoring Questionnaire, and EPA analytical sampling episodes. EPA used effluent data from a facility only if sufficient influent data were available to establish the presence of treatable levels of pollutants. In addition, for each of the regulated pollutants, the Agency analyzed all of the selected facilities to determine if the facility was utilizing treatment technologies, apart from those selected as the technology option, that may provide significant removals of that particular pollutant. For example, the data from a facility that employed carbon adsorption (a treatment technology that was not part of a selected technology option) would not be used in the calculation of the limit for a pollutant that may be treated by carbon adsorption. However, if an intermediate data point that preceded carbon adsorption treatment were available for this facility, then EPA did consider the use of that data point to characterize the performance of the treatment system up to that point. Furthermore, EPA edited EPA sampling data according to the criteria outlined in Chapter 4, Section 4.9.

Once EPA selected the facilities and effluent data points, the Agency calculated the average effluent concentration for each regulated pollutant at each facility. For facilities that EPA had data for both five-day EPA sampling and industry-supplied Detailed Monitoring Questionnaires (representing data collected over

the course of at least a year), EPA calculated long-term averages separately as long as the dates for the two data sets did not overlap. Therefore, by using both data sets, the long-term average accounted for the variability of leachate over a longer period of time.

The Agency estimated the long-term average for each regulated pollutant for each BPT/BAT facility by fitting a modified delta-lognormal distribution to the daily concentration data. The modified delta-lognormal distribution models the data as a mixture of non-detect observations and measured values that follow a lognormal distribution. The Agency selected this distribution because of the following reasons: (1) the data for many analytes consisted of a mixture of non-detects and measured values that were approximately lognormal, and (2) in cases where there are no non-detects, the distribution is equivalent to the usual two-parameter lognormal. This is the same basic distributional model used by EPA in the final rulemakings for the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF; 40 CFR Part 414) and the Pulp and Paper category (40 CFR Part 430) and for the proposed rulemaking for the Centralized Waste Treatment industrial category (proposed 40 CFR Part 437, 64 FR 2280 January 13, 1999). In the Pulp and Paper and the Centralized Waste Treatment studies, the modified delta-lognormal distribution assumes that all non-detects have a value equal to the reported sample-specific detection levels and that the detected values follow a lognormal distribution. EPA again used this model as the basis of estimates of the long-term average at a landfill facility. In the case of the OCPSF rule, EPA used the same basic model but the reported non-detect values were set equal to the pollutant analytical minimum level. A more detailed discussion of the modified delta-lognormal distribution can be found in the "Statistical Support Document for the Final Effluent Limitations Guidelines and Standards for the Landfills Point Source Category" (EPA-821-B-99-007).

After EPA developed the facility-level long-term averages for each regulated pollutant using the criteria outlined above, the Agency determined the median of the facility-level long-term averages for each regulated pollutant in each subcategory. The median of the facility-level long-term averages for each

regulated pollutant was the long-term average used in the calculation of the effluent limitation as described later in this section.

11.1.2 Calculation of Variability Factors

EPA calculated variability factors using the same data sets used to derive the long-term average values. As with the calculation of the long-term averages, EPA fit the daily concentration data to a modified delta-lognormal distribution. The Agency calculated separate variability factors for different averaging periods (either 1-day, 4-day, or 20-day averages). Thus, EPA applied different variability factors to daily data (single measurements without averaging) and to monthly-average data based on four measurements taken once per week ("4-day averages") or 20 measurements taken once each day, five days a week throughout a month ("20-day average").

For those facility data sets that had at least four observations for a given regulated pollutant, including two detected values, EPA used the modified delta-lognormal model to estimate daily and 4-day or 20-day average variability factors. There were several instances where EPA could not calculate variability factors from the landfills database because EPA measured fewer than two samples above the detection limit. In these cases, the Agency transferred variability factors from biological treatment systems used in the final rulemaking of the OCPSF guideline (40 CFR Part 414).

As stated above, in calculating the variability factors, EPA assumed a log-normal distribution of the data. In addition, the Agency used the following:

- The 95th percentile to establish the maximum monthly average.
- The 99th percentile to establish the maximum for any one day.

EPA defines the daily variability factor as the ratio of the estimated 99th percentile of the distribution of daily values to the estimated mean of the distribution. Similarly, the Agency defines the monthly variability

factor as the estimated 95th percentile of the distribution of 4-day or 20-day averages divided by the estimated mean of the monthly averages. EPA derived a monthly-average and daily-maximum variability factor for each pollutant and for each regulatory option. For each subcategory, the Agency defined the daily variability factor for each pollutant as the average of the facility-level daily variability factor. Likewise, EPA defines the 4-day average variability factor for each pollutant as the average of the facility-level 4-day average variability factors and the 20-day average variability factor for each pollutant as the average of the facility-level 20-day average variability factors.

11.1.3 Calculation of Effluent Limitations

The Agency used the median long-term average and the average variability factor for each pollutant in the calculation of the effluent limitations. For each subcategory, EPA calculated the daily-maximum limitations by multiplying the median of the long-term average for a given pollutant by the average daily variability factor for that pollutant. EPA calculated the monthly-maximum limitations by multiplying the median long-term average for a given pollutant by the average 4-day or 20-day variability factors for that pollutant. The Agency used twenty-day average limitations for the conventional pollutants, BOD_5 and TSS, and four-day average limitations for other nonconventional and toxic pollutants.

11.2 Best Practicable Control Technology Currently Available (BPT)

EPA promulgated BPT effluent limitations for the Subtitle D Non-Hazardous and Subtitle C Hazardous subcategories. BPT effluent limitations control identified conventional, toxic, and nonconventional pollutants when discharged from landfill facilities to surface waters of the U.S. Generally, EPA determines BPT effluent levels based on the average of the best existing performance by facilities of various sizes, ages, and unit processes within an industrial category or subcategory. In industrial categories where present practices are uniformly inadequate, however, EPA may determine that BPT requires higher levels of control than any currently in place if the technology to achieve those levels can be practicably applied. BPT may be transferred from a different category or subcategory. BPT normally focuses on end-of-process treatment

rather than process changes or internal controls, except when these technologies are common industry practice.

In addition, the Clean Water Act (CWA) Section 304(b)(1)(B) requires a cost-reasonableness assessment for BPT limitations. In determining the BPT limits, EPA must consider the total cost of treatment technologies in relation to the effluent reduction benefits achieved. This inquiry does not limit EPA's broad discretion to adopt BPT limitations that are achievable with available technology unless the required additional reductions are "wholly out of proportion to the costs of achieving such marginal level of reduction." A Legislative History of the Water Pollution Control Act Amendments of 1972, p. 170. Moreover, the inquiry does not require the Agency to quantify benefits in monetary terms. See e.g. *American Iron and Steel Institute* v. *EPA*, 526 F. 2d 1027 (3rd Cir., 1975).

In assessing the costs relative to the benefits of effluent reduction, EPA considers the volume and nature of expected discharges after application of BPT, the general environmental effects of pollutants, and the cost and economic impacts of the required level of pollution control. In developing guidelines, the Act does not require or permit consideration of water quality problems attributable to particular point sources, or water quality improvements in particular bodies of water. Therefore, EPA has not considered these factors in developing the final limitations. See *Weyerhaeuser Company* v. *Costle*, 590 F. 2d 1011 (D.C. Cir. 1978).

In setting BPT limitations based on a treatment technology, EPA does not require the use of that technology to treat landfill wastewater. Rather, to establish the limits, EPA has demonstrated that the concentration limits are achievable based on a well-operated system using selected technologies. The technologies that may be used to treat wastewater are left entirely to the discretion of the individual landfill operator, as long as the numerical discharge limits are achieved.

11.2.1 BPT Technology Options for the Subtitle D Non-Hazardous Subcategory

In the Agency's engineering assessment of the best practicable control technology currently available for treatment of wastewater from landfills, EPA first considered three technologies commonly in use by landfills and other industries as options for BPT: chemical precipitation, biological treatment, and multimedia filtration.

For its evaluation of chemical precipitation, EPA collected raw wastewater and treated effluent data from several non-hazardous landfills employing this technology. Based on these data, EPA removed chemical precipitation from further consideration as a BPT treatment option. While chemical precipitation is an effective treatment technology for the removal of metals, non-hazardous landfills typically have low concentrations of metals in treatment system influent wastewater. Observed metals concentrations were typically not found at levels that would inhibit biological treatment or that would be effectively removed by a chemical precipitation unit.

EPA sampling data collected at facilities in the Non-Hazardous subcategory showed relatively low levels (less than 1 mg/L) of pollutant of interest metals in untreated landfill generated wastewater. Furthermore, Table 11-1 presents several sources of performance data for metals removals in activated sludge systems along with published biological treatment inhibition ranges and raw wastewater characteristics from the non-hazardous facilities in the EPA database. Performance data for metals from biological treatment systems were obtained from the National Risk Management Research Laboratory (NRMRL) Treatability Database (formerly called the Risk Reduction Engineering Laboratory (RREL) Treatability Database), the 50-POTW Study, and a sampling program conducted at twelve OCPSF facilities that have biological treatment systems. Metal concentrations in the raw wastewater for this subcategory are below, or close to, the published inhibition levels for biological treatment systems. A review of performance data indicates that certain pollutant of interest metals, such as chromium and zinc, are removed by well-operated biological treatment processes at relatively high rates. See Table 11-1.

Based on this analysis, EPA concluded that pollutant of interest metals observed in the Non-Hazardous subcategory generally are present in landfill generated wastewater at levels that should not effect the operation and performance of a biological treatment system. Under these circumstances, biological treatment removes the metals identified as pollutants of interest in the Non-Hazardous subcategory. Therefore, EPA concluded that biological treatment is an adequate BPT control technology for pollutant of interest metals in the Non-Hazardous subcategory.

Based on the above assessment, EPA developed the following BPT regulatory options. Chapter 8 discusses these two technology options in detail and Chapter 9 discusses the cost estimates developed for these options.

Non-Hazardous Subcategory Option I: Biological Treatment

EPA first assessed the pollutant removal performance of equalization and biological treatment. EPA evaluated this as Option I due to its effectiveness in removing the large organic loads commonly associated with leachate. BPT Option I consists of aerated equalization followed by biological treatment. EPA included various types of biological treatment such as activated sludge, aerated lagoons, and anaerobic and aerobic biological towers or fixed film reactors in calculating limits for this option. The Agency based the costs for Option I on the cost of aerated equalization followed by an extended aeration activated sludge system and clarification, including sludge dewatering. Figure 11-1 presents a flow diagram of the treatment system costed for Option I. Approximately thirty percent of the direct-discharging municipal solid waste landfills employed some form of biological treatment, and fifteen percent had a combination of equalization and biological treatment.

Non-Hazardous Subcategory Option II: Biological Treatment and Multimedia Filtration

The second technology option considered for BPT treatment of non-hazardous landfill wastewater was equalization prior to biological treatment, followed by secondary clarification and multimedia filtration. EPA evaluated this as Option II due to its effectiveness in removing the large organic loads and suspended solids

commonly associated with leachate. Approximately nine percent of the direct discharging non-hazardous facilities used the technologies described in Option II. EPA based cost estimates for Option II on the cost of Option I plus a multimedia filtration system. Figure 11-2 presents a flow diagram of the treatment system costed for this option.

Selected BPT Technology Option

EPA selected Option II, equalization prior to biological treatment followed by secondary clarification and multimedia filtration, as the technology basis for BPT limitations for the Non-Hazardous landfills subcategory. EPA selected Option II for the basis of BPT limitations because of the demonstrated ability of biological treatment systems in controlling organics and the effectiveness of multimedia filtration in removing TSS. EPA's decision to base BPT limitations on Option II treatment primarily reflects two factors: the degree of effluent reductions attainable and the total cost of the treatment technologies in relation to the effluent reductions achieved. In assessing BPT, EPA considered the age, size, process, other engineering factors, and non-water quality impacts pertinent to the facilities treating wastes in this subcategory. No basis could be found for identifying different BPT limitations based on age, size, process or other engineering factors. Neither the age nor the size of the landfill facility will directly affect the treatability of the landfill wastewater, as discussed in Chapter 5. For the non-hazardous landfills, the most pertinent factors for establishing the limitations are costs of treatment and the level of effluent reductions obtainable.

EPA has selected Option II based on the comparison of the two options in terms of total costs of achieving the effluent reductions, pounds of pollutant removals, economic impacts, and general environmental effects of the reduced pollutant discharges. BPT Option II removed significantly more pounds of conventional pollutants than Option I with only a moderate associated cost increase. EPA estimated that BPT Option II will cost $340,000 (1998 dollars) more annually than BPT Option I for an additional removal of 142,000 pounds of conventional pollutants (mainly TSS).

Finally, EPA analyzed the costs of both options to determine the economic impact that this rule would have on the Landfills industry. EPA's assessment showed that, under either option, only two facilities would incur significant economic impacts. For this assessment, EPA defined significant economic impacts in two different ways, depending on the ownership of the facility. For privately-owned facilities, significant economic impacts exist when the facility's after-tax cash flow is negative following the addition of compliance costs. For municipally-owned facilities, significant economic impacts occur when the ratio of compliance costs to median household income are greater than one percent. The economic assessment for the final rule is described in the "Economic Analysis for the Final Effluent Limitations Guidelines and Standards for the Landfills Point Source Category." (EPA-821-B-99-005).

11.2.2 BPT Limits for the Subtitle D Non-Hazardous Subcategory

Selection of BPT Facilities

EPA based the final BPT effluent limitations for the Non-Hazardous subcategory on the average of the best existing wastewater treatment systems. The first criterion used in the selection of the average of the best facilities was effective treatment of BOD_5. In selecting BPT facilities, EPA identified facilities that employed either Option I or Option II technologies. Even though EPA selected Option II technologies as the basis for developing the BPT effluent limitations, EPA assumed that very little additional BOD_5 removal would occur because of the multimedia filter employed in Option II and, therefore, facilities employing biological treatment only (Option I) could achieve good removal of BOD_5 and be considered BPT. However, in determining the BPT effluent limitations for TSS, EPA only used the data from the best performers using the entire BPT Option II technology (biological treatment plus a filter) because of the multimedia filtration system's effectiveness in removing suspended solids.

There were 45 municipal solid waste landfill facilities (see Table 11-2) in the EPA database in the Non-Hazardous subcategory that utilized a biological treatment system that was considered for BPT. Even though both Subtitle D municipal solid waste landfills and non-municipal solid waste landfills make up the Non-Hazardous subcategory, EPA only considered municipal solid waste facilities for selection as BPT

for the Non-Hazardous subcategory because the wastewater at these landfills tends to contain a wider array of pollutants than that found at Subtitle D non-municipal facilities. The pollutants found at the non-municipal facilities tended to be a subset of the pollutants found at the municipal facilities. In fact, all nine pollutants of interest for non-municipal facilities were also pollutants of interest for the municipal facilities (see Chapter 7). In addition, EPA's data showed that the pollutants of interest present at non-municipal facilities were present at concentrations similar to, or less than, the concentrations typically found at municipal facilities. Therefore, EPA determined that a treatment system that can adequately control pollutant discharges from a municipal solid waste landfill should also be able to control discharges at Subtitle D non-municipal landfills. EPA discusses its reasons for establishing only one subcategory for non-hazardous landfills in Chapter 5 and discusses alternative technology options and costs of these options in Chapters 8 and 9, respectively.

In addition to the 45 non-hazardous municipal solid waste facilities identified as potential BPT, EPA also evaluated one hazardous facility (16041) in the EPA database. This facility used biological treatment in the form of a sequential batch reactor (SBR) to treat its landfill generated wastewater. The facility commingled leachate from both non-hazardous and hazardous landfills prior to treatment by the SBR. In determining whether it was reasonable to include a facility from the Hazardous subcategory as a potential BPT facility in the Non-Hazardous subcategory, EPA evaluated two different factors. First, because the facility accepted leachate from both hazardous and non-hazardous landfills, EPA sampling data showed that the waste stream contained almost all of the pollutants of interest for the Non-Hazardous subcategory at similar concentrations to those found in the non-hazardous landfill raw wastewater database (see Table 11-3). At this facility, EPA sampling detected all but one of the 32 pollutants of interest for the Non-Hazardous subcategory in the influent concentration (1,4-dioxane) and EPA did not include four others (barium, disulfoton, hexavalent chromium, and n,n-dimethylformamide) in the analytical effort. Therefore, the Agency determined that the raw wastewater concentrations for the non-hazardous pollutants of interest from this hazardous facility were similar to those concentrations found at the non-hazardous facilities. Second, the facility achieved good BOD_5 removal using biological treatment equivalent to BPT Option I.

Therefore, EPA concluded that a treatment system that can adequately control pollutant discharges from a hazardous landfill should also be able to control discharges at non-hazardous landfills.

Based on the assessment above, there were 46 in-scope landfill facilities in the EPA database that employed various forms of biological treatment considered for BPT for the Non-Hazardous subcategory. EPA evaluated these 46 landfill facilities selected as potential BPT candidates to determine the performance across the various types of biological treatment systems. To determine the best performers for biological treatment EPA established a number of criteria. The first criterion used in the selection of the best facilities was effective treatment of BOD_5. Under this criterion, there were several reasons why a facility might be eliminated from the selection of BPT facilities.

Of the 46 landfill facilities treating their wastewater with some form of biological treatment, only 26 facilities provided BOD_5 effluent data in their Detailed Questionnaire or Detailed Monitoring Questionnaire submitted to EPA or in the data that EPA collected during a sampling episode performed at the facility. EPA evaluated these data to assess the performance across the various biological systems. Two facilities, 16119 and 16123, provided carbonaceous BOD (CBOD) data rather than BOD_5 data and, therefore, EPA removed these facilities from further consideration. EPA eliminated the facilities reporting CBOD data because the analytical results of the CBOD tests can differ from the BOD_5 results, especially in cases where ammonia is present in the wastewater. Table 11-4 lists the 20 facilities that EPA eliminated from further consideration as BPT facilities since they did not supply BOD_5 effluent data. Table 11-5 lists the treatment in place at the 26 candidate BPT facilities in the Non-Hazardous subcategory that provided BOD_5 effluent data. Table 11-6 shows, for the 26 candidate BPT facilities, the baseline flow, the facility-average raw wastewater BOD_5 concentration, the facility-average effluent BOD_5 concentration, the influent and effluent BOD_5 concentrations from Section C of the Detailed Questionnaire (DET) data, Detailed Monitoring Questionnaire (DMQ) data, and EPA sampling episodes (ANL) data, and the reason (if any) why EPA eliminated the facility as a BPT facility. EPA determined the average raw wastewater BOD_5 concentration and average effluent BOD_5 concentration at a facility by calculating the flow-weighted average of the facility

data available in Section C of the Detailed Questionnaire, the Detailed Monitoring Questionnaire, and the data collected during the EPA sampling episode.

Because EPA based BPT limitations on the effectiveness of biological treatment, the Agency eliminated facilities that used additional forms of treatment for BOD_5 (other than biological treatment). EPA, therefore, removed two sites (16099, 16125) using carbon treatment in addition to biological treatment from the list of candidate BPT facilities. EPA eliminated another facility from consideration (16117) because it used two separate treatment trains in treating its wastewater, one with biological treatment and the other with chemical precipitation, before commingling the streams at the effluent sample point. After the elimination of these three facilities, 23 potential BPT facilities remained in the EPA non-hazardous landfill database.

To ensure that the facilities were operating effective biological treatment systems, EPA evaluated the influent concentrations of BOD_5 entering the wastewater treatment systems to determine which facilities had influent BOD_5 concentrations that most closely resembled typical non-hazardous landfills. The median concentration of BOD_5 for non-hazardous landfills was 240 mg/L and the average concentration was 1,229 mg/L. EPA determined that facilities with BOD_5 influent concentrations significantly lower than these values would not be representative of typical wastewater concentrations found in the Non-Hazardous subcategory. Therefore, EPA eliminated facilities where the influent BOD_5 was below 100 mg/L. EPA acknowledges that it is possible to operate a biological treatment system with influent BOD_5 concentrations lower than 100 mg/L. In fact, as can be seen in Table 11-6, four of the remaining candidate BPT facilities had influent BOD_5 concentrations much less than 100 mg/L (16077, 16093, 16097, and 16170) and operated biological treatment systems. Three of these four (16077, 16093, 16097) achieved BOD_5 effluent concentrations below the BPT effluent limit despite low influent BOD_5 concentrations. However, EPA did receive a significant number of comments on the proposal stating that the biological treatment option selected as BPT was infeasible for treatment of particular types of landfill leachate (ash monofill wastewater in particular) due to its low organic content. The BOD_5 raw wastewater data submitted by some of these commenters was below 10 mg/L. The Agency acknowledges that in many of these cases

(such as where BOD_5 is less than 10 mg/L), the concentration of organic material in the raw wastewater is too low to support biological treatment. Because the guidelines do not require the installation of any particular technology to meet the limitations, facilities remain free to use whatever technology they choose as long as these technologies can meet the limitations. In response to comments concerning the feasibility of biological treatment for certain types of monofills with very low BOD_5 in their raw leachate, the Agency developed costs for low BOD_5 facilities in the database for alternative, non-biological treatment such as breakpoint chlorination, granular activated carbon, and iron co-precipitation. These alternate forms of non-biological treatment are discussed in Chapter 8 and their associated costs presented in Chapter 9. EPA's decision not to further subcategorize the Non-Hazardous landfill subcategory is discussed in Chapter 5. Therefore, as a result of the influent BOD_5 greater than 100 mg/L edit, EPA did not consider four facilities (16077, 16093, 16097, and 16170) for BPT.

EPA eliminated eight other facilities (16048, 16049, 16052, 16065, 16161, 16164, 16171, and 16176) from BPT consideration because they did not supply BOD_5 influent data (from any data source). EPA did not select two facilities (16127 and 16129) because their raw wastewater streams consisted primarily of non-contaminated storm water or contaminated ground water, which are flows that this regulation does not cover. As discussed in Chapter 6, the Agency did not use monitoring data to characterize landfill generated wastewater from facilities where out-of-scope wastewater contributed greater than 15 percent of the total wastewater flow. Facility 16129 treated a combined raw wastewater influent stream consisting of 92 percent ground water and 7 percent leachate, and facility 16127 treated a combined raw wastewater influent stream consisting of 70 percent storm water and 30 percent leachate. After elimination of these facilities, a total of 9 candidate BPT facilities remained.

The final requirement for BPT selection in the Non-Hazardous landfill subcategory was that the biological treatment system at the facility had to achieve a BOD_5 effluent concentration less than 50 mg/L. EPA determined that facilities not able to maintain an effluent concentration below 50 mg/L were not operating their biological system effectively. Two of the remaining 9 facilities (16088 and 16165) did not achieve

BOD_5 effluent concentrations of less than 50 mg/L, leaving seven facilities in the database. The site-identification numbers for the seven facilities selected as BPT are 16041, 16058, 16118, 16120, 16122, 16132, and 16253.

The seven facilities that met all of the BPT criteria employed various types of biological treatment systems, including activated sludge, a sequential batch reactor, aerobic and anaerobic biological towers or fixed film, and aerated ponds or lagoons. Most of the facilities employed equalization tanks in addition to the biological treatment, while several facilities also employed chemical precipitation and neutralization in their treatment systems. Clarification or sedimentation stages followed the biological treatment systems. Table 11-7 shows the treatment technologies in-place at the facilities selected as BPT for the Non-Hazardous subcategory. EPA used all seven facilities employing well-operated biological treatment systems to calculate the effluent limitations for BOD_5. The average influent BOD_5 concentrations to these seven treatment systems ranged from 150 mg/L to 7,600 mg/L and, as mentioned above, all of the average effluent concentrations for these seven facilities were below 50 mg/L.

While the BOD_5 edits discussed above ensure good biological treatment and a basic level of TSS removal, treatment facilities meeting this level may not necessarily be operated for optimal control of TSS. To ensure that the effluent limitation developed for TSS reflects proper control, EPA established additional editing criteria for TSS.

EPA developed two criteria for editing TSS performance data. In addition to achieving the BOD_5 criteria cited above, EPA required that the facility employ technology sufficient to ensure adequate control of TSS, that is, a sand or multimedia filtration system. Three of the seven well-operated biological systems (16120, 16122, 16253) used sand or multimedia filters as a polishing step for additional control of suspended solids prior to discharge.

The second factor EPA considered was whether the treatment system achieved an effluent TSS concentration less than or equal to 100 mg/L. EPA selected treatment facilities meeting these criteria as the average of the best existing performers for TSS. Table 11-8 lists the baseline flow, the facility-average raw wastewater TSS concentration, the facility-average effluent TSS concentration, the influent and effluent TSS concentrations from Section C of the Detailed Questionnaire (DET) data, the Detailed Monitoring Questionnaire (DMQ) data, and the EPA sampling episode (ANL) data for the seven facilities selected as BPT in the Non-Hazardous subcategory. EPA determined the average raw wastewater TSS concentration and average effluent TSS concentration at a facility by calculating the flow-weighted average of the facility data available in Section C of the Detailed Questionnaire, the Detailed Monitoring Questionnaire, and the data collected during the EPA sampling episode. All three facilities that employed a sand or multimedia filtration system (16120, 16122, and 16253) achieved an effluent TSS concentration far less than 100 mg/L, and therefore EPA included these among the best existing performers for TSS. Although facility 16122 meets the TSS editing criteria, EPA eliminated it from further consideration as BPT for TSS because of potential settling of TSS in aerated tanks immediately prior to the filters that are not part of the selected BPT option. Therefore, EPA selected the remaining two facilities (16120 and 16253) as "average of the best" existing performers for TSS and based the TSS limitations on these two facilities.

EPA determined that the use of a multimedia filter after biological treatment with secondary clarification achieved significantly lower long-term average effluent concentrations of TSS than the other BPT facilities that did not employ multimedia filters after secondary clarification. As shown in Table 11-8, the two facilities (16120 and 16253) that employed multimedia filters after biological treatment with clarification achieved an average effluent TSS concentration of 19.5 mg/L whereas the other BOD_5 BPT facilities without multimedia filters achieved an average effluent concentration of 69.1 mg/L.

Development of BPT Limitations

EPA based the effluent limitations for BOD_5 on all seven non-hazardous BPT facilities; however, the BPT facilities often did not supply data for all of the regulated pollutants. Therefore, EPA used the data available

from the seven non-hazardous BPT facilities to develop the BPT limitations for ammonia, TSS, alpha terpineol, benzoic acid, p-cresol, phenol, and zinc. EPA applied additional editing criteria to the seven BPT facilities to select the "average of the best" existing performers for each of the regulated pollutants. The editing criteria applied to the available data were as follows:

- EPA only used data from the seven facilities which passed the BOD_5 criteria in the calculation of limits (16041, 16058, 16118, 16120, 16122, 16132, and 16253).

- EPA only used data from facilities that passed the TSS criteria in the calculation of TSS limits (16120 and 16253).

- EPA did not use effluent data from the Detailed Questionnaire (16000 series data) in the calculation of effluent limits. The pollutant data submitted in the Detailed Questionnaire contained the average concentration, the minimum and maximum concentrations, and the number of samples, whereas EPA sampling data and the Detailed Monitoring Questionnaire consisted of individual daily data. In developing limits, EPA calculated the long-term averages and variability factors using individual daily data. Furthermore, summary data (like the data submitted in the Detailed Questionnaire) may obscure the minimum detection levels used in the sampling data. The use of daily data (like the Detailed Monitoring Questionnaire and EPA sampling data) in developing limitations allows EPA to account for concentration values reported at or below the detection limits. In addition, in many cases, EPA considered reported averages from Detailed Questionnaires redundant because many facilities also reported the daily data from the Detailed Monitoring Questionnaire for the same time period in 1992 and, therefore, EPA would not have used the data in the calculation of limits. However, EPA did use, in cases where no other influent data were available, influent data from the Detailed Questionnaire to show that a landfill had treatable levels of a pollutant in the wastewater.

- Since chemical precipitation was not part of the selected BPT Option for the Non-Hazardous subcategory, EPA did not use data from BPT facilities employing chemical precipitation when developing limitations for metals. Therefore, since zinc was the only metal regulated, EPA did not include zinc effluent data from four of the seven facilities that employed chemical precipitation in the calculation of zinc limitations (16118, 16120, 16122, and 16253). In the Non-Hazardous subcategory, EPA determined that the levels of zinc found in raw wastewater were at low enough concentrations that chemical precipitation was not a necessary treatment technology. In the Non-Hazardous landfill subcategory, EPA's sampling, for the most part, did not find zinc raw wastewater concentrations that would inhibit biological treatment. In addition, raw wastewater concentrations of zinc were typically less than 1 mg/L, a level that would not be effectively removed by a chemical precipitation system.

- EPA did not use facility data demonstrating zero or negative percent removals in the calculation of limits. No facility data in the Non-Hazardous subcategory met this criterion.

- EPA did not include data from facility 16120 in the calculation of ammonia limitations because the treatment system included air stripping.

- EPA only used effluent data if sufficient influent data were available to establish the presence of treatable levels of pollutants. The Agency only used effluent data in calculating limits if influent data for a given pollutant were available for a facility. In cases where a facility supplied effluent data for a particular pollutant but did not supply influent data in the Detailed Monitoring Questionnaire (or supplied influent data below a treatable level), EPA used the effluent data so long as influent data were available from the EPA sampling episode or the Detailed Questionnaire at a concentration above a treatable level. However, EPA did not use effluent data from EPA sampling episodes to calculate limits unless matching influent data from the EPA sampling episode were at concentrations above treatable levels.

- For the EPA sampling episode at facility 16122, EPA did not use the effluent data collected from sample point 08 in the calculation of the limits because this sample point was located after two aerated holding tanks operated in parallel just prior to the multimedia filter (which was not part of the selected treatment option after biological treatment). Instead, EPA used data from sample point 07 (after biological treatment but before aeration in the holding tanks) in the calculation of limits for the final rule. In addition, EPA did not use effluent data from the Detailed Questionnaire and Detailed Monitoring Questionnaire from facility 16122 in the calculation of limits because the data were from sample point 03, which is located after the aeration tanks.

In Table 11-9, EPA presents the non-hazardous BPT facilities and sample points used to calculate the non-hazardous BPT limitations for conventional, nonconventional, and toxic pollutants. Table 11-10 presents the non-hazardous BPT facilities and sample points that EPA did not use to calculate the BPT limitations and the reason for their exclusion. Table 11-11 presents EPA's final BPT limitations for the Non-Hazardous subcategory.

Tables 11-12 and 11-13 present the national estimates of the pollutant of interest reductions for the BPT/BAT options for the municipal solid waste Subtitle D landfills and non-municipal Subtitle D landfills, respectively. Table 11-14 and Table 11-15 summarize the estimated amount of pollutants discharged

annually from direct discharging municipal landfills and direct-discharging non-municipal landfills, respectively, before and after the implementation of BAT for the Non-Hazardous subcategory.

EPA based all of the estimated costs on a facility installing aerated equalization tanks followed by an activated sludge biological system with clarification and a multimedia filter and included a sludge dewatering system. On a national scale, EPA estimates that the implementation of the BAT effluent limitations will require a capital cost of $18.87 million and annual operating cost of $6.50 million resulting in a total annualized cost of $7.64 million (post-tax) for the Subtitle D Non-Hazardous subcategory (1998 dollars).

11.2.3 BPT Technology Options for the Subtitle C Hazardous Subcategory

EPA's survey of the hazardous landfills industry identified no in-scope respondents that were classified as direct dischargers. All of the hazardous landfills within the scope of the rule are either indirect or zero/alternative dischargers. Consequently, EPA could not evaluate any treatment systems in-place at direct-discharging hazardous landfills for establishing BPT effluent limitations. Therefore, EPA relied on information and data from widely available treatment technologies in use at hazardous landfill facilities discharging indirectly and at non-hazardous landfills discharging directly and indirectly, termed "technology transfer." EPA concluded that the technology in-place at some indirect hazardous landfills is appropriate to use as the basis for regulation of direct dischargers because the wastewater generated at hazardous waste landfills discharging directly would be similar in character to the wastewater from indirect-discharge hazardous waste landfills.

Based on this assessment, EPA developed the following BPT regulatory options for establishing BPT effluent limitations for the Hazardous landfill subcategory: 1) aerated equalization followed by chemical precipitation with clarification and multimedia filtration, 2) aerated equalization followed by chemical precipitation with clarification, biological treatment with secondary clarification, and multimedia filtration, and 3) zero or alternative discharge. Chapter 8 discusses these options in detail and Chapter 9 discusses the cost estimates developed for these options.

Hazardous Subcategory Option I: Chemical Precipitation and Multimedia Filtration

EPA first assessed the pollutant removal performance of equalization, chemical precipitation, and multimedia filtration. EPA evaluated chemical precipitation as a treatment technology because of the metals concentrations typically found in hazardous landfill leachate and the efficient metals removals achieved through chemical precipitation. EPA also evaluated multimedia filtration as an appropriate technology to remove additional levels of metals and TSS following chemical precipitation.

Hazardous Subcategory Option II: Chemical Precipitation, Biological Treatment, and Multimedia Filtration

The second technology option considered for BPT treatment of hazardous landfill wastewater was aerated equalization, chemical precipitation, and biological treatment with secondary clarification, followed by multimedia filtration. EPA evaluated these technologies as Option II because of the effectiveness of chemical precipitation in removing metals and the effectiveness of biological treatment in removing the high organic loads present in the leachate. The Agency considered multimedia filtration to be an appropriate technology for consideration because of its effectiveness in removing TSS and metals remaining after primary or secondary clarification.

Hazardous Subcategory Option III: Zero or Alternative Discharge

Finally, EPA considered a zero or alternative discharge option as BPT Option III because a significant segment of the industry is currently not discharging wastewater to surface waters or to POTWs. The zero or alternative disposal option would require facilities to dispose of their wastewater in a manner that would not result in wastewater discharge to a surface water or a POTW.

Methods of achieving zero or alternative discharge currently in use by hazardous landfills are deep well injection, solidification, and contract hauling of wastewater to a Centralized Waste Treatment (CWT) facility or to a landfill wastewater treatment facility. Thirty seven facilities are estimated to inject landfill

wastewater underground on site, 103 facilities send their wastewater to a CWT or landfill treatment system, and one facility solidifies wastewater.

Selected BPT Technology Option

EPA selected Option II, aerated equalization and chemical precipitation followed by biological treatment with secondary clarification and multimedia filtration, as the technology basis for BPT limitations for the Hazardous landfills subcategory. EPA selected Option II because of the demonstrated ability of biological treatment and multimedia filtration in removing the large organic loads and suspended solids associated with hazardous leachate. Metals in the raw wastewater will be removed prior to the biological treatment system using chemical precipitation. Figure 11-3 presents a flow diagram of the treatment system for this option.

EPA eliminated Option I from consideration because it did not control organic pollutants effectively. In addition, based on consideration of comments submitted on the proposal, EPA decided not to establish BPT limitations based on zero or alternative discharge. EPA concluded that, for the industry as a whole, zero or alternative discharge options are either not viable or the cost is wholly disproportionate to the pollutant reduction benefits and, thus, not "practicable." Furthermore, the commenters' submissions support EPA's decision to reject zero or alternative discharge as the technology basis for BPT (or BAT) limitations for hazardous landfills. While EPA supports the use of zero or alternative discharges particularly where it does not result in media transfer of pollutants, many of the available zero discharge options have identifiable shortcomings, such as transfer of waste residuals to another media (e.g., ground water, soil) or the availability of an alternative disposal option only in certain geographic locations.

For example, one demonstrated alternative disposal option for large wastewater flows is underground injection. However, this is not considered a practically available option on a nationwide basis because it is not allowed in many geographic regions of the country where landfills may be located. These restrictions may preclude underground injection at a given landfill. In such circumstances, landfills would need to resort

to contract hauling to a CWT facility. Unless the CWT itself were a zero discharge facility, the ultimate result would be treatment and discharge to surface waters or a POTW following waste treatment that may be no more effective than that provided on site. This might result in substantial transportation costs for the landfill and associated non-water quality environmental impacts (e.g., truck emissions) resulting in no net reduction in the discharge of pollutants. EPA's survey demonstrated that only landfills with relatively low flows (under 500 gpd) currently contract haul their wastewater to a CWT. The costs of contract hauling are directly proportional to the volume and distance over which the wastewater must be transported, generally making it excessively costly to send large wastewater flows to a CWT, particularly if it is not located nearby.

EPA evaluated the cost of requiring all hazardous landfills to achieve zero or alternative discharge status. For the purposes of costing, EPA assumed that a facility would have to contract haul wastewater off site because it may be impossible to pursue other zero or alternative discharge options. EPA concluded that the cost of contract hauling off site for high flow facilities was unreasonably high and disproportionate to the removals potentially achieved. In addition, EPA concluded that the wastewater shipped to a CWT will typically receive treatment equivalent to that promulgated, and that zero/alternative discharge requirements would result in additional costs to discharge without greater removals for hazardous landfill wastewater. To calculate costs for this option, EPA estimated that all facilities currently discharging to a POTW would have to contract haul wastewater approximately 500 miles to a CWT facility. EPA based cost estimates on a $0.35 per gallon disposal cost at a CWT facility, and $3.00 per loaded mile for transport. EPA estimated the total cost to the industry at approximately $30 million dollars.

11.2.4 BPT Limits for the Subtitle C Hazardous Subcategory

Selection of BPT Facilities

EPA based the BPT effluent limitations for the Hazardous subcategory upon the average of the best existing landfill facilities. Based on the characteristics of hazardous landfill leachate and on an evaluation of appropriate technology options, the Agency selected aerated equalization, chemical precipitation, and

biological treatment followed by secondary clarification and multimedia filtration as BPT technology for the Hazardous subcategory. As previously noted, EPA relied on data from both hazardous and non-hazardous facilities to develop the limitations for this subcategory. Because there are currently no hazardous landfills discharging directly, EPA used data from indirectly discharging facilities to develop the limitations.

Apart from the 139 hazardous, zero, or alternative discharge facilities estimated to be in the U.S. based on the responses to the Detailed Questionnaire, EPA identified only three other hazardous respondents (16017, 16041, and 16087) to the Detailed Questionnaire, all of which discharged indirectly to POTWs. Facility 16017 only collected and treated landfill gas collection condensate which was very dilute, had low flows, and required only minimal treatment (neutralization using ammonia) prior to discharge. Consequently, EPA did not consider this facility as appropriate for establishing BPT limitations. The two remaining facilities (16041 and 16087) both had treatment systems in-place that achieved very good pollutant reductions. The treatment at facility 16087 consisted of equalization and a chemical precipitation unit followed by an activated sludge system with secondary clarification; the other facility (16041) utilized equalization tanks and a sequential batch reactor. The treatment systems in-place at these indirect-discharging hazardous facilities achieved low effluent concentrations with average removals of 88 to 98 percent of organic toxic pollutants, and 55 to 80 percent of metal pollutants. Thus, EPA concluded that both facilities should be used in the development of the Hazardous subcategory BPT limitations for nonconventional and toxic pollutants. Table 11-16 presents the treatment technologies in-place at the facilities selected as BPT for the Hazardous subcategory.

Development of BPT Effluent Limitations

As discussed above, because there were no direct-discharging hazardous facilities in EPA's database, the Agency relied on technology transfer to establish BPT effluent limitations, using performance data from treatment technologies at hazardous landfill facilities discharging indirectly and non-hazardous facilities discharging directly and indirectly. EPA used the data from the two hazardous indirect-discharging facilities (16041 and 16087) to calculate the BPT effluent limitations for the following toxic pollutant parameters:

alpha terpineol, aniline, arsenic (total), benzoic acid, chromium (total), naphthalene, p-cresol, phenol, pyridine, and zinc (total). Chapter 7 discusses the methodology used to select toxic pollutants for regulation.

EPA concluded that establishing BPT effluent limitations for ammonia, BOD_5, and TSS based only on performance data from these two hazardous indirect-discharging facilities was not appropriate. In general, removal of classical pollutant parameters such as ammonia, BOD_5, and TSS in treatment systems at indirect-discharging facilities is incidental to toxic pollutant removals, since these pollutants are a major component of domestic sewage and are adequately treated at POTWs. Since removals of ammonia, BOD_5, and TSS at these two hazardous indirect-discharging facilities ranged from poor to adequate, EPA concluded that the use of performance data from BPT facilities in both the Hazardous and Non-Hazardous subcategories that employed variations of biological treatment would result in more representative hazardous BPT effluent limitations for these pollutants.

EPA supplemented the Hazardous subcategory data for these three pollutants with data from non-hazardous landfill facilities. For calculation of BPT effluent limitations for BOD_5, EPA supplemented the performance data from the two hazardous indirect-discharging facilities (16041 and 16087), with performance data from direct- and indirect-discharging non-hazardous facilities (16058, 16118, 16120, 16122, 16132 and 16253) to obtain a more representative mix of facilities. For calculation of BPT effluent limitations for TSS, because neither of the treatment systems for the two hazardous indirect-discharging facilities included multimedia filtration to control TSS discharges, EPA used technology transfer to establish TSS limitations, using performance data from two non-hazardous facilities (16120 and 16253) that passed the TSS effluent editing criteria for the BPT effluent limitations for Non-Hazardous subcategory.

For calculation of BPT effluent limitations for ammonia, since the treatment system for only one of the two hazardous indirect-discharging facilities was considered a good performer (16041), EPA supplemented

these data with performance data from two non-hazardous BPT facilities (16122 and 16132) that were considered good performers in the Non-Hazardous subcategory.

In addition, EPA applied editing criteria to the data to determine the final list of BPT facilities and sample points used to develop the BPT limits for the Hazardous subcategory. The editing criteria applied to the available data were as follows:

- EPA only used data from the two hazardous facilities selected as BPT (16041 and 16087) in the calculation of limits for toxic pollutants (except ammonia).

- EPA used technology transfer from the Non-Hazardous subcategory in establishing limits for BOD_5, TSS, and ammonia.

- EPA only used data from facilities that passed the TSS criteria in the calculation of TSS limits (16120 and 16253).

- EPA did not use effluent data from the Detailed Questionnaire (16000 series data) in the calculation of effluent limits. The pollutant data submitted in the Detailed Questionnaire contained the average concentration, the minimum and maximum concentrations, and the number of samples, whereas EPA sampling data and the Detailed Monitoring Questionnaire consisted of individual daily data. In developing limits, EPA calculated the long-term averages and variability factors using individual daily data. Furthermore, summary data (like the data submitted in the Detailed Questionnaire) may obscure the minimum detection levels used in the sampling data. The use of daily data (like the Detailed Monitoring Questionnaire and EPA sampling data) in developing limitations allows EPA to account for concentration values reported at or below the detection limits. In addition, in many cases, EPA considered reported averages from Detailed Questionnaires redundant because many facilities also reported the daily data from the Detailed Monitoring Questionnaire for the same time period in 1992 and, therefore, EPA would not have used the data in the calculation of limits. However, EPA did use, in cases where no other influent data were available, influent data from the Detailed Questionnaire to show that a landfill had treatable levels of a pollutant in the wastewater.

- EPA did not use facility data demonstrating zero or negative percent removals in the calculation of limits.

- EPA did not include data from facility 16120 in the calculation of ammonia limitations because the treatment system included air stripping.

- EPA only used effluent data if sufficient influent data were available to establish the presence of treatable levels of pollutants. The Agency only used effluent data in calculating limits if influent data for a given pollutant were available for a facility. In cases where a facility supplied effluent data for a particular pollutant but did not supply influent data in the Detailed Monitoring Questionnaire (or supplied influent data below a treatable level), EPA used the effluent data so long as influent data were available from the EPA sampling episode or the Detailed Questionnaire at a concentration above a treatable level. However, EPA did not use effluent data from EPA sampling episodes to calculate limits unless matching influent data from the EPA sampling episode are at concentrations above treatable levels.

Table 11-17 presents the hazardous BPT facilities and sample points used to calculate the hazardous BPT limitations for conventional, nonconventional, and toxic pollutants. Table 11-18 presents the hazardous BPT facilities and sample points EPA did not use to calculate the BPT limitations and the reason for their exclusion. In Table 11-19, EPA presents the final BPT limitations for the Hazardous subcategory.

Since there are no direct discharging hazardous landfills in the EPA database, EPA could not estimate pollutant reductions as a result of the regulation and the average facility costs for implementation of the regulation.

11.3 Best Conventional Pollutant Control Technology (BCT)

BCT limitations control the discharge of conventional pollutants from direct dischargers. Conventional pollutants include BOD, TSS, oil and grease, and pH. BCT is not an additional limitation, but rather replaces BAT for the control of conventional pollutants. To develop BCT limitations, EPA conducts a cost-reasonableness evaluation, which consists of a two-part cost test: 1) the POTW test and 2) the industry cost-effectiveness test.

In the POTW test, EPA calculates the cost per pound of conventional pollutants removed by industrial dischargers in upgrading from BPT to a BCT candidate technology and then compares this to the cost per pound of conventional pollutants removed in upgrading POTWs from secondary to tertiary treatment. The upgrade cost to industry, which is represented in dollars per pound of conventional pollutants removed,

must be less than the POTW benchmark of $0.25 per pound (in 1976 dollars). In the industry cost-effectiveness test, the ratio of the incremental BPT to BCT cost, divided by the BPT cost for the industry, must be less than 1.29 (i.e. the cost increase must be less than 29 percent).

For the final rule, EPA established effluent limitations guidelines and standards equivalent to the BPT guidelines for the conventional pollutants covered under BPT for both subcategories. In developing BCT limits, EPA considered whether there are technologies that achieve greater removals of conventional pollutants than for BPT and whether those technologies are cost-reasonable according to the BCT cost-reasonableness evaluation. In each subcategory, EPA identified no technologies that can achieve greater removals of conventional pollutants than those promulgated for BPT that are also cost-reasonable under the BCT cost-reasonableness evaluation, and, accordingly, EPA established BCT effluent limitations equal to the BPT effluent limitations guidelines and standards.

11.4 Best Available Technology Economically Achievable (BAT)

The factors considered in establishing a BAT level of control include the following: the age of process equipment and facilities, the processes employed, process changes, the engineering aspects of applying various types of control techniques to the costs of applying the control technology, non-water quality environmental impacts such as energy requirements, air pollution and solid waste generation, and such other factors as the Administrator deems appropriate (Section 304(b)(2)(B) of the Act). In general, the BAT technology level represents the best existing economically achievable performance among facilities with shared characteristics. BAT may include process changes or internal plant controls which are not common in the industry. BAT may also be transferred from a different subcategory or industrial category.

EPA promulgated BAT effluent limitations for both landfill subcategories based upon the same technologies evaluated and selected for BPT. The BAT effluent limitations control identified toxic and nonconventional pollutants discharged from facilities. EPA did not identify any additional technologies beyond BPT that could provide additional toxic pollutant removals and that are economically achievable.

11.4.1 BAT Limits for the Subtitle D Non-Hazardous Subcategory

EPA evaluated reverse osmosis technology as a potential option for establishing BAT effluent limits more stringent than BPT for the control of toxic pollutants for the Non-Hazardous subcategory. EPA considered reverse osmosis for evaluation because of its effective control of a wide variety of toxic pollutants in addition to controlling conventional and nonconventional parameters.

EPA evaluated BAT treatment options as an increment to the baseline treatment technology used to develop BPT limits. Therefore, the BAT Option III consisted of BPT Option II (biological treatment followed by multimedia filtration) followed by a single-stage reverse osmosis unit. Figure 11-4 presents a flow diagram of the treatment system costed for BAT Option III. EPA acknowledges that reverse osmosis treatment of landfill wastewater does not require biological pretreatment. However, in evaluating potential BAT options, EPA considers the removal and costs of BAT in addition to the selected BPT option. Therefore, to analyze the incremental removals and incremental costs, EPA evaluated the reverse osmosis system after the selected BPT option (biological treatment and multimedia filtration).

EPA promulgated limits based on a BAT technology that is equivalent to the BPT technology. After an assessment of costs and pollutant reductions associated with reverse osmosis, EPA concluded that limits should not be established based on more advanced treatment technology than the BPT technology. EPA concluded that a biological system followed by multimedia filtration would remove the majority of toxic pollutants, leaving the single-stage reverse osmosis to treat the very low levels of pollutants that remained. In the Agency's analysis, BPT Option II removed 170,000 pounds of toxic pollutants per year, whereas BAT Option III removed 172,000 pounds of toxic pollutants per year. The small incremental removal of pounds of toxic pollutants achieved by BAT Option III was not justified by the large cost for the reverse osmosis treatment system. According to EPA's costing analysis, the BAT Option III, consisting of BPT Option II plus reverse osmosis, was estimated to cost the Landfills industry $130.3 million in capital costs (1998 dollars) and $45.95 million in annualized costs (pre-tax, 1998 dollars). By contrast, the selected option, BPT Option II, had capital costs of $18.87 million (1998 dollars) and annualized costs of $7.64

million (post-tax, 1998 dollars). It should be noted that reverse osmosis was much more effective than the BPT Option II at removing the often-high quantities of dissolved metals such as iron, manganese, and aluminum. However, these parameters were not included in the calculation of pound-equivalent reductions due to their use as treatment chemicals.

Table 11-20 compares the long-term averages achieved by BPT Option II, consisting of equalization, biological treatment, and multimedia filtration, to the long-term averages achieved by the reverse osmosis treatment system. For the long-term average comparison, the effluent concentrations are from the reverse osmosis treatment system sampled by EPA and described in Section 8.2.1.5, including the flow diagram in Figure 8-30. Table 11-20 shows BPT Option II achieves very low effluent concentrations that are similar to the effluent concentrations achieved by the reverse osmosis system.

Several commenters on the proposal supported EPA's decision to reject reverse osmosis as the selected technology option. While EPA rejected reverse osmosis as the basis for BAT limitations because it was very expensive and achieved very little additional removal of pollutant, other technical factors also supported this decision. EPA agrees with the commenters that there may be additional site-specific costs associated with the operation of reverse osmosis systems at landfills that it could not directly factor into its cost analysis. EPA found that it was difficult to evaluate potential operating and concentrate-disposal problems and the associated potential increase in the cost of operating a reverse osmosis system at a landfill. The fact that reverse osmosis is a technology that concentrates rather than destroys pollutants is an important consideration. These concentrates still need to be treated and disposed and, as noted by one commenter, some states may not allow them to be recycled back into the landfill. Further, recirculation may inhibit rather than stimulate anaerobic decomposition of the landfilled wastes. While the sludges generated by chemical precipitation and biological treatment require minimal treatment prior to disposal, reverse osmosis concentrates may require additional costly treatment steps prior to final disposal.

11.4.2 BAT Limits for the Subtitle C Hazardous Subcategory

As stated in the BPT analysis, EPA's survey of the hazardous landfills industry identified no in-scope respondents which were classified as direct dischargers. All of the hazardous landfills in the EPA survey were indirect or zero or alternative dischargers. Therefore, the Agency based BPT limitations on technology transfer and treatment systems in place for indirect dischargers in the Hazardous subcategory and on treatment systems in-place for BPT facilities in the Non-Hazardous subcategory. In EPA's engineering assessment of the possible BAT technology for direct-discharging hazardous facilities, EPA evaluated the same three potential technology options as those evaluated for BPT for the Hazardous landfill subcategory. These technology options were 1) aerated equalization followed by chemical precipitation with clarification and multimedia filtration, 2) aerated equalization followed by chemical precipitation with clarification, biological treatment with secondary clarification, and multimedia filtration, and 3) zero or alternative discharge, as explained above. EPA has identified no other technologies that would represent BAT level of control for this industry.

EPA determined that BAT limits should be established based on the same technology evaluated for BPT limits. As explained above at Section 11.2.3, zero or alternative discharge is not an available alternative treatment technology for this industry. Therefore, EPA promulgated BAT effluent limitations for the Hazardous landfill subcategory based upon the same treatment technology selected for BPT: equalization prior to chemical precipitation with clarification, followed by biological treatment with secondary clarification, and multimedia filtration.

11.5 New Source Performance Standards (NSPS)

New Source Performance Standards under Section 306 of the Clean Water Act represent the greatest degree of effluent reduction achievable through the application of the best available demonstrated control technology for all pollutants (i.e. conventional, nonconventional, and toxic pollutants). NSPS are applicable to new industrial direct-discharging facilities, for which construction has commenced after the publication of final regulations. Congress envisioned that new treatment systems could meet tighter controls than

existing sources because of the opportunity to incorporate the most efficient processes and treatment systems into plant design. Therefore, Congress directed EPA, in establishing NSPS, to consider the best demonstrated process changes, in-plant controls, operating methods, and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible.

EPA established New Source Performance Standards (NSPS) that would control the same conventional, toxic, and nonconventional pollutants promulgated for control by the BAT effluent limitations for both subcategories. The treatment technologies used to control pollutants at existing facilities are fully applicable to new facilities. Furthermore, EPA has not identified any other technologies or combinations of technologies that are demonstrated for new sources that are different from those used to establish BPT/BCT/BAT for existing sources. Therefore, EPA established NSPS limitations that are identical to those promulgated in both subcategories for BPT/BCT/BAT.

In the proposed rule, EPA solicited comments and data on other technologies that may be appropriate for the treatment of landfill leachate from new sources. One commenter urged EPA to consider reverse osmosis as an appropriate technology for the treatment of leachate. While EPA acknowledges that reverse osmosis can treat landfill leachate to levels equivalent to, and even lower than, the final BAT limitations, EPA concluded that the reverse osmosis treatment system did not remove significantly more pounds of toxic pollutants than the treatment option selected as BAT. Therefore, EPA concluded that the large costs associated with the installation, operation, and maintenance of a reverse osmosis system would not justify the small incremental removal of pounds of toxic pollutants achieved. Therefore, EPA is promulgating NSPS limitations that are identical to those in each subcategory for BPT/BCT/BAT.

11.6 Pretreatment Standards for Existing Sources (PSES)

Section 307(b) of the Act requires EPA to promulgate pretreatment standards for pollutants that are not susceptible to treatment by POTWs or which would interfere with the operation of POTWs. After a thorough analysis of indirect-discharging landfills in the EPA database, EPA has decided not to establish

PSES for either subcategory in the Landfills Point Source Category. For the proposal, EPA proposed *not* to establish pretreatment standards for indirectly discharging landfills in the Non-Hazardous subcategory. However, for the Hazardous subcategory, EPA proposed effluent limitations and pretreatment standards for six pollutants. In response to its proposal, EPA received a number of comments supporting the decision not to propose pretreatment standards for Subtitle D landfills. In addition, a number of commenters suggested that EPA should also reconsider whether Subtitle C landfills require national categorical pretreatment standards. As a result of these comments, EPA took a second look at its data and determined that pretreatment standards were not necessary for the Landfills Point Source Category.

For both subcategories, EPA looked at a number of factors in deciding whether a pollutant was not susceptible to treatment at a POTW or would interfere with POTW operations – the predicate to establishment of pretreatment standards. First, EPA assessed the pollutant removals achieved at POTWs relative to those achieved by landfills using BAT treatment systems. Second, EPA estimated the quantity of pollutants likely to be discharged to receiving waters after POTW removals. Third, EPA studied whether any of the pollutants introduced to POTWs by landfills interfered with or were otherwise incompatible with POTW operations. EPA, in some cases, also looked at the costs and other economic impacts of pretreatment standards and the effluent reduction benefits in light of treatment systems currently in-place at POTWs. The result of EPA's evaluation showed that POTWs could adequately treat discharges of landfill pollutants. Therefore, EPA is not establishing pretreatment standards for either subcategory in this point source category.

As noted above, among the factors EPA considers before establishing pretreatment standards is whether the pollutants discharged by an industry pass through a POTW or interfere with the POTW operation or sludge disposal practices. One of the tools traditionally used by EPA in evaluating whether pollutants pass through a POTW, is a comparison of the percentage of a pollutant removed by POTWs with the percentage of the pollutant removed by discharging facilities applying BAT. In most cases, EPA has concluded that a pollutant passes through the POTW when the median percentage removed nationwide

by representative POTWs (those meeting secondary treatment requirements) is less than the median percentage removed by facilities complying with BAT effluent limitations guidelines for that pollutant. For a full explanation of how EPA performs its removal analysis, see Chapter 7.

In developing the final guidelines, EPA has made a number of modifications to its calculations of pollutant removal used to compare POTW operations with BAT treatment. For example, the primary source of POTW percent removal data used for removal comparisons is an EPA document, "Fate of Priority Pollutants in Publicly Owned Treatment Works" (EPA 440/1-82/303) commonly referred to as the "50-POTW Study". The 50-POTW Study presents data on 50 well-operated POTWs with secondary treatment in removing toxic pollutants. For its removal comparison for this guideline, EPA eliminated influent values that were close to the detection limit, thereby minimizing the possibility that low POTW removals might simply reflect low influent concentrations instead of being a true measure of treatment effectiveness.

After revising the database, EPA calculated POTW-specific percent removals for each pollutant based on its average influent and average effluent values. The POTW percent removal used for each pollutant for the comparison is the median value of all the POTW-specific percent removals for that pollutant. EPA then compared the median POTW percent removal to the median percent removal for the BAT option treatment technology in order to determine pass through.

11.6.1 EPA's Decision Not to Establish PSES for the Subtitle D Non-Hazardous Subcategory

EPA estimates that there are 756 Subtitle D landfill facilities in the U.S. that discharge landfill wastewater to a POTW. The Agency did not establish pretreatment standards for existing sources (PSES) for the Non-Hazardous landfill subcategory. The Agency decided not to establish PSES for this subcategory after an assessment of the effect of landfill leachate on receiving POTWs and the cost of pretreatment standards.

EPA looked at three measures of effects on POTWs: biological inhibition levels, contamination of POTW biosolids, and a comparison of BAT and POTW removals. For the proposed rule, following procedures outlined above, the removal comparison suggested that one pollutant, ammonia, would pass through in the Non-Hazardous subcategory. However, EPA concluded that ammonia was susceptible to treatment and did not interfere with POTW operations. Therefore, the Agency did not propose to establish national pretreatment standards for ammonia.

Following the proposal, EPA reviewed the data available in the proposed Public Record for both the POTW percent removal calculations and the BAT percent removal calculations and made a number of adjustments. For the proposal, EPA calculated the BAT percent removals using data from well-operated biological treatment facilities in EPA's database. However, some of these facilities did not pass the editing criteria for selection as a BPT/BAT facility. For the revised removal comparison, EPA calculated percent removals using data from only those seven facilities that passed the BPT/BAT editing criteria. In addition, in the proposal, EPA inadvertently neglected to use selected BAT facilities in the calculation of percent removals for several pollutants even though the data for the facility passed the editing criteria.

The result of this revised comparison of removal for the Non-Hazardous subcategory suggested that BAT removal would be greater than POTW removal for four pollutants: ammonia, benzoic acid, p-cresol, and phenol. However, as explained below, EPA concluded that these pollutants do not pass through or interfere with POTW operations on a national basis and therefore has not established national categorical pretreatment regulations for these pollutants. Moreover, as discussed later in this chapter, EPA notes that adoption of PSES would result in the removal of only a small quantity of pollutants, approximately 14 toxic pound equivalents per facility per year. Such a reduction is low relative to that seen in other categorical pretreatment standards promulgated by EPA. (See 64 FR 45077).

11.6.1.1 EPA's Rationale for Not Establishing PSES for Ammonia

EPA has decided not to establish ammonia pretreatment standards for several reasons. First, while EPA's

removal comparison suggests that ammonia in landfill leachate is not as amenable to POTW treatment as to pretreatment, in reality, EPA has concluded that ammonia is susceptible to POTW treatment on a national basis. Further, landfill discharges will not result in POTW upsets or interfere with POTW operations. The Public Record indicates that POTWs are not currently experiencing any difficulty in adequately treating ammonia discharges from Subtitle D landfills. No POTWs commenting on the proposal cited any persistent POTW upsets associated with landfill leachate discharges. Finally, EPA has determined that pretreatment standards for ammonia for landfill indirect dischargers would be extremely costly, given the high levels of removal currently observed. In these circumstances, EPA has concluded that ammonia is susceptible to treatment by POTWs and national pretreatment standards are not required.

Ammonia Removals

In the case of ammonia, the median BAT percent removal for the landfills industry is 99 percent compared to the median POTW percent removal which is 39 percent. (For the proposed rule, EPA calculated the POTW percent removal for ammonia to be 60 percent. However, upon applying the revised data editing procedures to the 50-POTW Study, EPA has now determined that ammonia POTW percent removal is 39 percent.) This comparison suggests that ammonia is not susceptible to treatment at a POTW and passes through. However, as discussed below, most subtitle D landfills discharging to POTWs are discharging small quantities of leachate with an ammonia concentration comparable to that observed in raw sewage.

EPA's data show that over 75 percent of indirectly discharging landfills discharge fewer than 10 pounds of ammonia per day at a concentration similar to that observed in raw sewage. Because many POTWs are designed and operated to treat ammonia (and other pollutants) in raw sewage, a POTW will adequately control landfill discharges of ammonia so long as the ammonia loadings to a POTW did not significantly differ from that typically observed. In those circumstances, ammonia will not pass through such POTWs.

Moreover, some POTWs have installed additional treatment to control ammonia. The data on POTW removal used for EPA's comparison does not reflect this fact. POTWs that have installed additional

ammonia treatment (or modified existing treatment) typically achieve removals in excess of 95 percent -- much higher than the 39 percent removal observed for the POTWs in the comparison analysis. Thus, ammonia does not pass through POTWs with nitrification even in cases where significant loadings of ammonia are discharged to a POTW.

In these circumstances, EPA has concluded ammonia at levels discharged by landfills is generally susceptible to POTW treatment. Therefore, EPA concluded that ammonia limits are best established by local POTWs based on site-specific conditions in accordance with the POTW's design treatment capacity and existing mass loadings.

Upset and Interference

EPA also assessed the ammonia concentrations and loads received by POTWs from Subtitle D leachate discharges to evaluate potential upsets or interference with POTW treatment systems. EPA concluded that national pretreatment standards were not required to prevent interference with POTW operations.

In terms of landfill leachate ammonia concentrations discharged to POTWs, only one of the Subtitle D landfill facilities in EPA's database is currently discharging (i.e. after treatment, if treatment is in place) wastewater to a POTW which contains more than 105 mg/L of ammonia. The remainder of the indirect-discharging Subtitle D landfills discharged an average concentration of 37 mg/L of ammonia to POTWs, with one-half of the facilities discharging less than 32 mg/L. Typical ammonia concentrations in raw domestic sewage range from 12 to 50 mg/L ("Operation of Municipal Wastewater Treatment Plants: Manual of Practice, Volume II," Water Pollution Control Federation).

The one facility in EPA's database that was discharging more than 105 mg/L of ammonia to a POTW was discharging 1,018 mg/L of ammonia to a 114 MGD POTW which currently has ammonia control (nitrification) in place. EPA also received influent ammonia data from several POTWs that commented on the proposed rule. The average ammonia influent concentration to POTWs ranged from 14 mg/L to 35

mg/L with an average concentration of 17 mg/L. Therefore, with the exception of the one outlier, the average concentration of ammonia in leachate discharged to POTWs (37 mg/L) noted in EPA's data closely parallels POTW experience (35 mg/L). However, it should be noted that the upper ranges of leachate concentrations were higher than the upper ranges observed in domestic sewage. Nevertheless, in most instances, observed ammonia discharge levels to POTWs fall within a POTW's treatment capabilities. Thus, EPA determined that the vast majority of Subtitle D landfills are discharging ammonia to POTWs at levels comparable to that which POTWs in the ordinary course of operations receive and treat in raw domestic sewage.

No POTWs commenting on the proposal cited any specific incidents where POTW acceptance of landfill leachate containing high levels of ammonia caused persistent upsets at the POTW. The data are consistent with that supplied by commenters and further supported EPA's understanding prior to the proposal of no documented persistent problems at POTWs due to ammonia concentrations in landfill leachate.

EPA also analyzed the effects that ammonia concentrations found in landfill leachate can have on the biological treatment systems at POTWs. In this analysis, EPA compared the concentrations of ammonia found in leachate with the activated sludge biological minimum threshold toxicity value (or inhibition value). With respect to ammonia, the inhibition value for activated sludge systems is 480 mg/L (Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program, Volume 1. EPA, November 1987). The average raw wastewater concentration of ammonia found in Subtitle D landfills in EPA's database was 199 mg/L for direct, indirect and zero dischargers. In addition, all of the average and median ammonia concentration values observed in the data submitted to EPA in comments were below the activated sludge inhibition value. EPA has consequently determined that ammonia does not represent a threat to biological treatment systems that would require establishment of pretreatment standards.

Effect on Receiving Streams

Subsequent to the proposal, EPA evaluated total wastewater flows and loads of ammonia to receiving streams associated with non-hazardous landfill indirect dischargers (an estimated 756 facilities). EPA estimated that the non-hazardous landfill industry discharges 2.7 million pounds per year of ammonia to POTWs, which results in 1.6 million pounds per year being discharged to receiving streams, assuming that the POTWs have secondary treatment achieving 39 percent removal but do not have additional treatment for ammonia control. However, as mentioned above, EPA is aware that many POTWs have installed additional treatment specifically for the control of ammonia and typically achieve removals in excess of 95 percent. A review of EPA's 1996 Clean Water Needs Survey and its Permit Compliance System database indicates that approximately 20 percent of the POTWs in the U.S. employ some sort of ammonia control. Over 75 percent of the Subtitle D landfills in EPA's database discharge less than 10 pounds per day to the POTW (3,500 pounds/year), which results in discharging less than six pounds per day (2,100 pounds/year) to receiving streams, again assuming secondary treatment only and no additional POTW ammonia controls. In light of existing ammonia control in place at POTWs, actual discharges to receiving streams are likely to be even smaller.

Cost of Pretreatment Standards

EPA has evaluated the economic costs of ammonia pretreatment standards. EPA's economic assessment of these options demonstrated very high removal costs with low associated pollutant removals. Given the high cost, EPA concluded that it is not appropriate to establish national pretreatment standards to address the limited circumstances in which POTW removal might not match BAT removal performance.

EPA evaluated the costs of pretreatment standards in terms of the toxic pound equivalents. Pound-equivalents is a term used to describe a pound of pollutant weighted by its toxicity relative to copper. These weights are known as toxic weighting factors. The Agency calculates pound-equivalents by multiplying the pounds of a pollutant discharged from a landfill by the toxic weighting factor for that pollutant. The use of pounds-equivalent reflects the fact that some pollutants are more toxic than others.

The first treatment option that EPA evaluated is biological treatment. EPA evaluated PSES Option I equivalent to BPT/BAT Option I, which was equalization plus biological treatment. This option had a total annualized cost of $34.6 million (1998 dollars). Biological treatment removed 10,650 pound-equivalents annually, or an average of 14 pound equivalents per facility per year. This represents a cost of removal of $1,900/lb-equivalents (1981 dollars) and represents the cost of removing all of the pound-equivalents removed, not just ammonia. If EPA took credit only for the pound-equivalents of ammonia removed, the annual removal cost for this option is $7,100/lb-equivalents (1981 dollars). Moreover, these calculations are based on the assumption that POTWs will only remove 39 percent of the ammonia discharged to it. If POTWs remove more ammonia than that assumed, then the cost of each pound of pollutant removed by the industrial user raises. Given the installation of additional ammonia controls at many POTWs, actual ammonia removal by POTWs will be greater than assumed.

The second technology option EPA evaluated for the control of ammonia is ammonia stripping with appropriate air pollution controls. However, according to EPA's survey of the landfills industry, only two percent of survey respondents use this technology for the treatment of landfill leachate. In addition, air or steam stripping is more commonly used for treatment of wastewater containing concentrations of ammonia that are several orders of magnitude greater than those typically found in landfill wastewater. Therefore, EPA concluded that biological treatment systems are more appropriate for the treatment of the ammonia concentrations found in landfill leachate. In addition, air stripping for ammonia removal generally requires warm climates, and therefore this may not be a viable treatment option for all landfills located in the United States. In these circumstances, effluent levels associated with air stripping may not be attainable in all cases and thus not broadly available in the landfill industry. In addition, the air stripping option for the treatment of ammonia has an estimated annualized cost of $15.1 million (1998 dollars, pre-tax costs). The cost-effectiveness for this option is also high, $4,400/lb-equivalents (1981 dollars).

As explained above, EPA concluded that the vast majority of POTWs experience no difficulty in treating the ammonia loads received from landfill indirect dischargers, and that as a result, there is generally no pass through of ammonia from landfill leachate on a national basis. Moreover, the cost of pretreatment is not warranted by the limited circumstances where pretreatment would result in reduced ammonia to surface water. But there are POTWs without additional controls for ammonia that may not be equipped to handle landfill leachate ammonia discharges. Consequently, in the proposal, EPA requested comments on requiring ammonia pretreatment standards for those landfills discharging to POTWs that do not have ammonia controls in place. Several commenters supported no pretreatment standard because of their conclusion that ammonia loads from landfills made up an insignificant amount of the total ammonia loads discharged to POTWs. Others favored pretreatment standards because of smaller POTWs that do not employ nutrient removal systems. EPA, however, is not convinced that national ammonia pretreatment standards are warranted even where landfills are discharging to POTWs without ammonia controls given the high cost of pretreatment and current ammonia concentrations in landfill leachate discharged to POTWs that are generally consistent with values observed in raw sewage. Special ammonia situations are best addressed by the local POTW based on site-specific conditions in accordance with the POTW's design treatment capacity and existing mass loadings.

All of these factors discussed above confirm EPA's decision not to establish national ammonia pretreatment standards. EPA has concluded that landfills typically discharge wastewater to POTWs containing ammonia concentrations that can be adequately treated by POTWs. Further, in cases where ammonia loading rates are at levels which may be of concern or where ammonia discharges are a water quality concern, POTWs retain the ability to establish local limits on ammonia.

11.6.1.2 EPA's Rationale for Not Establishing PSES for Benzoic Acid

Benzoic Acid Pass-Through Analysis

As stated above, for the proposal, benzoic acid was not one of the pollutants EPA determined would pass through. However, after the proposal, EPA reviewed the BAT facilities and the representative POTW

facilities used for the removal comparison and determined that it had not used the appropriate editing rules. As a result of these revisions, the comparison showed that the median percent removal for benzoic acid at the landfills BAT facilities was 99 percent compared to the median POTW percent removal which was determined to be 81 percent. Because the 50-POTW database does not contain information on the percent removal of benzoic acid, EPA used the National Risk Management Research Laboratory Treatability database to estimate the percent removal. (For more information on EPA's use of the NRMRL database, see Chapter 7.)

Despite the difference in the BAT and POTW percent removals, further analysis of the data showed that both systems were achieving the same level of treatment of benzoic acid. That is, both the NRMRL database facilities representing POTWs and the landfills BAT facilities were treating benzoic acid down to non-detect levels (50 ug/L). Therefore, the smaller percent removal achieved by facilities in the NRMRL database (used to represent the POTW percent removal) is a function of lower influent concentrations at those facilities and is not necessarily indicative of inferior treatment at POTWs. EPA concluded that benzoic acid in these circumstances is susceptible to treatment at the POTW and does not pass through.

Benzoic Acid Loads Discharged to POTWs

In addition, EPA also evaluated the total flows and loads of benzoic acid discharged from non-hazardous landfills to POTWs. EPA compared the current discharge loads to the loads that would be anticipated after the implementation of pretreatment standards. As was explained above, EPA selected Option I (biological treatment) as the appropriate treatment technology and has analyzed the costs and benefits of pretreatment standards for the Non-Hazardous subcategory for this option. According to EPA's estimates, non-hazardous landfills currently discharge approximately 4,700 pounds of benzoic acid to POTWs per year resulting in an annual discharge of 900 pounds to receiving streams. PSES Option I (biological treatment) would reduce this annual discharge to receiving streams to 400 pounds per year. The average non-hazardous facility discharges only 6.4 pounds of benzoic acid annually (less than 0.02 pounds per day), and the median discharge is only 1.9 pounds per year. Furthermore, benzoic acid has a toxic weighting factor

of only 0.0003. Therefore, for the entire indirect-discharging non-hazardous landfills population (approximately 756 facilities), Option I would only remove an additional 0.16 pound-equivalents per year.

As a result of the above analysis, EPA determined that national pretreatment standards for benzoic acid are not necessary because benzoic acid is susceptible to treatment by POTWs. POTWs and landfill BAT facilities both treat benzoic acid down to non-detect levels. In addition, EPA determined that the pounds of benzoic acid currently being discharged by landfills are compatible with POTW treatment and that pretreatment standards would result in little further reduction of benzoic acid.

11.6.1.3 EPA's Rationale for Not Establishing PSES for P-Cresol

P-Cresol Pass-Through Analysis

Like benzoic acid, p-cresol also did not pass through POTWs according to EPA's pass-through analysis at proposal. However, the result of its revised removal comparison showed some difference in removal. The landfills median BAT percent removal for p-cresol is 99 percent, while the estimated median POTW percent removal is 68 percent. (Again, because the 50-POTW database does not contain percent removal data for p-cresol, EPA used the NRMRL database to determine POTW removal.)

P-Cresol Concentrations and Loads Discharged to POTWs

EPA also analyzed the flows and loads of p-cresol being discharged from non-hazardous landfills to POTWs. According to EPA's estimates, non-hazardous landfills currently discharge approximately 2,730 pounds of p-cresol to POTWs per year resulting in an annual discharge of 870 pounds to receiving streams. PSES Option I (biological treatment) would reduce this discharge to receiving streams to 130 pounds/year. Furthermore, p-cresol has a toxic weighting factor of only 0.0024. Therefore, the implementation of Option I results in an additional reduction of only 3.0 pound-equivalents per year across the entire Subtitle D indirect discharge population. On average, non-hazardous landfill facilities discharge only 3.4 pounds of p-cresol annually (or 0.01 pounds per day), and the median discharge load is only 0.7 pounds per year.

Based on the data shown above, EPA concluded that the implementation of pretreatment standards for p-cresol would result in only minimal reductions in the pounds of p-cresol discharged to surface waters. In addition, p-cresol is found in non-hazardous landfill leachate at concentrations which will not cause upsets at POTWs nor should POTWs have difficulty effectively treating such concentrations. The median raw wastewater concentration for p-cresol at municipal landfills is 75 ug/L. This concentration is well below the Universal Treatment Standard (UTS) of 770 ug/L established for F039 wastes (multi-source leachate) in 40 CFR 268.48. (EPA bases UTS on the Best Demonstrated Available Treatment Technology (BDAT) for each listed hazardous waste. BDAT represents the treatment technology that EPA concludes is the most effective for treating a particular waste that is also readily available to generators and treaters.)

11.6.1.4 EPA's Rationale for Not Establishing PSES for Phenol

Although phenol appeared to pass through, EPA decided not to establish pretreatment standards for phenol based on the fact that phenol is highly biodegradable and is treated by POTWs to the same degree as the landfill direct dischargers. Furthermore, the Agency concluded that the differences in influent concentrations caused the apparent difference in removal performance between landfill direct dischargers and POTWs. As a result, the performance across the landfills direct dischargers showed higher removals than the performance at the POTWs.

In EPA's landfills database, raw wastewater concentrations of phenol at the BAT facilities in the Non-Hazardous subcategory were much higher than the influent concentrations at the POTWs used in the determination of the POTW percent removal. The average influent concentrations for phenol for the three non-hazardous BAT facilities used in the pass-through analysis ranged from 350 ug/L to 5,120 ug/L. All three of the facilities treated phenol down to the analytical minimum level (10 ug/L), corresponding to a median percent removal of 97.5 percent. For POTW performance, EPA used a total of eight POTWs in the analysis for POTW percent removal of phenol. The average influent concentration for phenol at these eight POTWs was 387 ug/L, and six of the eight effluent values were below the analytical minimum level and therefore assigned values of 10 ug/L. Thus, the average percent removal for the POTWs was 95.3 percent.

In this case, EPA concluded that the differences in removals for POTWs (95.3 percent) and BAT facilities (97.5 percent) is an artifact of the differing influent concentrations and does not necessarily reflect a real difference in treatment performance. Therefore, EPA concluded that phenol is treated to essentially the same level by direct dischargers and POTWs and, therefore, does not pass through.

Based on the pollutant loadings rationale described above for ammonia , benzoic acid, and p-cresol, and based on the highly biodegradable nature of phenol, EPA decided not to set pretreatment standards for landfills in the Non-Hazardous subcategory. In addition, the Agency concluded that in the case of discharges from Subtitle D landfills, problems that may result from elevated ammonia loads in landfill leachate are best addressed at the local level. Furthermore, the Agency has determined that as a result of the ability of POTWs to adequately treat the small quantities of benzoic acid and p-cresol being discharged from landfills, a pretreatment standard for these two pollutants is also unnecessary. EPA also concluded that the cost to implement pretreatment standards for this subcategory is not warranted by the environmental benefits associated with any small additional removals.

11.6.1.5 Public Comments to the Proposed Rule Regarding Non-Hazardous PSES

In support of EPA's proposal not to establish PSES for the Non-Hazardous subcategory, EPA received comments and data following the proposal concerning the treatment of non-hazardous landfill leachate at POTWs. A total of seventeen commenters, representing municipalities, POTWs, privately-owned landfills, trade associations, and engineering consulting firms, stated that in their experience, no POTW upsets or adverse impacts on sludge quality had occurred as a result of a POTW accepting non-hazardous landfill leachate. Several of these commenters supported their claim with data or anecdotal evidence from over 20 landfills discharging leachate to POTWs. Most of these commenters felt that local limits are currently addressing discharges from non-hazardous landfills and that any particular pollutant that may be of concern should be dealt with on a case-by-case basis. Commenters also stated that the implementation of pretreatment standards would be extremely costly for very little improvement in water quality. Commenters stressed that any mandatory pretreatment that did not take into account the ability of receiving POTWs to

handle the wastewater would inevitably result in unnecessary pretreatment of some waste streams. EPA found that this comment is particularly applicable to ammonia because of the varying degrees of treatment that can be achieved by POTWs. Furthermore, several commenters felt that the constituents found in landfill leachate are similar to those found in the influent to POTWs and that the flow contribution from landfills is relatively small.

There were also several commenters who supported the establishment of pretreatment standards for non-hazardous landfill leachate. One municipality was concerned with the effects that landfill leachate can have on small community POTWs with low flows. Specifically, the commenter was concerned with elevated levels of three specific pollutants (zinc, chromium, and cyanide) at three landfills that discharge to the city's POTW. The concentrations cited by the commenter for chromium and zinc were much higher than the median concentration determined for these metals by EPA's data gathering efforts. In addition, EPA did not detect cyanide in its analytical sampling at Subtitle D landfills. As a result, EPA determined that the pollutant concentrations identified by this municipality are not indicative of the concentrations typically present at Subtitle D landfills. Therefore, in cases where elevated levels of pollutants present in landfill leachate may cause problems for a POTW, local, site-specific limits are the best way to implement controls on such discharges. Furthermore, EPA did not receive any comments from POTWs that had experienced persistent upsets as a result of accepting landfill leachate.

One other municipality felt that EPA should set pretreatment standards for non-hazardous landfills since close to 70 percent of the wastewater flow discharged from Subtitle D landfills is discharged to POTWs. EPA establishes pretreatment standards for pollutants that are not susceptible to treatment by POTWs to prevent pass through and interference based on the ability of POTWs to achieve treatment equivalent to that of direct dischargers. The percentage of total flow of an industry being discharged to POTWs is not a basis for establishing pretreatment standards. Furthermore, EPA determined that the total loads of the pollutants that are discharged to POTWs made up only a very small fraction of what the POTW receives, and that the concentrations of these pollutants are at levels that are compatible with POTW treatment.

Other commenters disagreed with EPA's statements that non-hazardous leachate is of the same quality as the headwaters of a POTW. Three of these commenters were particularly concerned with ammonia concentrations in landfill leachate (the data from these commenters was discussed in the ammonia discussion above). EPA reviewed the data submitted by these commenters and, although some pollutants exceeded EPA's median concentrations, the commenters did not cite any specific instances where the reported leachate concentrations created a problem for a receiving POTW. EPA acknowledges that elevated levels of pollutants can exist in landfill wastewater. However, the median concentrations of pollutants determined by EPA's sampling program indicate that, on a national basis, concentration levels of pollutants are not at a level to be of concern to POTWs. In addition, in many cases, the loads of pollutants discharged from landfills to POTWs make up a very small portion of the total pollutant loads received by the POTW.

Another commenter suggested that EPA consider setting pretreatment standards for sulfates and sodium in landfill discharges. The commenter stated that the levels of sodium found in landfill leachate is generally greater than the level of 20 mg/L indicated in EPA's Drinking Water Contaminant Candidate List. EPA did not include limits for sulfates or sodium since these can be found in naturally occurring compounds in landfill soils and are often constituents in treatment chemicals commonly used for wastewater treatment.

One municipality commented in favor of PSES for ammonia since its regional POTWs had to establish a local ammonia pretreatment limit of 100 mg/L to protect water quality in ocean outfalls. However, in this case, the local authority has determined that a 100 mg/L pretreatment standard is adequate for the protection of water quality in the ocean outfalls. EPA acknowledges that there may be circumstances in which POTWs may have to establish local limits in order to prevent upsets or pass through. These situations do not undercut EPA's decision not to establish national pretreatment standards for ammonia. As explained in Section 11.6.1.1, the removal technologies evaluated for PSES would result in very low ammonia discharge levels, much lower than that established by the commenter (100 mg/L). This situation further supports EPA's conclusion that local limits for ammonia provide the most appropriate control and that national pretreatment requirements for ammonia may result in unnecessary pretreatment of some waste streams. In fact, one of

the two landfills discharging leachate to the district's POTW has since installed an SBR. As a result, the leachate ammonia concentration for this landfill has dropped from an average of 393 mg/L to 52 mg/L. The fact that one of the landfills has installed pretreatment to lower ammonia discharges is a good example that existing pretreatment programs are effective at requiring landfills to control their discharges.

One of the commenters in support of PSES already employs biological pretreatment at its landfill. This landfill specifically stated that concentrations of ammonia as nitrogen and total toxic organics should undergo pretreatment prior to discharge to a POTW unless the leachate is a very small constituent of the total flow of the POTW. The raw wastewater ammonia concentrations at this landfill were consistent with the median determined by EPA's sampling efforts and the facility employed biological treatment to achieve an effluent ammonia concentration that was acceptable to the local POTW. In addition, the concentrations of toxic organics found in EPA's sampling of Subtitle D landfill leachate were typically not at levels that would cause inhibition to biological treatment at a POTW. The specific organic pollutants that EPA determined to pass through were found in very low concentrations, resulting in minimal loadings discharged to POTWs. The fact that this landfill already employs pretreatment is a good example that existing pretreatment programs are effective at requiring landfills to control their discharges.

11.6.2 EPA's Decision Not to Establish PSES for the Subtitle C Hazardous Subcategory

In the proposed rule, EPA proposed pretreatment standards for six pollutants that EPA determined to pass through in the Hazardous subcategory. However, after reviewing the comments received and re-evaluating the pollutant loads in the Hazardous subcategory, EPA has decided not to establish national pretreatment standards for Subtitle C landfills.

As previously explained, EPA establishes pretreatment standards for pollutants that are not susceptible to treatment at a POTW or for pollutants that may interfere with POTW operations. As explained at section 11.2.3, for the Hazardous subcategory, EPA identified only three Subtitle C landfills, all of them indirect dischargers. EPA used data from these hazardous landfills to develop the BPT/BAT limitations for toxic

pollutants because these landfills were using the treatment systems for their leachate that EPA determined was the BPT/BAT treatment technology.

EPA also performed an analysis for this subcategory in order to compare POTW removals with BAT treatment systems. As was the case for the Non-Hazardous subcategory, EPA revised the pass-through analysis data editing procedures after the proposal and as a result EPA's removal results have changed. The result of the revised comparison show BAT removals greater than POTW removals for the following eight pollutants: ammonia, alpha terpineol, aniline, benzoic acid, naphthalene, p-cresol, phenol, and pyridine.

For its removal comparison for ammonia, EPA compared the nation-wide median percentage of ammonia removed by well-operated POTWs to the percentage of ammonia removed by BAT treatment systems from both the Hazardous and Non-Hazardous subcategories. (For the reasons explained in section 11.2.4, in the case of ammonia, EPA supplemented the Hazardous subcategory data with data from non-hazardous landfill facilities.) For all other toxic pollutants, in determining whether a pollutant would pass through a POTW, the Agency compared the nation-wide median percentage of a pollutant removed by well-operated POTWs with secondary treatment to the percentage of a pollutant removed by BAT treatment systems from only the Hazardous subcategory. For the proposal, EPA proposed pretreatment standards that were equivalent to the BPT/BAT limitations for the pollutants that passed through. EPA has reconsidered its decision that it should promulgate national pretreatment standards for hazardous landfills. The reasons for this decision are explained in more detail below.

Two of the indirect discharging landfills have treatment technology in place that EPA considers to be BAT, and currently discharge very low concentrations of pollutants to their local POTWs. The third and only other indirectly discharging Subtitle C landfill for which EPA has data discharged less than 1,000 gal/day of landfill gas collection condensate to a POTW. In addition to the low wastewater flow at this landfill, the facility has relatively low raw wastewater pollutant concentrations and employs neutralization with ammonia followed by settling prior to discharge to the POTW.

Several commenters on the proposal questioned EPA's rationale for developing ammonia pretreatment standards for the Hazardous subcategory while not establishing ammonia pretreatment standards for the Non-Hazardous subcategory. EPA's database indicate that the median raw wastewater ammonia concentration for hazardous landfills is 268 mg/L as compared to the raw wastewater ammonia concentration for Subtitle D landfills which is 199 mg/L.[1] EPA has current information on ammonia concentration in wastewater discharges for two of the three Subtitle C landfills in EPA's database. One of the landfills employs biological treatment and discharges an average of 4.9 mg/L of ammonia to the POTW. The other landfill employs chemical precipitation prior to biological treatment and discharges ammonia at an average concentration of 156 mg/L. This discharge level presents no apparent problem to the receiving POTW. According to discussions with this facility and the POTW, the POTW has not set local pretreatment standards for ammonia for this landfill, and the POTW does not perform nitrification nor is there an ammonia limit in the POTW's NPDES permit. Since 1995, the POTW has seen the ammonia concentration at its headworks increase from 13 mg/L to 20 mg/L and has experienced some upsets at the POTW. However, the POTW explained that it was unsure whether the upsets are a result of the increased ammonia concentrations or due to some other constituent in the wastewater. In addition, the POTW is not sure if the landfill leachate discharge is contributing at all to the upsets. As was the case in the Non-Hazardous subcategory, EPA concluded that national pretreatment standards for ammonia are not warranted by the small quantity of ammonia being discharged to POTWs from landfills in this subcategory and due to the site-specific water quality and POTW nitrification issues associated with ammonia.

Although the removal comparison suggests that phenol may pass through, EPA decided not to establish pretreatment standards for it because it is highly biodegradable and is, in fact, treated by POTWs to the same degree as the landfill direct dischargers. The Agency concluded that any apparent difference in

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1 In the comments received on the proposal, some commenters referred to the Hazardous subcategory median ammonia raw wastewater concentration referred to in Table 6-8 on page 6-44 of the Proposed Landfills Development Document (EPA -821-R-97-022). This table lists the median ammonia raw wastewater concentration of 8.6 mg/L. However, this median concentration included numerous CERCLA facilities with discharges that consisted primarily of ground water. After proposal, EPA recalculated the median ammonia raw wastewater concentration for the Hazardous subcategory using only data from Subtitle C landfills in EPA's database. This results in a median raw wastewater ammonia concentration of 268 mg/L.

removals in the removal comparison is an artifact of differing influent concentrations rather than any difference in performance between landfill direct dischargers and POTWs.

In EPA's landfills database, raw wastewater concentrations of phenol at the two BAT facilities in the Hazardous subcategory were much higher than the influent concentrations at the POTWs used in the determination of the POTW percent removal. The average influent concentrations for phenol for the two hazardous BAT facilities used in the pass-through analysis ranged from 5,120 ug/L to 98,500 ug/L, and the average effluent concentrations ranged from 10 ug/L to 814 ug/L corresponding to an average percent removal of 99.8 percent. For POTW performance, EPA used a total of eight POTWs in the analysis for POTW percent removal of phenol. The average influent concentration for phenol at these eight POTWs was 387 ug/L, and six of the eight effluent values were below the analytical minimum level and therefore assigned values of 10 ug/L. Thus, the average percent removal for the POTWs was 95.3 percent, and therefore EPA determined that the pollutant passed through. In this case, EPA concluded that the pass-through determination is an artifact of the differing influent concentrations and does not necessarily reflect a real difference in removals. Therefore, EPA concluded that phenol is treated to essentially the same level by direct dischargers and POTWs and, therefore, does not pass through.

Further review of the comparison for alpha terpineol, aniline, benzoic acid, naphthalene, and pyridine under the revised analysis showed that all of these pollutants were treated down to non-detect levels in both the landfill's BAT treatment option and in the NRMRL facilities representing POTWs. That is, both BAT facilities and POTWs achieve the same level of treatment for these pollutants, and the differences in removal once again were simply a function of smaller influent concentrations at facilities representing POTWs. (Alpha terpineol and benzoic acid are compounds for which a high removal efficiency would be expected at a POTW due to their relatively high biodegradability.) Therefore, the Agency determined that, not only are the current pollutant loads not a problem for POTWs, but also all of these pollutants are present in concentrations that are treated down to non-detect levels in a well-operated POTW. Thus, given the small

loadings and low concentrations of these pollutants, EPA concluded that these five pollutants are susceptible to treatment at the POTW and do not pass through.

Furthermore, EPA has concluded that while the removal comparison suggests that two pollutants, naphthalene and aniline, may not be susceptible to POTW treatment, in fact, they will receive equivalent treatment. First, the median untreated wastewater concentration observed in EPA's data collection effort for these pollutants is less than the Universal Treatment Standards (UTS) EPA has developed for these pollutants in F039 wastes (multi-source leachate) in 40 CFR 268.48. The UTS for naphthalene is 0.059 mg/L which is slightly greater than the median concentration found in hazardous landfills (0.049 mg/L). The UTS standard for aniline is 0.81 mg/L while the median concentration in hazardous landfills is 0.237 mg/L. Second, aniline and naphthalene (as well as p-cresol and pyridine) will be removed from wastewater through attachment to the biosolids in the POTW's biological treatment system and then undergo subsequent biodegradation while entrained in the biosolids.

In addition, as noted above, the revised comparison shows a lower POTW removal for p-cresol than that achieved by BAT treatment. However, as was the case in the Non-Hazardous subcategory, EPA has concluded that the concentrations of p-cresol and the associated loadings discharged to POTWs from landfills in the Hazardous subcategory would be insignificant compared to the total loads received at the POTW. The median Subtitle C raw wastewater concentration for p-cresol is 144 ug/L (this includes only Subtitle C landfills and not the CERCLA data included in the median on page 6-44 of the Proposed Landfills Development Document) which is less than the UTS developed for p-cresol in F039 wastes which is 770 ug/L (40 CFR 268.48).

Therefore, based on the small quantity of pollutants involved and low pollutant concentrations discharged from landfills in the Hazardous subcategory, EPA concluded that national pretreatment standards for landfills in the Hazardous subcategory are unnecessary. In addition, EPA concluded that local limits are adequately controlling wastewater discharges from Subtitle C landfills.

11.7 Pretreatment Standards for New Sources (PSNS)

Section 307 of the Clean Water Act requires EPA to promulgate both pretreatment standards for new sources and new source performance standards. New indirect-discharging facilities, like new direct-discharging facilities, have the opportunity to incorporate the best available demonstrated technologies, including process changes, in-facility controls, and end-of-pipe treatment technologies.

EPA decided not to establish pretreatment standards for new sources for both subcategories for many of the same reasons that EPA did not establish PSES limits. As stated in the PSES discussions above, EPA concluded that the typical concentrations of pollutants in landfill leachate are not at levels that will cause problems for POTWs. In addition, EPA determined that the relatively small wastewater flows from landfills, coupled with the concentrations of pollutants typically found, result in small pollutant loading rates discharged to POTWs from landfills. Finally, in site-specific cases where a particular pollutant may be found at concentrations that are of concern to the POTW, EPA concluded that local pretreatment standards are the most appropriate means for controlling such discharges.

Table 11-1: Removal of Pollutant of Interest Metals in the Non-Hazardous Subcategory (ug/L)

Non-Hazardous POI Metals	CAS #	Landfills Raw Wastewater Data		NRMRL Treatability Data (1)		Published Inhibition Levels (2)	50-POTW Study (3)			OCPSF 12 Plant Sampling Data (4)	
		Subtitle D Municipal Median Concentration	Subtitle D Non-Municipal Median Concentration	Biological Treatment Systems			Maximum Influent Concentration	Mean Influent Concentration	Median Percent Removal	Biological Treatment Systems	
				Influent Concentration	Percent Removal					Median Influent Concentration	Percent Removal
Barium	7440393	483	822	1,000-10,000	84.0	NA	NA	NA	NA	NA	NA
Chromium	7440473	28	NA	44	45.0	1,000-100,000	2,380	173	82	440	68.5
Strontium	7440246	1,671	4,615	1,000-10,000	14.0	NA	NA	NA	NA	NA	NA
Titanium	7440326	64	11.8	55	34.0	NA	NA	NA	NA	NA	NA
Zinc	7440666	100	93	372	56.0	80-5,000	9,250	723	79	322	58.5

NA - Not applicable or not available.
(1) Source: EPA National Risk Management Research Laboratory (NRMRL) Treatability Database.
(2) Source: EPA Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program, Volume 1. EPA Nov 1987.
(3) Source: EPA Fate of Priority Pollutants in Publicly Owned Treatment Works. (EPA 440/1-82/303, September 1982).
(4) Source: EPA Organic Chemicals, Plastics and Synthetic Fibers Public Record.

Table 11-2: List of Subtitle D Municipal Solid Waste Facilities Employing Biological Treatment Considered for BPT in the Non-Hazardous Subcategory

Facility Questionnaire ID Numbers	
16001	16119
16047	16120
16048	16121
16049	16122
16052	16123
16056	16125
16058	16127
16059	16129
16060	16132
16063	16154
16065	16155
16077	16158
16078	16159
16079	16161
16083	16164
16085	16165
16088	16166
16093	16170
16097	16171
16099	16174
16102	16176
16117	16253
16118	

Table 11-3: Comparison of Raw Wastewater Mean Concentrations of Non-Hazardous Pollutants of Interest for Municipal Solid Waste Landfills and Hazardous Facility 16041

Cas No.	Pollutant	Mean concentration of Pollutants of Interest for All Municipal Landfills in EPA Database	Mean Concentration of Pollutants of Interest for Hazardous Facility 16041
C-002	Biochemical Oxygen Demand	1,228,534	877,875
C-004	Chemical Oxygen Demand	2,024,932	2,033,750
C-005	Nitrate/Nitrite	5,844	1,770
C-009	Total Suspended Solids	735,308	191,375
C-010	Total Dissolved Solids	4,195,518	12,275,000
C-012	Total Organic Carbon	661,478	562,250
C-020	Total Phenols	142,838	3,195
106445	P-Cresol	246	218
108101	4-Methyl-2-Pentanone	3,789	2,175
108883	Toluene	166	1,468
108952	Phenol	287	1,553
120365	Dichloroprop	10	2
123911	1,4-Dioxane	118	10
142621	Hexanoic Acid	13,148	1,632
18540299	Chromium (Hexavalent)	77	Not analyzed
20324338	Tripropyleneglycol Methyl Ether	568	1,750
298044	Disulfoton	9	Not analyzed
3268879	OCDD	0.03	6
35822469	1234678-HpCDD	0.002	1
65850	Benzoic Acid	7,220	5,294
67641	2-Propanone	2,407	4,398
68122	N,N-Dimethylformamide	214	Not analyzed
7440213	Silicon	30,913	5,518
7440246	Strontium	1,569	2,846
7440326	Titanium	66	65
7440393	Barium	720	Not analyzed
7440428	Boron	3,005	8,839
7440473	Chromium	46	87
7440666	Zinc	1,476	253
75092	Methylene Chloride	70	49
7664417	Ammonia Nitrogen	238,163	382,250
78933	2-Butanone	5,119	6,398
95487	O-Cresol	298	10
98555	Alpha Terpineol	334	691

Table 11-4: Candidate BPT Facilities for the Non-Hazardous Subcategory Eliminated from BPT Consideration Because No BOD_5 Effluent Data Was Available

Facility Questionnaire ID Numbers	
16001	16102
16047	16119
16056	16121
16059	16123
16060	16154
16063	16155
16078	16158
16079	16159
16083	16166
16085	16174

Table 11-5: Treatment Systems In Place at Landfill Facilities Considered for BPT Which Supplied BOD_5 Effluent Data

Facility QID	Treatment in Place
16041	Sequencing batch reactor (SBR)
16048	Aerobic (oxidation pond)
16049	Aerobic-anaerobic (facultative pond)
16052	Aerobic-anaerobic (oxidation pond)
16058	Aerated lagoon
16065	Aerobic pond
16077	Aerated lagoon
16088	Equalization, sand filter, carbon adsorption, aerobic
16093	Activated sludge, secondary clarifier, disinfection, multimedia filtration
16097	Activated sludge, secondary clarifier
16099	Equalization, chemical precipitation, flocculation, coalescing, anaerobic, activated sludge with PACT, nitrification, secondary clarifier
16117	Equalization, chemical precipitation, primary clarifier, aerated fixed film, secondary clarifier, denitrification
16118	Equalization, chemical precipitation, primary clarifier, anaerobic, aerobic, secondary clarifier
16120	Settling, aeration, chemical precip, primary clarifier, air stripper, neutralization, activated sludge, secondary clarifier, multimedia filtration, disinfection
16122	Equalization, chemical precipitation, primary clarifier, anaerobic, aerobic, secondary clarifier, aerobic equalization, multimedia filtration
16125	Aeration, chemical precipitation, primary clarifier, SBR, secondary clarifier, carbon adsorption, multimedia filtration
16127	Unstirred tank, aeration
16129	Neutralization (lime), chemical precipitation, primary clarifier, activated sludge, secondary clarifier, sand filter, air stripping
16132	Aerated pond
16161	Aeration, aerobic, settling (aerated pond)
16164	Aeration, chemical precipitation, primary clarifier, neutralization, equalization, aerobic, secondary clarifier
16165	Aerobic, settling (aerated pond)
16170	Equalization, stabilization pond
16171	Equalization, activated sludge, settling
16176	Aeration, activated sludge, settling
16253	Equalization, chemical precipitation, primary clarifier, anaerobic, activated sludge, secondary clarifier, nitrification, multimedia filter

Table 11-6: Landfill Facilities Considered for BPT in the Non-Hazardous Subcategory which Supplied BOD_5 Effluent Data

Facility QID	Bsl Flow (MGD)	BOD5 (mg/L)								Reason Facility Data was not Considered for BOD Limitations
		Facility Avg		DET		DMQ		ANL		
		Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	
16041	0.058917	910	47	-	-	-	-	910	45	Data used for calculating BOD limits
16048	0.000005	NA	41	-	-	-	-	-	-	No BOD influent data
16049	0.0017	NA	NA	-	4.8	-	-	-	-	No BOD influent data
16052	0.0546	NA	37	-	37	-	-	-	-	No BOD influent data
16058	0.003	153	24	-	22	-	30	153	-	Data used for calculating BOD limits
16065	0.008	NA	35	-	35	-	-	-	-	No BOD influent data
16077	0.00816	54	10	54	10	-	-	-	-	Average influent BOD concentration below 100 mg/L
16088	0.03621	3799	209	-	200	3799	223	-	-	Effluent BOD concentration greater than 50 mg/L
16093	0.081575	24	8.3	27	6	22	8.3	-	-	Average influent BOD concentration below 100 mg/L
16097	0.019	23	14	-	20	23	14.3	-	-	Average influent BOD concentration below 100 mg/L
16099	0.01533	3600	11.5	-	8	3600	11.5	-	-	Carbon treatment used in addition to biological treatment
16117	0.04	180	4.8	-	4	180	5.5	-	-	Separate treatment trains (BIO/CPR) employed before
16118	0.0288	1990	48	2200	49	1890	46	-	-	Data used for calculating BOD limits
16120	0.042775	790	10	-	16	780	4.6	1290	-	Data used for calculating BOD and TSS limits
16122	0.0255	1007	6.1	-	5.3	-	5.4	1007	30	Data used for calculating BOD and TSS limits
16125	0.014193	1673	57	1141	10	2394	-	379	171	Carbon treatment used in addition to biological treatment
16127	0.003627	NA	40	-	-	-	40	-	-	Wastewater stream consists primarily of storm water
16129	0.00469	214	1.8	-	-	214	1.8	-	-	Wastewater stream consists primarily of ground water
16132	0.03	7609	15.7	5581	7	4741	16	-	-	Data used for calculating BOD limits
16161	0.053	NA	171	-	171	-	-	-	-	No BOD influent data
16164	0.01	NA	487	-	487	-	-	-	-	No BOD influent data
16165	0.030218	1812	974	1812	974	-	-	-	-	Effluent BOD concentration greater than 50 mg/L
16170	0.0048	69	63	-	54	69	72	-	-	Average influent BOD concentration below 100 mg/L
16171	0.024	NA	213	-	213	-	-	-	-	No BOD influent data
16176	0.037272	NA	112	-	112	-	-	-	-	No BOD influent data
16253	0.01776	327	6.4	1000	5.2	159	6.4	-	-	Data used for calculating BOD and TSS limits

Bsl Flow: Baseline flow

Facility Avg: Flow weighted average calculated from all data sources available at the facility (DET, DMQ, ANL)

DET: Detailed Questionnaire data from 1992

DMQ: Detailed Monitoring Questionnaire data from 1992 through 1994

ANL: Analytical data from sampling episodes 1993-1995

NA: Not Available

Table 11-7: Selected BPT Facilities for the Non-Hazardous Subcategory

Detailed Questionnaire ID Number	Discharge Status	Treatment in Place
16041	Indirect	sequential batch reactor
16058	Direct	equalization, aerated lagoon
16118	Indirect	aerated equalization, chemical precipitation, anaerobic fixed film, aerobic fixed film, clarification
16120	Direct	aerated equalization, chemical precipitation, ammonia strip lagoons, neutralization, activated sludge, multimedia filter, chlorination
16122	Direct	aerated equalization, chemical precipitation, flocculation, clarification, neutralization, anaerobic fixed film, aerobic fixed film, neutralization, coagulation, flocculation, clarification, chlorination, aerated equalization, multimedia filter
16132	Indirect	aerated pond
16253	Direct	equalization, chemical precipitation, flocculation, clarification, neutralization, anaerobic filtration, 2-stage activated sludge, multimedia filter

Table 11-8: TSS Data from Landfill Facilities Selected for BPT in the Non-Hazardous Subcategory

Facility QID	Baseline Flow (MGD)	TSS (mg/L)							
		Facility Average		DET		DMQ		ANL	
		Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
16041	0.058917	330	36	364	36	307	35	70	46
16058	0.003	14470	188	-	216	-	188	14470	-
16118	0.0288	NA	NA	-	-	-	-	-	-
16120	0.042775	1221	14	-	14	1241	13.6	200	-
16122	0.0255	267	5.4	-	5.6	-	5.4	267	12.5
16132	0.03	244	47	244	39	-	47	-	-
16253	0.01776	150	25	180	17.5	120	25	-	-

Facility Avg: weighted average calculated from all data sources available at the facility (DET, DMQ, ANL).

DET: Detailed Questionnaire data from 1992

DMQ: Detailed Monitoring Questionnaire data from 1992 through 1994

ANL: Analytical data from sampling episodes 1993-1995

NA: Not Available

Table 11-9: Facilities and Sample Points Used for the Development of BPT/BAT Effluent Limitations for the Non-Hazardous Subcategory

BPT Facility	Data Source	Influent Sample Point	Avg. Influent Concentration	Effluent Sample Point	Avg. Effluent Concentration
Ammonia (mg/L)					
16041	DMQ ANL	02 01, 03, 05, 06	679 475	04 02	5.4 1.4
16122	ANL	01, 02, 03	181	07	1.2
16132	DMQ	01, 02, 03	206	04	5.9
BOD_5 (mg/L)					
16041	ANL	01, 03, 05, 06	910	02	47
16058	DMQ ANL	- 01, 02	- 153	01 -	29.7 Only influent conc. used
16118	DMQ	01	1,890	02	45.5
16120	DMQ	01	780	02	4.6
16122	ANL	01, 02, 03	1,007	07	35.2
16132	DMQ	01, 02, 03	4,740	04	15.8
16253	DMQ	01	159	02	6.4
TSS (mg/L)					
16120	DMQ	01	1,240	02	13.6
16253	DMQ	01	120	02	24.9
Alpha Terpineol (ug/L)					
16041	ANL	01, 03, 05, 06	653	02	10
16122	ANL	01, 02, 03	123	07	10
Benzoic Acid (ug/L)					
16041	ANL	01, 03, 05, 06	15,400	02	50
16122	ANL	01, 02, 03	9,300	07	50
P-Cresol (ug/L)					
16041	ANL	01, 03, 05, 06	1,360	02	10

Table 11-9: Facilities and Sample Points Used for the Development of BPT/BAT Effluent Limitations for the Non-Hazardous Subcategory (continued)

BPT Facility	Data Source	Influent Sample Point	Avg. Influent Concentration	Effluent Sample Point	Avg. Effluent Concentration
Phenol (ug/L)					
16041	ANL	01, 03, 05, 06	5,120	02	10
16118	DET DMQ	01 01	350 -	02 02	Only influent conc. used 11
16120	DMQ ANL	01 01	16 712	02 -	27.7 Only influent conc. used
16122	ANL	01, 02, 03	395	07	10
Zinc (ug/L)					
16041	DMQ ANL	02 01, 03, 05, 06	505 310	04 02	214 87
16058	DMQ ANL	- 01, 02	- 995	01 -	59 Only influent conc. used
16132	DMQ	01, 02, 03	490	04	50

ANL: Analytical data
DET: Detailed Questionnaire data
DMQ: Detailed Monitoring Questionnaire data

Table 11-10: BPT Facility Data Excluded from the Calculation of Non-Hazardous BPT/BAT Limitations

BPT Facility	Influent Sample Point	Avg. Influent Conc.	Effluent Sample Point	Avg. Effluent Conc.	Reason for Exclusion
BOD_5 (mg/L)					
16041 DMQ	02 02	- -	04 04	- -	No data No data
16058	-	-	01	22	Detailed questionnaire data was not used
16118	01	2,200	02	49	Detailed questionnaire data was not used
16120 ANL	- 01	- 1,290	02 -	15.9 -	Detailed questionnaire data was not used No effluent data
16122 DMQ	01 01	- -	03 03	5.3 5.4	Effluent sample point 03 located after aerated equalization
16132	01,02,03	5,581	04	7	Detailed questionnaire data was not used
16253	01	1,000	02	5.2	Detailed questionnaire data was not used
TSS (mg/L)					
16041 DMQ ANL	02 02 1, 3, 5, 6	364 307 70	04 04 02	36 35 46	Facility wastewater treatment system does not employ filtration
16058 DMQ ANL	- - 01, 02	- - 14,470	01 01 -	216 188 -	Facility wastewater treatment system does not employ filtration
16118 DMQ	01 01	- -	02 02	- -	Facility wastewater treatment system does not employ filtration
16120 ANL	- 01	- 200	02 -	14 -	Detailed questionnaire data was not used No effluent data
16122 DMQ ANL	01 01 01,02,03	- - 267	03 03 07	5.6 5.4 12.5	Facility eliminated due to settling that can occur in equalization tanks prior to filtration
16132 DMQ	01,02,03 01,02,03	244 -	04 04	39 47	Facility wastewater treatment system does not employ filtration
16253	01	180	02	17.5	Detailed questionnaire data was not used

Table 11-10: BPT Facility Data Excluded from the Calculation of Non-Hazardous BPT/BAT Limitations (continued)

BPT Facility	Influent Sample Point	Avg. Influent Conc.	Effluent Sample Point	Avg. Effluent Conc.	Reason for Exclusion
Ammonia (mg/L)					
16041	02	554	04	5.0	Detailed questionnaire data was not used
16058 DMQ ANL	- - 01, 02	- - 2,900	01 01 -	- - -	No data No data No effluent data
16118 DMQ	01 01	- -	02 02	- -	No data No data
16120 DMQ ANL	- 01 01	- 362 245	02 02 -	1.35 5.98 -	Facility wastewater treatment system employed an air stripper
16122 DMQ	01 01	136 135	03 03	0.87 0.48	Effluent sample point 03 located after aerated equalization
16132	01,02,03	-	04	-	No data
16253 DMQ	01 01	- -	02 02	- 0.01	No data No influent data
Alpha Terpineol (ug/L)					
16041 DMQ	02 02	- -	04 04	- -	No data No data
16058 DMQ ANL	- - 01, 02	- - -	01 01 -	- - -	No data No data No data
16118 DMQ	01 01	- -	02 02	- -	No data No data
16120 DMQ ANL	- 01 01	- - -	02 02 -	- - -	No data No data No data
16122 DMQ	01 01	- -	03 03	- -	No data No data
16132 DMQ	01,02,03 01,02,03	- -	04 04	- -	No data No data
16253 DMQ	01 01	- -	02 02	- -	No data No data

Table 11-10: BPT Facility Data Excluded from the Calculation of Non-Hazardous BPT/BAT Limitations (continued)

BPT Facility	Influent Sample Point	Avg. Influent Conc.	Effluent Sample Point	Avg. Effluent Conc.	Reason for Exclusion
Benzoic Acid (ug/L)					
16041	02	-	04	-	No data
DMQ	02	-	04	-	No data
16058	-	-	01	-	No data
DMQ	-	-	01	50	No influent data
ANL	01, 02	50	-	-	Influent concentration < 10xMDL
16118	01	-	02	-	No data
DMQ	01	-	02	-	No data
16120	-	-	02	-	No data
DMQ	01	-	02	-	No data
ANL	01	-	-	-	No data
16122	01	-	03	-	No data
DMQ	01	-	03	-	No data
16132	01,02,03	-	04	-	No data
DMQ	01,02,03	-	04	-	No data
16253	01	-	02	-	No data
DMQ	01	-	02	20	No influent data
P-Cresol (ug/L)					
16041	02	-	04	-	No data
DMQ	02	-	04	-	No data
16058	-	-	01	-	No data
DMQ	-	-	01	10	No influent data
ANL	01, 02	48	-	-	Influent concentration < 10xMDL
16118	01	-	02	-	No data
DMQ	01	-	02	-	No data
16120	-	-	02	-	No data
DMQ	01	30	02	10	Influent concentration < 10xMDL
ANL	01	10	-	-	Influent concentration < 10xMDL
16122	01	-	03	-	No data
DMQ	01	425	03	-	No effluent data
ANL	01,02,03	10	07	10	Influent concentration < 10xMDL
16132	01,02,03	-	04	-	No data
DMQ	01,02,03	-	04	-	No data

Table 11-10: BPT Facility Data Excluded from the Calculation of Non-Hazardous BPT/BAT Limitations (continued)

BPT Facility	Influent Sample Point	Avg. Influent Conc.	Effluent Sample Point	Avg. Effluent Conc.	Reason for Exclusion
16253 DMQ	01 01	- -	02 02	- -	No data No data
Phenol (ug/L)					
16041 DMQ	02 02	- -	04 04	- -	No data No data
16058 DMQ ANL	- - 01, 02	- - 10	01 01 -	10 10 -	Detailed questionnaire data was not used No influent data Influent concentration < 10xMDL
16120	-	-	02	-	No data
16122 DMQ	01 01	3,050 -	03 03	10 -	Effluent sample point 03 located after aerated equalization
16132 DMQ	01,02,03 01,02,03	- -	04 04	- -	No data No data
16253 DMQ	01 01	- -	02 02	- -	No data No data
Zinc (ug/L)					
16041	02	1,130	04	200	Detailed questionnaire data was not used
16058	-	-	01	10	Detailed questionnaire data was not used
16118 DMQ	01 01	380 295	02 02	50 45	Facility wastewater treatment system includes chemical precipitation
16120 DMQ ANL	- 01 01	- 230 85	02 02 -	40 37 -	Facility wastewater treatment system includes chemical precipitation
16122 DMQ ANL	01 01 01,02,03	212,000 805 120	03 03 07	16 22 12	Facility wastewater treatment system includes chemical precipitation
16132	01,02,03	575	04	10	Detailed questionnaire data was not used
16253 DMQ	01 01	20 90	02 02	38 50	Facility wastewater treatment system includes chemical precipitation

ANL: Analytical data
DET: Detailed Questionnaire data
DMQ: Detailed Monitoring Questionnaire data

Table 11-11: BPT/BAT Limitations for the Non-Hazardous Subcategory

Pollutant or Pollutant Property	Maximum for 1 day (mg/L)	Monthly Average Shall Not Exceed (mg/L)
BOD_5	140	37
TSS	88	27
Ammonia	10	4.9
Alpha Terpineol	0.033	0.016
Benzoic Acid	0.12	0.071
P-Cresol	0.025	0.014
Phenol	0.026	0.015
Zinc	0.20	0.11
pH	([1])	([1])

([1]) pH shall be in the range 6.0 - 9.0 pH units.

Table 11-12: National Estimates of Pollutant of Interest Reductions for BPT/BAT Options for Municipal Solid Waste Landfills - Direct Dischargers

		National Estimates			
Pollutant of Interest CAS Number	Pollutant of Interest	Current Discharge Loads (pounds/yr)	BPT/BAT Option I Loads (pounds/yr)	BPT/BAT Option II Loads (pounds/yr)	BAT Option III -RO Loads (pounds/yr)
C-020	TOTAL PHENOLS (CHLOROFORM EXTRACTION)	1,005	166	125	125
C-012	TOTAL ORGANIC CARBON	692,275	352,957	231,875	127,805
C-010	TOTAL DISSOLVED SOLIDS	13,158,362	13,109,304	12,086,905	621,714
C-009	TOTAL SUSPENDED SOLIDS	319,754	195,173	92,491	21,328
C-005	NITRATE/NITRITE	109,494	109,494	109,494	3,527
C-004	CHEMICAL OXYGEN DEMAND	2,364,028	1,597,988	1,497,581	373,389
C-002	BIOCHEMICAL OXYGEN DEMAND	478,004	144,915	105,561	105,561
98555	ALPHA-TERPINEOL	247	53	53	53
95487	O-CRESOL	62	53	53	53
78933	2-BUTANONE	2,846	2,846	2,846	2,846
7664417	AMMONIA NITROGEN	174,382	26,279	16,978	16,978
75092	METHYLENE CHLORIDE	385	385	385	385
7440666	ZINC	857	249	249	249
7440473	CHROMIUM	110	103	103	103
7440393	BARIUM	1,449	926	926	639
7440326	TITANIUM	123	20	20	20
7440246	STRONTIUM	3,404	1,812	1,812	533
68122	N,N-DIMETHYLFORMAMIDE	69	53	53	53
67641	2-PROPANONE	1,642	1,642	1,642	1,642
65850	BENZOIC ACID	350	265	265	265
298044	DISULFOTON	22	22	22	11
20324338	TRIPROPYLENEGLYCOL METHYL ETHER	840	528	528	528
18540299	CHROMIUM (HEXAVALENT)	117	117	117	50
142621	HEXANOIC ACID	9,183	53	53	53
123911	1,4-DIOXANE	55	55	55	55
120365	DICHLOROPROP	16	6	6	5
108952	PHENOL	298	56	56	56
108883	TOLUENE	191	191	191	191
108101	4-METHYL-2-PENTANONE	228	228	228	228
106445	P-CRESOL	151	48	48	48
35822469	1234678-HPCDD	6E-04	3E-04	3E-04	3E-04
3268879	OCDD	7E-03	2E-03	1E-03	1E-03

Table 11-13: National Estimates of Pollutant of Interest Reductions for BPT/BAT Options for Non-Municipal Solid Waste Landfills - Direct Dischargers

		National Estimates			
Pollutant of Interest CAS Number	Pollutant of Interest	Current Discharge Loads (pounds/yr)	BPT/BAT Option I Loads (pounds/yr)	BPT/BAT Option II Loads (pounds/yr)	BAT Option III -RO Loads (pounds/yr)
C-002	Biochemical Oxygen Demand	24,492	24,492	24,492	24,492
C-004	Chemical Oxygen Demand	5,633,111	1,033,662	907,417	147,359
C-009	Total Suspended Solids	22,451	22,451	22,451	8,164
C-005	Nitrate/Nitrite	73,475	1,939	1,939	1,359
C-020	Total Phenols	241	78	53	53
C-012	Total Organic Carbon	55,107	55,107	55,107	51,025
C-010	Total Dissolved Solids	69,189,296	13,878,575	6,385,329	339,723
7664417	Ammonia as Nitrogen	153,074	11,062	6,994	6,994
7440246	Strontium	61,229	54,494	54,494	204

Table 11-14: Annual Pollutant Discharge Before and After the Implementation of BPT for Subtitle D Municipal Solid Waste Landfill Facilities in the Non-Hazardous Subcategory

Pollutant Group	Current Annual Pollutant Discharge (pounds)	Annual Pollutant Discharge After Implementation of BPT (pounds)	Annual Amount of Pollutants Removed by BPT (pounds)
Conventional Pollutants(1)	800,000	200,000	600,000
Nonconventional Pollutants(2)	16,500,000	13,950,000	2,550,000
Metal Pollutants(3)	6,000	3,200	2,800
Organic Pollutants(4)	16,500	6,500	10,000 (7)
Pesticides(5)	40	29	11
Dioxins/ Furans(6)	0.0075	0.0013	0.0062

(1) Includes BOD_5 and TSS
(2) Includes ammonia, COD, TDS, TOC, total phenols, and nitrate/nitrite
(3) Includes barium, chromium, hexavalent chromium, strontium, titanium, and zinc
(4) Includes alpha terpineol, benzoic acid, hexanoic acid, N,N-Dimethylformamide, o-cresol, p-cresol, phenol, tripropyleneglycol methyl ether, methylene chloride, 1,4 dioxane, 2-butanone, 2-propanone, 4-methyl-2-pentanone, and toluene
(5) Includes dichloroprop and disulfoton
(6) Includes OCDD and 1,2,3,4,6,7,8-HpCDD
(7) EPA did not include the removal of the following volatile organic compounds: methylene chloride, 1,4 dioxane, 2-butanone, 2-propanone, 4-methyl 2-pentanone, and toluene

Table 11-15: Annual Pollutant Discharge Before and After The Implementation of BPT for Subtitle D Non-Municipal Solid Waste Landfill Facilities in the Non-Hazardous Subcategory

Pollutant Group	Current Annual Pollutant Discharge (pounds)	Annual Pollutant Discharge After Implementation of BPT (pounds)	Annual Amount of Pollutants Removed by BPT (pounds)
Conventional Pollutants (1)	47,000	47,000	0
Nonconventional Pollutants (2)	75,100,000	7,350,000	67,750,000
Metal Pollutants (3)	61,200	54,500	6,700

(1) Includes BOD_5 and TSS. Both facilities in the database were already in compliance with the BOD_5 and TSS limits.
(2) Includes ammonia, nitrate/nitrite, TDS, TOC, total phenol, and COD.
(3) Includes strontium - the only metal pollutant of interest for non-municipal solid waste landfills.

Table 11-16: Selected BPT Facilities for the Hazardous Subcategory

Detailed Questionnaire ID Number	Discharge Status	Treatment in Place
16041	Indirect	sequential batch reactor
16087	Indirect	stirred equalization, chemical precipitation, flocculation, neutralization, clarification, activated sludge, chemical oxidation

Table 11-17: Facilities and Sample Points Used for the Development of BPT/BAT Effluent Limitations for the Hazardous Subcategory

BPT Facility	Data Source	Influent Sample Point	Avg. Influent Concentration	Effluent Sample Point	Avg. Effluent Concentration
Ammonia (mg/L)					
16041	DMQ ANL	02 01, 03, 05, 06	679 475	04 02	5.4 1.4
16122	ANL	01, 02, 03	181	07	1.2
16132	DMQ	01, 02, 03	206	04	5.9
BOD_5 (mg/L)					
16041	ANL	01, 03, 05, 06	910	02	47
16058	DMQ ANL	- 01, 02	- 153	01 -	29.7 Only influent conc. used
16087	DMQ	01	2,929	05	29
16118	DMQ	01	1,890	02	45.5
16120	DMQ	01	780	02	4.6
16122	ANL	01, 02, 03	1,007	07	35.2
16132	DMQ	01, 02, 03	4,740	04	15.8
16253	DMQ	01	159	02	6.4
TSS (mg/L)					
16120	DMQ	01	1,240	02	13.6
16253	DMQ	01	120	02	24.9
Alpha Terpineol (ug/L)					
16041	ANL	01, 03, 05, 06	653	02	10
Aniline (ug/L)					
16041	ANL	01, 03, 05, 06	1,060	02	10
16087	ANL	01	533	03	10
Benzoic Acid (ug/L)					
16041	ANL	01, 03, 05, 06	15,400	02	50
16087	ANL	01	64,957	03	50

Table 11-17: Facilities and Sample Points Used for the Development of BPT/BAT Effluent Limitations for the Hazardous Subcategory (continued)

Pollutant	BPT Facility	Influent Sample Point	Avg. Influent Concentration	Effluent Sample Point	Avg. Effluent Concentration
Naphthalene (ug/L)					
16041	ANL	01, 03, 05, 06	645	02	10
P-Cresol (ug/L)					
16041	ANL	01, 03, 05, 06	1,360	02	10
16087	ANL	01	5,022	03	10
Phenol (ug/L)					
16041	ANL	01, 03, 05, 06	5,120	02	10
16087	ANL	01	65,417	03	29.7
Pyridine (ug/L)					
16087	ANL	01	301	03	10
Arsenic (ug/L)					
16087	DMQ ANL	01 01	1,400 584	05 03	325 312
Chromium (ug/L)					
16087	DMQ ANL	01 01	730 415	05 03	312 82
Zinc (ug/L)					
16041	DMQ ANL	02 01, 03, 05, 06	505 310	04 02	214 85
16087	DMQ	01	550	05	380

ANL: Analytical data
DET: Detailed Questionnaire data
DMQ: Detailed Monitoring Questionnaire data

Table 11-18: BPT Facility Data Excluded from the Calculation of Hazardous BPT/BAT Limitations

BPT Facility	Influent Sample Point	Avg. Influent Conc.	Effluent Sample Point	Avg. Effluent Conc.	Reason for Exclusion
BOD_5 (Transferred from the Non-Hazardous subcategory) (mg/L)					
16041 DMQ	02 02	- -	04 04	- -	No data No data
16058	-	-	01	22	Detailed questionnaire data was not used
16087 ANL	01 01	2,980 3,721	03 03	258 66	Effluent concentration above 50 mg/L Effluent concentration above 50 mg/L
16118	01	2,200	02	49	Detailed questionnaire data was not used
16120 ANL	- 01	- 1,290	02 -	15.9 -	Detailed questionnaire data was not used No effluent data.
16122 DMQ	01 01	- -	03 03	5.3 5.4	Effluent sample point 03 located after aerated equalization
16132	01,02,03	5,581	04	7	Detailed questionnaire data was not used
16253	01	1,000	02	5.2	Detailed questionnaire data was not used
TSS (Transferred from the Non-Hazardous subcategory) (mg/L)					
16041 DMQ ANL	02 02 1, 3, 5, 6	364 307 70	04 04 02	36 35 46	Facility wastewater treatment system does not employ filtration
16058 DMQ ANL	- - 01, 02	- - 14,470	01 01 -	216 188 -	Facility wastewater treatment system does not employ filtration
16087 DMQ ANL	01 01 01	586 579 172	03 05 03	51 114 78	Facility wastewater treatment system does not employ filtration
16118 DMQ	01 01	- -	02 02	- -	Facility wastewater treatment system does not employ filtration
16120 ANL	- 01	- 200	02 -	14 -	Detailed questionnaire data was not used No effluent data
16122 DMQ ANL	01 01 01,02,03	- - 267	03 03 07	5.6 5.4 12.5	Facility eliminated due to settling that can occur in equalization tanks prior to filtration
16132 DMQ	01,02,03 01,02,03	244 -	04 04	39 47	Facility wastewater treatment system does not employ filtration
16253	01	180	02	17.5	Detailed questionnaire data was not used

Table 11-18: BPT Facility Data Excluded from the Calculation of Hazardous BPT/BAT Limitations (continued)

BPT Facility	Influent Sample Point	Avg. Influent Conc.	Effluent Sample Point	Avg. Effluent Conc.	Reason for Exclusion
Ammonia (Transferred from the Non-Hazardous subcategory) (mg/L)					
16041	02	554	04	5.0	Detailed questionnaire data was not used
16058 DMQ ANL	- - 01, 02	- - 2,900	01 01 -	- - -	No data No data No effluent data
16087 DMQ ANL	01 01 01	- - 209	03 05 03	- - 153	No data No data Minimal ammonia removal
16118 DMQ	01 01	- -	02 02	- -	No data No data
16120 DMQ ANL	- 01 01	- 362 245	02 02 -	1.35 5.98 -	Facility wastewater treatment system employed an air stripper
16122 DMQ	01 01	136 135	03 03	0.87 0.48	Effluent sample point 03 located after aerated equalization
16132	01,02,03	-	04	-	No data
16253 DMQ	01 01	- -	02 02	- 0.01	No data No influent data
Alpha Terpineol (ug/L)					
16041 DMQ	02 02	- -	04 04	- -	No data No data
16087 DMQ ANL	01 01 01	- - 10	03 05 03	- - 10	No data No data Influent concentration < 10xMDL
Aniline (ug/L)					
16041 DMQ	02 02	- -	04 04	- -	No data No data
16087 DMQ	01 01	- -	03 05	- -	No data No data
Benzoic Acid (ug/L)					
16041 DMQ	02 02	- -	04 04	- -	No data No data
16087 DMQ	01 01	- -	03 05	- -	No data No data

Table 11-18: BPT Facility Data Excluded from the Calculation of Hazardous BPT/BAT Limitations (continued)

BPT Facility	Influent Sample Point	Avg. Influent Conc.	Effluent Sample Point	Avg. Effluent Conc.	Reason for Exclusion
Naphthalene (ug/L)					
16041	02	-	04	-	No data
DMQ	02	-	04	-	No data
16087	01	-	03	-	No data
DMQ	01	-	05	-	No data
ANL	01	25	03	10	Influent concentration < 10xMDL
P-Cresol (ug/L)					
16041	02	-	04	-	No data
DMQ	02	-	04	-	No data
16087	01	-	03	-	No data
DMQ	01	-	05	-	No data
Phenol (ug/L)					
16041	02	-	04	-	No data
DMQ	02	-	04	-	No data
16087	01	98,500	03	814	Detailed questionnaire data was not used
DMQ		-	05	-	No data
Pyridine (ug/L)					
16041	02	-	04	-	No data
DMQ	02	-	04	-	No data
ANL	1, 3, 5, 6	23	02	10	Influent concentration < 10xMDL
16087	01	-	03	-	No data
DMQ	01	-	05	-	No data

Table 11-18: BPT Facility Data Excluded from the Calculation of Hazardous BPT/BAT Limitations (continued)

BPT Facility	Influent Sample Point	Avg. Influent Conc.	Effluent Sample Point	Avg. Effluent Conc.	Reason for Exclusion
Arsenic (ug/L)					
16041	02	-	04	-	No data
DMQ	02	-	04	-	No data
ANL	1, 3, 5, 6	535	02	569	Negative percent removal
16087	01	1,420	03	193	Detailed questionnaire data was not used
Chromium (ug/L)					
16041	02	210	04	120	Detailed Questionnaire data was not used
DMQ	02	419	04	417	No removal
ANL	1, 3, 5, 6	82	02	46	Influent concentration < 10xMDL
16087	01	731	03	501	Detailed questionnaire data was not used
Zinc (ug/L)					
16041	02	1,130	04	200	Detailed questionnaire data was not used
16087	01	560	03	279	Detailed questionnaire data was not used
ANL	01	126	03	52	Influent concentration < 10xMDL

ANL: Analytical data
DET: Detailed Questionnaire data
DMQ: Detailed Monitoring Questionnaire data

Table 11-19**:** BPT/BAT Limitations for the Hazardous Subcategory

Pollutant or Pollutant Property	Maximum for 1 day (mg/L)	Monthly Average Shall Not Exceed (mg/L)
BOD_5	220	56
TSS	88	27
Ammonia	10	4.9
Alpha Terpineol	0.042	0.019
Aniline	0.024	0.015
Benzoic Acid	0.119	0.073
Naphthalene	0.059	0.022
P-Cresol	0.024	0.015
Phenol	0.048	0.029
Pyridine	0.072	0.025
Arsenic	1.1	0.54
Chromium	1.1	0.46
Zinc	0.535	0.296
pH	([1])	([1])

([1]) pH shall be in the range 6.0 - 9.0 pH units.

Table 11-20: Comparison of Long-Term Averages for Nonconventional and Toxic Pollutants Regulated Under BAT for the Non-Hazardous Subcategory

Pollutant	BPT Option II: Equalization + Biological + Multimedia Filter (mg/L)	Reverse Osmosis single stage effluent (mg/L)	Reverse Osmosis second stage effluent (mg/L)
Ammonia	5.4	13	0.59
Alpha Terpineol	0.010 ND	0.010 ND	0.010 ND
Benzoic Acid	0.050 ND	0.093	0.050 ND
P-Cresol	0.010 ND	0.253	0.022
Phenol	0.010 ND	0.185	0.029

ND: Non-detect

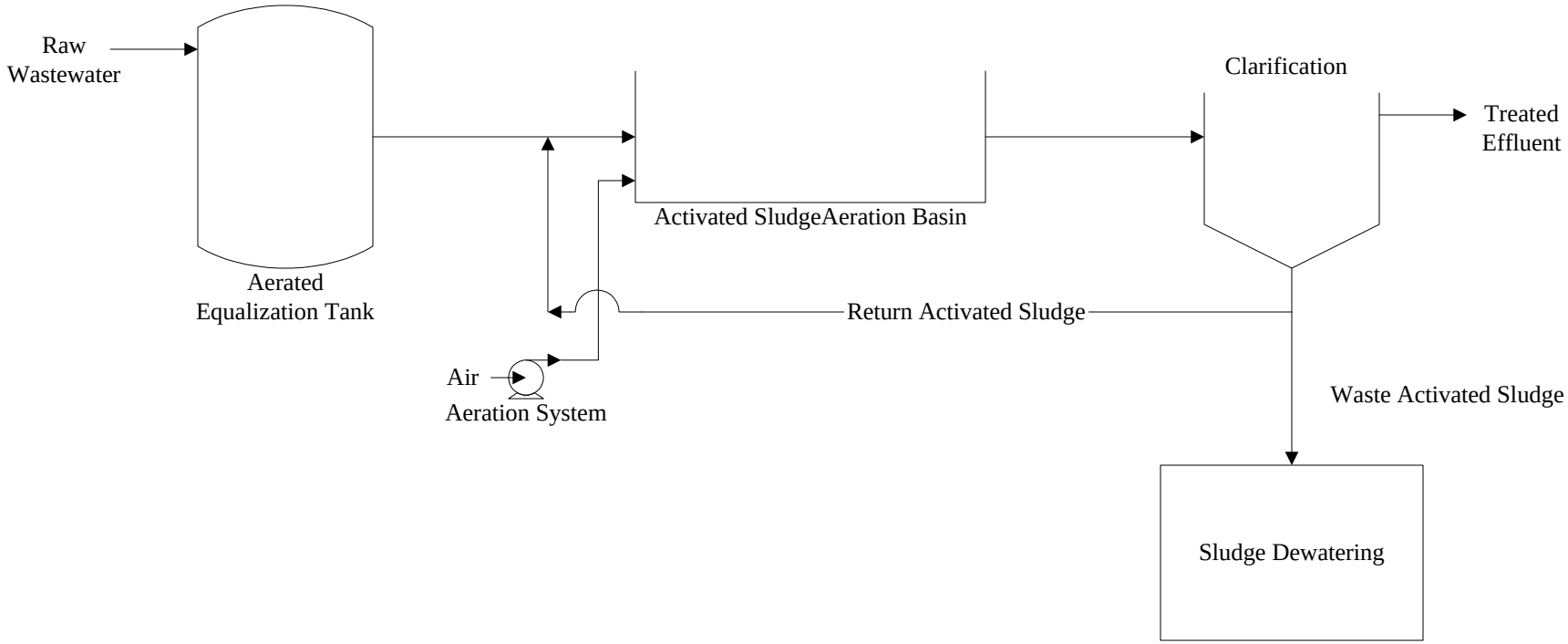

Figure 11-1: BPT/BCT/BAT/PSES/PSNS Non-Hazardous Subcategory Option I Flow Diagram

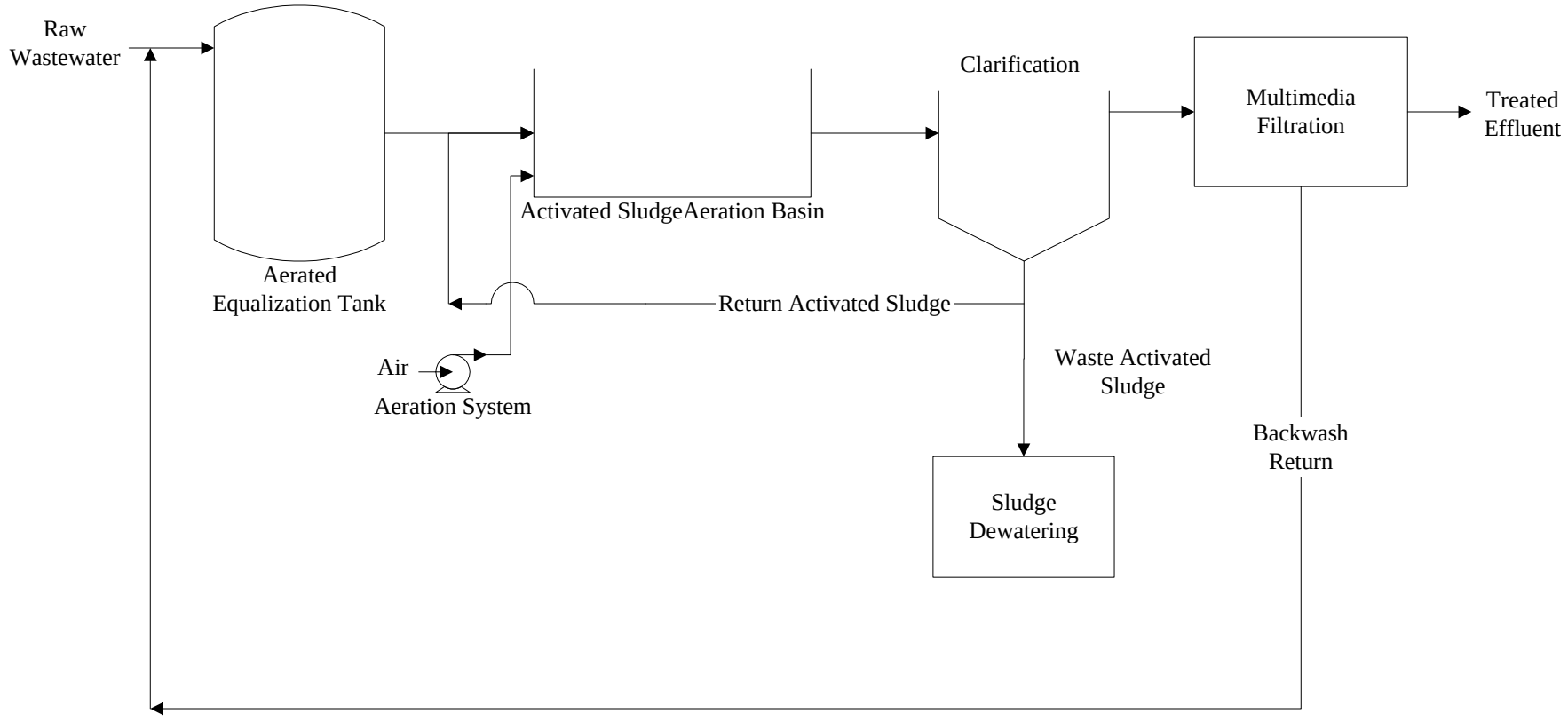

Figure 11-2: BPT/BCT/BAT Non-Hazardous Subcategory Option II & NSPS Flow Diagram

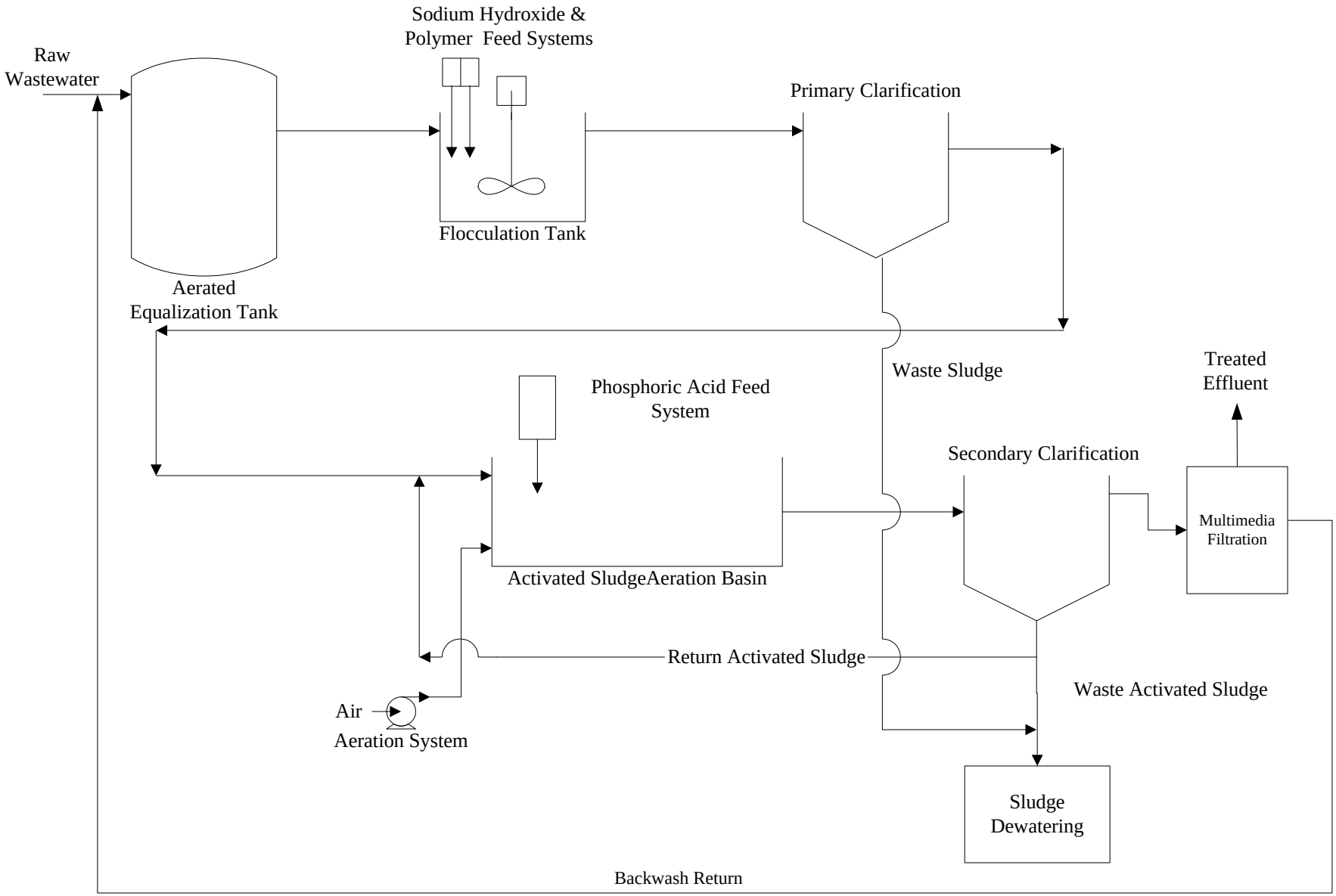

Figure 11-3: BPT/BCT/BAT Hazardous Subcategory Option II & NSPS Flow Diagram

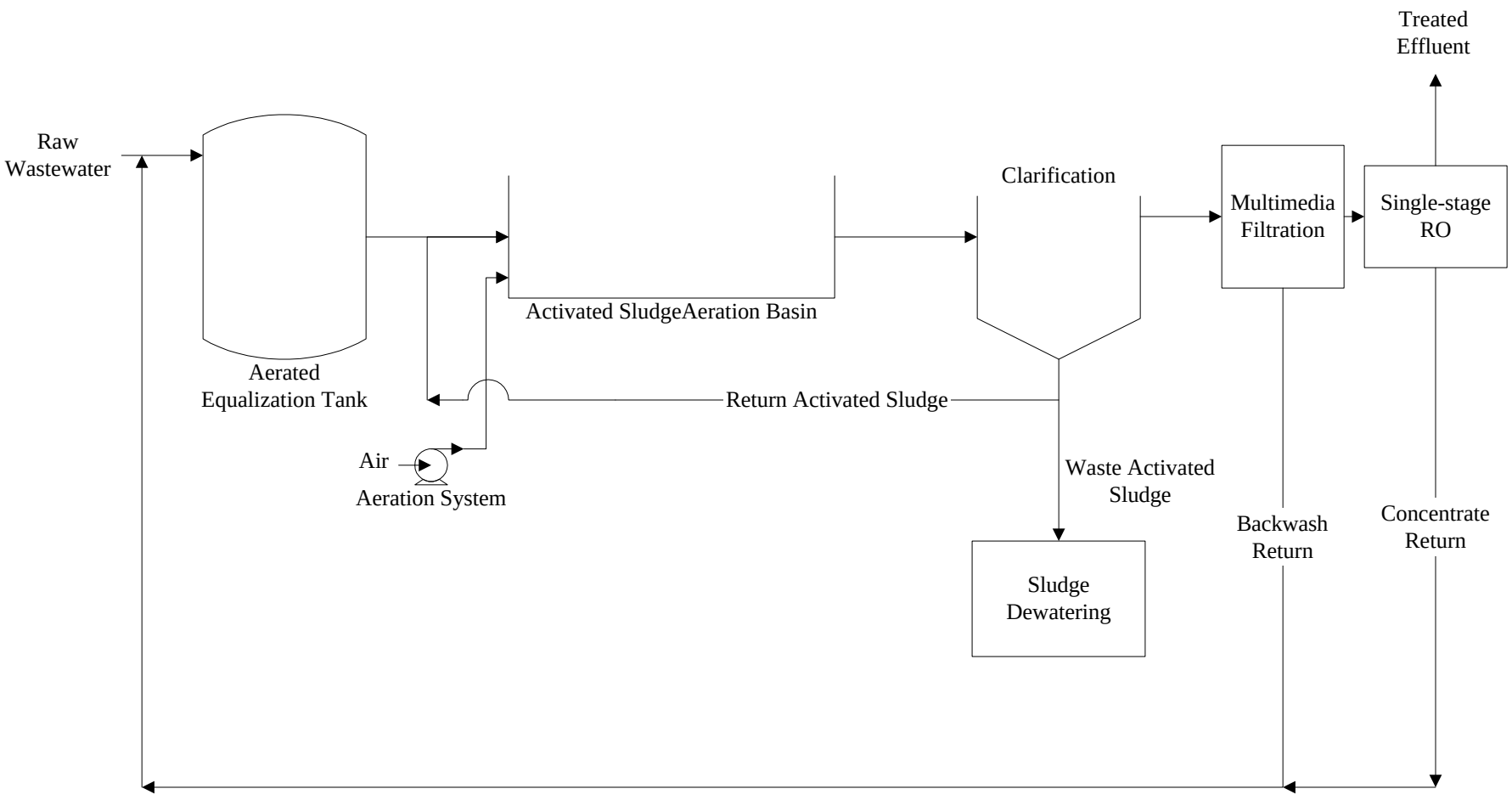

Figure 11-4: BAT Non-Hazardous Subcategory Option III Flow Diagram

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APPENDIX A:

SECTION 308 SURVEY FOR LANDFILLS - INDUSTRY POPULATION ANALYSIS

Appendix A: Section 308 Survey for Landfills-Industry Population Analysis

The list of landfills needed to define the landfill population in the United States was developed from various sources: state environmental and solid waste departments, and other state contacts; the National Survey of Hazardous Waste Treatment Storage, Disposal, and Recycling Facilities respondent list; Environmental Ltd.'s 1991 Directory of Industrial and Hazardous Waste Management Firms; the Resource Conservation and Recovery Act (RCRA) 1992 list of Municipal Solid Waste Landfills; and the Resource Conservation and Recovery Information System (RCRIS) National Oversight Database.

The information provided by state environmental departments was requested during early stages of the rulemaking process for Centralized Waste Treatment and represented 1987-88 data for both active and inactive landfills. This information was incomplete to some extent. For 18 of the 50 states only limited or no information was available. Hence, these states were contacted during the data gathering effort for the development of effluent guidelines and standards for Landfills and Incinerators to obtain updated lists of landfills and wastewater collection information.

The duplication of landfill entries among various sources was eliminated as far as possible by cross checking using computer programs. However, some duplication in Subtitle D landfills is inevitable as some of the various identifiers were unclear.

Landfill population was divided into two categories: Subtitle C (hazardous waste) and Subtitle D (non-hazardous waste). In total, mailing addresses were compiled for 595 Subtitle C landfills and 9,882 Subtitle D landfills. In addition, 448 Subtitle D landfills were identified for which addresses were inadequate for delivery. Thus the population of Subtitle D amounted to 10,330. Table 1 provides a list of the number of landfills with deliverable mailing addresses in each state by category.

Selection of the landfills to survey

From the identified landfill population of 10,925 Subtitle C and D facilities, screener surveys were mailed to 4996. Facilities receiving the screener survey included all of the 595 Subtitle C landfills and a sample of the 9,882 Subtitle D facilities with mailable addresses.

TABLE 1. COUNT OF LANDFILLS WITH MAILABLE ENTRIES IN EACH STATE

State	Subtitle-D	Subtitle-C	Total
Alabama	238	38	276
Alaska	201	1	202
Arizona	90	2	92
Arkansas	134	3	137
California	630	16	646
Colorado	216	12	228
Connecti-cut	125	22	147
Delaware	8	14	22
Florida	91	9	100
Georgia	277	17	294
Hawaii	15	1	16
Idaho	112	6	118
Illinois	182	14	196
Indiana	101	29	130
Iowa	118	13	131
Kansas	118	8	126
Kentucky	121	33	154
Louisiana	73	17	90

State	Subtitle-D	Subtitle-C	Total
Maine	291	2	293
Maryland	50	5	55
Massachu-setts	722	1	723
Michigan	762	9	771
Minnesota	257	4	261
Mississippi	97	3	100
Missouri	128	7	135
Montana	257	1	258
Nebraska	41	8	49
Nevada	127	3	130
New Hapmshire	58	0	58
New Jersey	467	8	475
New Mexico	121	7	128
New York	565	10	575
North Carolina	244	39	283
North Dakota	85	1	86
Ohio	119	24	143
Oklahoma	189	7	196
Oregon	231	10	241
Pennsyl-vania	41	22	63
Rhode Island	12	0	12
South Carolina	127	9	136

State	Subtitle-D	Subtitle-C	Total
South Dakota	193	0	193
Tennessee	112	9	121
Texas	601	70	671
Utah	92	7	99
Vermont	73	0	73
Virginia	440	8	448
Washing-ton	72	9	81
West Virginia	57	5	62
Wisconsin	183	3	186
Wyoming	218	45	263
Puerto Rico	0	3	3
Guam	0	1	1
Total	9882	595	10477

The remaining 4401 screener surveys were sent to Subtitle D landfills. A statistical approach was taken to sample the 9882 deliverable Subtitle D facilities. For sampling purposes, the 9882 Subtitle D landfills were stratified into three categories:

1) landfills with known wastewater collection
2) landfills from states with fewer than 100 landfills and
3) landfills from states with more than 100 landfills.

All landfills with known wastewater collection were included in the landfill survey sample. The population included 134 landfills with known wastewater collection (1.35%).

Landfills in states with fewer than 100 landfills were stratified from the landfills in states with more than 100 landfills. This was simply a sampling technique for random sampling and was done to ensure the inclusion of a representative number of facilities from each stratum.

There were 16 states with under 100 landfills each (after exclusion of known wastewater collectors), which accounted for 892 landfills. A screener survey was mailed to each of these 892 landfills. The remaining 24 states, with over 100 landfills each, accounted for 8856 landfills. A random sample of 3375 was taken from this strata, and a screener survey was mailed to each of these randomly selected landfills. Table 2 summarizes the stratification.

Screener surveys were distributed by both Federal Express and U.S. certified mail: 1916 surveys were sent via Federal Express, which resulted in 94% receipt confirmation; 3080 surveys were sent via U.S. certified mail, which resulted in 92% receipt confirmation. Twenty three additional screener surveys were mailed because of change of ownership, or different mailing address, even though the physical location of the landfill remained same. A summary of analysis on these additional surveys is presented in Table 3. Thus, a total of 5020 landfill screener surveys were distributed.

TABLE 2. SUMMARY OF STRATIFICATION

Strata #	Population	# in frame	# in sample
1	Subtitle C	595	595
2	Subtitle D -known wastewater generators	134	134
3	Subtitle D - states with ≤ 100 landfills	892	892
4	Subtitle D - states with >100 landfills	8856	3375
	Total	10477	4996

A completed screener survey was received from 3628 landfills excluding the late arrivals. This includes response from a pre-test screener survey. The status of remaining screener surveys is:

- 353 surveys were deemed non-deliverables due to incorrect/non-traceable addresses and were returned to the sender
- 1008 landfills were presumed to be non-respondents
- 4 landfills were found to be out-of-business
- 26 landfills were declared ineligible to participate in the survey for reasons discovered during the mid-point remainder calls
- 1 respondent refused to respond to the survey.

For statistical analysis purposes, screener surveys in each of the above categories were traced back to the respective strata. Table 4 presents a breakdown of these remaining screener surveys by strata.

TABLE 3. SUMMARY OF ADDITIONAL SCREENER SURVEY ANALYSIS

Screener ID	Original ID	Stratum	Reason for re-assignment
15100	13235	4	screener sent to former owner or incorrect address
15101	14044	4	screener sent to former owner or incorrect address
15102	13876	4	screener sent to former owner or incorrect address
15103	11594	4	screener sent to former owner or incorrect address
15104	14117	4	screener sent to former owner or incorrect address
15105	13953	4	screener sent to former owner or incorrect address
15106	13264	4	screener sent to former owner or incorrect address
15107	10985	4	additional screener resp. was obtained for a new landfill
15108	14449	4	additional screener resp. was obtained for a new landfill
15109	12167	1	additional screener resp. was obtained for a new landfill
15110	12883	4	additional screener resp. was obtained for a new landfill
15111			response transferred from pre-test screener survey
15112	14112	4	screener sent to former owner or incorrect address
15113	11319	3	screener sent to former owner or incorrect address
15114	12327	4	screener sent to former owner or incorrect address
15116	11528	4	screener sent to former owner or incorrect address
15117	13389	3	screener sent to former owner or incorrect address
15118	13995	4	screener sent to former owner or incorrect address
15119	14779	4	screener sent to former owner or incorrect address
15120	11422	4	screener sent to former owner or incorrect address
15121	13976	4	screener sent to former owner or incorrect address
15122	12422	1	screener sent to former owner or incorrect address
15123	11299	4	screener sent to former owner or incorrect address
15124	10851	4	screener sent to former owner or incorrect address

Among the 3628 survey responses received, a total of 3581 surveys were sent to data entry; 44 were declared ineligible upon reviewing their response, and were not processed any further; 3 remained incomplete because of unsuccessful attempts to contact the respondents to complete the review process. A total of 859 respondents were found collecting some type of wastewater (landfills collecting only storm water were not included) generated from their landfill operations, and were considered as in scope population from which a sample of facilities will be selected to receive the detailed Section 308 landfill questionnaire. The rest of the surveys sent to data entry were considered out of scope. For statistical analysis purposes, screener surveys not sent to data entry, the out of scope surveys, and the in scope surveys were traced back to the respective strata, and a count of these in each strata is presented in Table 4.

A response bias query was conducted on about 5.65% (57 landfills) of the 1008 presumed non-respondents. Each of these 57 randomly-selected landfills was called to discern the reasons that the screener survey was not received. The result of this effort is as follows:

- 25 facility contacts said that they over looked/misplaced/forgotten the survey (1 in stratum 2; 1 in stratum 3; and 23 in stratum 4)

- 19 facility contacts said that they did not recall receiving any survey (2 in stratum 1; 3 in stratum 3; and 14 in stratum 4)

- 7 facility contacts said that they did not feel it was applicable to them (1 in stratum 1; 2 in stratum 3; and 4 in stratum 4)

- 3 facility contacts said that they forgot and would complete the survey and return (2 in stratum 3; and 1 in stratum 4)

- 2 facility contacts said that they received duplicate surveys, and this was checked and found correct (these 2 are in stratum 4)

- 1 facility contact said that they are under bankruptcy proceedings (this is in stratum 1).

A total of 39 landfill screener survey responses were received past the deadline. since these were received after the close of the screener survey database, they were not considered for any further analyses. Among these 39 late arrivals, only four landfills collected wastewater generated from landfill operations (landfill leachate and contaminated groundwater), and none of these four landfills have any on-site treatment. Additional information on these four landfills is: two were municipal, non-commercial, and discharged untreated wastewater to a Publicly Owned Treatment Works (POTW); one was government, commercial, and discharged untreated wastewater to a POTW; one was private and sent their wastewaters for off-site disposal.

Questionnaire distribution

A total of 859 landfill operators reported that they collect one or more type of wastewater generated from the landfill operations (landfills collecting only storm water were not included). These landfills were considered as the sample frame to receive the Section 308 questionnaire for landfills. Facilities with treatment were targeted most heavily, while some facilities without treatment but collect wastewater were randomly selected to receive only Section A of the questionnaire. The facilities selected fall into any of the following eight categories:

1. Commercial private, municipal, or government facilities which have wastewater treatment and are direct or indirect dischargers. A census was conducted of this part of the industry.

2. Commercial private, municipal, or government facilities which have wastewater treatment and are zero dischargers (do not discharge to surface water or to a POTW). Approximately 25% of these were randomly chosen to receive the questionnaire.

3. Non-commercial private facilities with wastewater treatment. Approximately 40% of these were randomly chosen to receive the questionnaire.

4. Facilities with no wastewater treatment. Approximately 10% of these were randomly chosen to receive only Section A of the questionnaire.

5. Commercial facilities who accept PCB wastes. Only one facility was in this category, and was chosen.

6. Municipal hazardous waste landfills. There were two facilities in this category, and a census was conducted of this part of the industry.

7. Small business with no wastewater treatment. A census was conducted of this part of the industry.

8. Pre-test facility which was not in the screener population. Only one facility was in this category, and was chosen based on knowledge of the industry and professional judgement.

For statistical analysis purposes, the facilities in each of the aforementioned categories were traced back through their screener surveys to the respective strata, and a count of these in each strata is presented in Table 5.

Section 308 Questionnaires were sent to a total of 252 mailing addresses that were considered in scope from their screener responses. The questionnaire response was received from 248 landfills. The remaining four landfills were presumed to be non-respondents. The questionnaire responses received included four responses from pre-test questionnaires. Thus a total of 248 responses were available for further review.

Among the survey responses obtained, 22 were declared out of scope upon reviewing their response and were not processed any further; 226 were reviewed for completeness and technical accuracy and

were entered into the landfill questionnaire database. For statistical analysis purposes, the 252 questionnaires that were sent, including the 226 questionnaires reviewed and placed in the database, were traced back to the original screener population strata, and a count of these in each strata is presented in Table 4.

TABLE 4. COUNT OF SCREENER SURVEYS IN EACH CATEGORY BY STRATA[1]

Category	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Total
Non-respondents	69	15	170	755	1009
Ineligible[2]	79	9	45	294	427
Incomplete	2	0	1	0	3
In scope	141	91	222	405	859
Out of scope	305	20	456	1941	2722
Quest. recipients	51	35	77	88	252[3]
Quest. in database	46	32	71	76	226[3]
Quest. out of scope	4	3	4	11	22
Quest. non-response	1	0	2	1	4

[1]For each of the category presented below, a list of Survey ID numbers and their respective strata # is presented in Appendix A.

[2]This includes all non-deliverables, out-of-business, and duplicate addresses.

[3]An additional one is the pre-test questionnaire, which is not part of any stratum.

TABLE 5. QUESTIONNAIRE SELECTION BY CATEGORY

Category	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Total
Pri/com/muni/govt./with treat/D-I discharge	12	27	51	38	128
Pri/non-com/with treatment	30	2	3	7	42
Pri/com/muni/govt./with treat/Zero discharge	1	0	7	0	8
No treatment	5	6	14	38	63
PCB facilities with treatment	0	0	1	0	1
Municipal/hazardous	2	0	0	0	2
Small business/no treatment	1	0	1	5	7
Pre-test not in Screener population[4]	-	-	-	-	1
Totals	51	35	77	88	252

[4]This is a pre-test questionnaire and is not in any stratum because, it was not in the screener database.

TABLE 6. IN SCOPE SCREENERS NOT SELECTED FOR QUESTIONNAIRE BY CATEGORY

Category	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Total
Pri/com/muni/govt./with treat/D-I discharge	0	0	0	0	0
Pri/non-com/with treatment	31	0	6	27	64
Pri/com/muni/govt./with treat/Zero discharge	7	2	9	7	25
No treatment	52	54	130	283	519
PCB facilities with treatment	0	0	0	0	0
Municipal/hazardous	0	0	0	0	0
Small business/no treatment	0	0	0	0	0
Totals	90	56	145	317	608

APPENDIX B:

DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

APPENDIX B: DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

ADMINISTRATOR: The Administrator of the U.S. Environmental Protection Agency.

AGENCY: The U.S. Environmental Protection Agency.

AVERAGE MASTER FILE: A method of calculating the average raw wastewater concentration for each pollutant of interest in a subcategory. The Average Master File was calculated using all available data collected in the Landfills industry study.

BASELINE FLOW: Estimated wastewater discharge flow rate for a selected facility in 1992 based on their Detailed Questionnaire response.

BAT: The best available technology economically achievable, applicable to effluent limitations to be achieved by July 1, 1984, for industrial discharges to surface waters, as defined by Sec. 304(b)(2)(B) of the CWA.

BCT: The best conventional pollutant control technology, applicable to discharges of conventional pollutants from existing industrial point sources, as defined by Sec. 304(b)(4) of the CWA.

BOD_5: Biochemical oxygen demand - Five Day. A measure of the biochemical decomposition of organic matter in a water sample. It is determined by measuring the dissolved oxygen consumed by microorganisms to oxidize the organic contaminants in a water sample under standard laboratory conditions of five days and 70 degrees Celsius. BOD_5 is not related to the oxygen requirements in chemical combustion.

BPT: The best practicable control technology currently available, applicable to effluent limitations to be achieved by July 1, 1977, for industrial discharges to surface waters, as defined by Sec. 304(b)(1) of the CWA.

CAPDET: Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems. Developed by the U.S. Army Corp. of Engineers, CAPDET is intended to provide planning level cost estimates to analyze alternate design technologies for wastewater treatment systems.

CAPTIVE: Used to describe a landfill that is directly associated with an industrial or commercial operation. See Chapter 2 for the conditions that a captive landfill must meet in order to be excluded from the landfill effluent guideline.

CELL: An area of a landfill that is separated from other areas by an impervious structure. Each cell has a separate leachate collection system or would require a separate leachate collection system if one were installed. Individual leachate collection systems that are combined at the surface are considered separate systems by this definition.

CLEAN WATER ACT (CWA): The Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. Section 1251 et seq.), as amended by the Clean Water Act of 1977 (Pub. L. 95-217), and the Water Quality Act of 1987 (Pub. L. 100-4).

CLEAN WATER ACT (CWA) SECTION 308 QUESTIONNAIRE:
A questionnaire sent to facilities under the authority of Section 308 of the CWA, which requests information to be used in the development of national effluent guidelines and standards.

CLOSED: A facility or portion thereof that is currently not receiving or accepting wastes and has undergone final closure.

COMMERCIAL FACILITY: A facility that treats, disposes, or recycles/recovers the wastes of other facilities not under the same ownership as this facility. Commercial operations are usually made available for a fee or other remuneration. Commercial waste treatment, disposal, or recycling/recovery does not have to be the primary activity at a facility for an operation or unit to be considered "commercial".

CONTAMINATED GROUND WATER: Water below the land surface in the zone of saturation which has been contaminated by landfill leachate. Contaminated ground water occurs at landfills without liners or at facilities that have released contaminants from a liner system. Ground water may also become contaminated if the water table rises to a point where it infiltrates the landfill or the leachate collection system.

CONTAMINATED STORM WATER: Storm water which comes in direct contact with landfill wastes, the waste handling and treatment areas, or wastewater that is subject to the limitations and standards. Some specific areas of a landfill that may produce contaminated storm water include (but are not limited to): the open face of an active landfill with exposed waste (no cover added); the areas around wastewater treatment operations; trucks, equipment or machinery that has been in direct contact with the waste; and waste dumping areas.

CONVENTIONAL POLLUTANTS: Constituents of wastewater as determined by Sec. 304(a)(4) of the CWA, including pollutants classified as biochemical oxygen demand, total suspended solids, oil and grease, fecal coliform, and pH.

DEEP WELL INJECTION: Disposal of wastewater into a deep well such that a porous, permeable formation of a larger area and thickness is available at sufficient depth to ensure continued, permanent storage.

DETAILED MONITORING QUESTIONNAIRE (DMQ): Questionnaires sent to collect monitoring data from 27 selected landfill facilities based on responses to the Section 308 Questionnaire.

DIRECT DISCHARGER: A facility that discharges or may discharge treated or untreated wastewater into waters of the United States.

DRAINED FREE LIQUIDS: Aqueous wastes drained from waste containers (e.g., drums, etc.) prior to landfilling. Landfills which accept containerized waste may generate this type of wastewater.

EFFLUENT LIMITATION: Any restriction, including schedules of compliance, established by a State or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents

which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean. (CWA Sections 301(b) and 304(b)).

EPA: The U.S. Environmental Protection Agency.

EXISTING SOURCE: Any facility from which there is or may be a discharge of pollutants, the construction of which is commenced before the publication of the proposed regulations prescribing a standard of performance under Sec. 306 of the CWA.

FACILITY: All contiguous property owned, operated, leased or under the control of the same person or entity.

GAS CONDENSATE: A liquid which has condensed in the landfill gas collection system during the extraction of gas from within the landfill. Gases such as methane and carbon dioxide are generated due to microbial activity within the landfill, and must be removed to avoid hazardous conditions.

GROUND WATER: The body of water that is retained in the saturated zone which tends to move by hydraulic gradient to lower levels.

HAZARDOUS SUBCATEGORY: For the purposes of this guideline, Hazardous subcategory refers to all landfills regulated under Subtitle C of RCRA.

HAZARDOUS WASTE: Any waste, including wastewater, defined as hazardous under RCRA (40 CFR 261.3).

INACTIVE: A facility or portion thereof that is currently not treating, disposing, or recycling/recovering wastes.

INDIRECT DISCHARGER: A facility that discharges or may discharge wastewater into a publicly-owned treatment works (POTW).

INTRA-COMPANY: A facility that treats, disposes, or recycles/recovers wastes generated by off-site facilities under the same corporate ownership. The facility may also treat on-site generated wastes.

LANDFILL: An area of land or an excavation in which wastes are placed for permanent disposal, that is not a land application or land treatment unit, surface impoundment, underground injection well, waste pile, salt dome formation, a salt bed formation, an underground mine or a cave.

LANDFILL GENERATED WASTEWATER: Wastewater generated by landfill activities and collected for treatment, discharge or reuse, include: leachate, contaminated ground water, storm water runoff, landfill gas condensate, truck/equipment washwater, drained free liquids, floor washings, and wastewater from recovering pumping wells.

LEACHATE: Leachate is a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste. Leachate is typically collected from a liner system

above which waste is placed for disposal. Leachate may also be collected through the use of slurry walls, trenches or other containment systems.

LEACHATE COLLECTION SYSTEM: The purpose of a leachate collection system is to collect leachate for treatment or alternative disposal and to reduce the depths of leachate buildup or level of saturation over the low permeability liner.

LINER: The liner is a low permeability material or combination of materials placed at the base of a landfill to reduce the discharge to the underlying or surrounding hydrogeologic environment. The liner is designed as a barrier to intercept leachate and to direct it to a leachate collection system.

LONG-TERM AVERAGE (LTA): For purposes of the effluent guidelines, average pollutant levels achieved over a period of time by a facility, subcategory, or technology option. LTAs are used in developing the limitations and standards in the landfill regulation.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT:
A permit to discharge wastewater into waters of the United States issued under the National Pollutant Discharge Elimination System, authorized by Section 402 of the CWA.

NEW SOURCE: As defined in 40 CFR 122.2, 122.29, and 403.3 (k), a new source is any building, structure, facility, or installation from which there is or may be a discharge of pollutants, the construction of which commenced (1) for purposes of compliance with New Source Performance Standards (NSPS) established under CWA section 306, after the promulgation of these standards; or (2) for the purposes of compliance with Pretreatment Standards for New Sources (PSNS), after the publication of proposed standards under CWA section 307 (c), if such standards are thereafter promulgated in accordance with that section.

NONCONVENTIONAL POLLUTANTS: Pollutants that are neither conventional pollutants listed at 40 CFR Part 401.16 nor priority pollutants listed in Appendix A of 40 CFR Part 423.

NON-CONTAMINATED STORM WATER: Storm water which does not come in direct contact with landfill wastes, the waste handling and treatment areas, or wastewater that is subject to the limitations and standards. Non-contaminated storm water includes storm water which flows off the cap, cover, intermediate cover, daily cover, and/or final cover of the landfill.

NON-HAZARDOUS SUBCATEGORY: For the purposes of this report, Non-Hazardous subcategory refers to all landfills regulated under Subtitle D of RCRA.

NON-WATER QUALITY ENVIRONMENTAL IMPACT: Deleterious aspects of control and treatment technologies applicable to point source category wastes, including, but not limited to air pollution, noise, radiation, sludge and solid waste generation, and energy usage.

NSPS: New Source Performance Standards, applicable to new sources of direct dischargers whose construction is begun after the publication of the proposed effluent regulations under CWA section 306.

OCPSF: Organic chemicals, plastics, and synthetic fibers manufacturing point source category. (40 CFR Part 414).

OFF-SITE: Outside the boundaries of a facility.

ON-SITE: The same or geographically contiguous property, which may be divided by a public or private right-of-way, provided the entrance and exit between the properties is at a crossroads intersection, and access is by crossing as opposed to going along the right-of-way. Non-contiguous properties owned by the same company or locality but connected by a right-of-way, which it controls, and to which the public does not have access, is also considered on-site property.

PASS THROUGH: A pollutant is determined to "pass through" POTWs when the nationwide median percentage removed by well-operated POTWs achieving secondary treatment is less than the percentage removed by the industry's direct dischargers that are using the BAT technology.

POINT SOURCE: Any discernable, confined, and discrete conveyance from which pollutants are or may be discharged.

POLLUTANTS OF INTEREST (POIs): Pollutants commonly found in landfill generated wastewater. For the purposes of this report, a pollutant of interest is a pollutant that is detected three or more times above a treatable level at a landfill, and must be present at more than one facility.

PRIORITY POLLUTANT: One hundred twenty-six compounds that are a subset of the 65 toxic pollutants and classes of pollutants outlined in Section 307 of the CWA. The priority pollutants are specified in the NRDC settlement agreement (Natural Resources Defense Council et al v. Train, 8 E.R.C. 2120 [D.D.C. 1976], modified 12 E.R.C. 1833 [D.D.C. 1979]).

PRODUCT STEWARDSHIP: These activities mean the acceptance for treatment and disposal of only the following materials: spent, or unused products; shipping and storage containers with product residue; off-specification products.

PSES: Pretreatment standards for existing sources of indirect discharges, under Sec. 307(b) of the CWA.

PSNS: Pretreatment standards for new sources of indirect discharges, applicable to new sources whose construction has begun after the publication of proposed standards under CWA section 307 (c), if such standards are thereafter promulgated in accordance with that section.

PUBLIC SERVICE: The provision of landfill waste disposal services to individual members of the general public, publicly-owned organizations (schools, universities, government agencies, municipalities) and not-for-profit organizations for which the landfill does not receive a fee or other remuneration.

PUBLICLY OWNED TREATMENT WORKS (POTW): Any device or system, owned by a state or municipality, used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature that is owned by a state or municipality. This includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment (40 CFR 122.2).

RCRA: The Resource Conservation and Recovery Act of 1976 (RCRA) (42 U.S.C. Section 6901 et seq.), which regulates the generation, treatment, storage, disposal, or recycling of solid and hazardous wastes.

SUBTITLE C LANDFILL: A landfill permitted to accept hazardous wastes under Sections 3001 and 3019 of RCRA and the regulations promulgated pursuant to these sections, including 40 CFR Parts 260 through 272.

SUBTITLE D LANDFILL: A landfill permitted to accept only non-hazardous wastes under Sections 4001 through 4010 of RCRA and the regulations promulgated pursuant to these sections, including 40 CFR Parts 257 and 258.

SURFACE IMPOUNDMENT: A natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), used to temporarily or permanently treat, store, or dispose of waste, usually in the liquid form. Surface impoundments do not include areas constructed to hold containers of wastes. Other common names for surface impoundments include ponds, pits, lagoons, finishing ponds, settling ponds, surge ponds, seepage ponds, and clarification ponds.

TOXIC POLLUTANTS: Pollutants declared “toxic” under Section 307(a)(1) of the Clean Water Act.

TRUCK/EQUIPMENT WASHWATER: Wastewater generated during either truck or equipment washes at the landfill. During routine maintenance or repair operations, trucks and/or equipment used within the landfill (e.g., loaders, compactors, or dump trucks) are washed and the resultant washwaters are collected for treatment.

VARIABILITY FACTOR: The daily variability factor is the ratio of the estimated 99th percentile of the distribution of daily values divided by the expected value, median or mean, of the distribution of the daily data. The monthly variability factor is the estimated 95th percentile of the distribution of the monthly averages of the data divided by the expected value of the monthly averages.

ZERO DISCHARGE: No discharge of pollutants to waters of the United States or to a POTW. Also included in this definition are alternative discharge or disposal of pollutants by way of evaporation, deep-well injection, off-site transfer, and land application.

INDEX

Activated Sludge
- Capital Cost Curves (9-71, 9-72)
- Costing (9-20, 9-36)
- Evaluated as BAT - Hazardous Subcategory (11-31, 11-84)
- Evaluated as BAT - Non-Hazardous Subcategory (11-29, 11-82, 11-83, 11-85)
- Evaluated as BPT - Hazardous Subcategory (11-20, 11-84)
- Evaluated as BPT - Non-Hazardous Subcategory (11-8, 11-82, 11-83)
- O&M Cost Curve (9-73)
- Technology Description (8-34, 8-79)
- Treatment Performance (8-50, 8-58, 8-88)
- Types (8-36)

Age (see Landfills Industry)

Air Pollution Reduction Impacts (10-1)

Air Stripping
- Number of Landfills currently using (8-53)
- Technology Description (8-14, 8-67)

Ammonia
- Limitations - Hazardous Subcategory (2-20, 11-80)
- Limitations - Non-Hazardous Subcategory (2-21, 11-68)
- National Estimates of Pollutant of Interest Reductions (11-69, 11-70)
- Pretreatment Standards - Hazardous Subcategory (2-5, 11-48)
- Pretreatment Standards - Non-Hazardous Subcategory (2-5, 11-35)
- Raw Wastewater Concentrations - Hazardous Subcategory (5-20, 5-25, 6-50, 6-51, 8-56, 8-58, 11-56, 11-74, 11-77)
- Raw Wastewater Concentrations - Non-Hazardous Subcategory (5-20, 5-23, 5-24, 5-27, 5-30, 6-49, 6-51, 8-54, 8-55, 8-60, 11-56, 11-62, 11-65)
- Treated Effluent Concentrations - Hazardous Subcategory (8-56, 8-58, 11-56, 11-74, 11-77)
- Treated Effluent Concentrations - Non-Hazardous Subcategory (8-54, 8-55, 8-60, 11-56, 11-62, 11-65)

Anaerobic Biological Systems
- Technology Description (8-30, 8-75)
- Technology Performance (8-46, 8-54, 8-85)

Applicable Waste Streams (2-2, 6-1, 6-8, 6-30)

INDEX

Aqueous Waste Disposal Impacts (10-3)

Attached-Growth Biological Systems
- Technology Description (8-31, 8-76, 8-77, 8-78)
- Types (8-31)

BAT (1-2)
- Costs (9-31, 9-32, 9-40, 9-44, 9-49, 9-54)
- Limitations - Hazardous Subcategory (2-4, 2-20, 11-31, 11-80)
- Limitations - Non-Hazardous Subcategory (2-4, 2-21, 11-29, 11-68)
- Technology Description (8-1)
- Technology Options - Hazardous Subcategory (11-84)
- Technology Options - Non-Hazardous Subcategory (11-81, 11-82, 11-83, 11-85)

BCT (1-2)
- Costs (9-30, 9-31, 9-40, 9-44, 9-49)
- Limitations (2-4, 11-27)
- Technology Options (11-82, 11-83, 11-84)

Best Management Practices (8-1)

Benzoic Acid
- Limitations - Hazardous Subcategory (2-20, 11-80)
- Limitations - Non-Hazardous Subcategory (2-21, 11-68)
- National Estimates of Pollutant of Interest Reductions (11-69)
- Pretreatment Standards - Hazardous Subcategory (11-48)
- Pretreatment Standards - Non-Hazardous Subcategory (11-41)
- Raw Wastewater Concentrations - Hazardous Subcategory (5-20, 5-25, 6-50, 6-53, 8-56, 8-58, 11-56, 11-74, 11-77)
- Raw Wastewater Concentrations - Non-Hazardous Subcategory (5-20, 5-22, 5-24, 5-27, 5-30, 6-49, 6-53, 8-54, 8-55, 8-60, 11-56, 11-62, 11-66)
- Treated Effluent Concentrations - Hazardous Subcategory (8-56, 8-58, 11-56, 11-74, 11-77)
- Treated Effluent Concentrations - Non-Hazardous Subcategory (8-54, 8-55, 8-60, 11-56, 11-62, 11-66)

Biological Treatment
- As a selection criteria for BPT facilities (11-8, 11-9, 11-10, 11-20, 11-21, 11-22, 11-55, 11-58, 11-59, 11-60, 11-73, 11-82, 11-83, 11-84)
- Number of Landfills currently using (3-37, 8-26, 8-53)

INDEX

Technology Description (8-24)
Types (8-26)

BOD_5 (4-2, 5-13, 6-10, 6-18)
As a selection criteria for BPT facilities (11-11, 11-55, 11-57, 11-58, 11-59)
Concentration with Age of Landfill (5-11, 5-30, 6-10)
Limitations - Hazardous Subcategory (2-20, 11-80)
Limitations - Non-Hazardous Subcategory (2-21, 11-68)
National Estimates of Pollutant of Interest Reductions (11-69, 11-70)
Raw Wastewater Concentrations - Hazardous Subcategory (5-20, 5-25, 6-50, 6-51, 8-56, 8-58, 11-56, 11-74, 11-76)
Raw Wastewater Concentrations - Non-Hazardous Subcategory (5-20, 5-23, 5-24, 5-27, 5-30, 6-31, 6-49, 6-51, 8-54, 8-55, 8-60, 11-56, 11-59, 11-62, 11-64)
Regulated Pollutant (7-14, 7-21)
Treated Effluent Concentrations - Hazardous Subcategory (8-56, 8-58, 11-74, 11-76)
Treated Effluent Concentrations - Non-Hazardous Subcategory (8-54, 8-55, 8-60, 11-62, 11-64)

BPT (1-1, 11-6)
Costs (9-29, 9-30, 9-40, 9-44, 9-49)
Limitations - Hazardous Subcategory (2-4, 2-20, 11-23, 11-80)
Limitations - Non-Hazardous Subcategory (2-4, 2-21, 11-11, 11-68)
Selected Facilities (11-60, 11-73)
Technology Options - Hazardous Subcategory (11-20, 11-84)
Technology Options - Non-Hazardous Subcategory (11-8, 11-82, 11-83)

Breakpoint Chlorination
Capital Cost Curve (9-83)
Costs (9-27, 9-36)
O&M Cost Curve (9-84)
Technology Description (8-12)

Captive/Intra-Company Facilities
Definition (3-2)
Exemption from Guideline (2-10, 3-13)
Number in Landfills Population (3-12, 3-25)

Carbon Adsorption
Capital Cost Curve (9-81)
Costs (9-26, 9-36)

INDEX

Number of Landfills currently using (8-53)
O&M Cost Curve (9-82)
Technology Description (8-21, 8-71)
Treatment Performance (8-48, 8-55)

Chemical Oxidation/Reduction
Number of Landfills currently using (8-53)
Technology Description (8-11, 8-12, 8-65, 8-66)

Chemical Precipitation
Capital Cost Curves (9-63, 9-65, 9-67)
Costs (9-14, 9-36, 9-41, 9-42, 9-43)
Evaluated as BAT (11-28, 11-31, 11-84)
Evaluated as BPT - Hazardous Subcategory (11-20, 11-21, 11-22 11-84)
Evaluated as BPT - Non-Hazardous Subcategory (11-8)
Number of Landfills currently using (3-37, 8-53)
O&M Cost Curves (9-64, 9-66, 9-68)
Technology Description (8-8)
Treatment Performance (8-46, 8-48, 8-50, 8-54, 8-55, 8-58, 8-85, 8-86, 8-88)

Clarification
Capital Cost Curves (9-69, 9-74)
Costs (9-19, 9-22, 9-36)
Evaluated as BAT - Hazardous Subcategory (11-31, 11-84)
Evaluated as BAT - Non-Hazardous Subcategory (11-29, 11-82, 11-83, 11-85)
Evaluated as BPT - Hazardous Subcategory (11-20, 11-84)
Evaluated as BPT - Non-Hazardous Subcategory (11-8, 11-82, 11-83, 11-85)
O&M Cost Curves (9-70, 9-75)
Technology Description (8-6, 8-62)

Contaminated Ground Water
CERCLA Ground Water Data (4-13, 6-7)
Concentration of Pollutants (5-8, 5-25, 5-27)
Definition (3-19, 6-4)
Exclusion from Guideline (2-5, 3-12, 3-19, 5-8, 6-1, 6-4)
Monitoring (3-6, 3-8, 3-9)
Quantity of Flow Generated (3-19, 3-34, 6-26, 6-27, 6-29)

INDEX

Costs (9-1)
- Additional Cost Factors (9-8, 9-37)
- BAT (9-31, 9-40, 9-44, 9-49, 9-54)
- BCT (9-30, 9-40, 9-44, 9-49)
- BPT (9-29, 9-40, 9-44, 9-49)
- Land Costs (9-9)
- Methodology (9-6, 9-7, 9-11)
- Models (9-1, 9-3, 9-34, 9-35, 9-40)
- Monitoring Costs (9-10, 9-38)
- NSPS (9-32, 9-40)
- Off-Site Disposal Costs (9-11, 9-39, 11-23)
- Option Specific Costing Logic Flow Diagram (9-59)
- Residual Disposal Costs (9-9)
- Retrofit Costs (9-9)
- Treatment Chemicals (9-14, 9-41, 9-42, 9-43)
- Treatment Technologies (5-14, 9-11, 9-36, 9-40)

Cost Models (9-1)

Current Discharge Concentrations (7-3)
- Alternate Methodology - Hazardous Subcategory (7-5)
- Alternate Methodology - Non-Hazardous Subcategory (7-5)

Denitrification Systems
- In Removal of Nitrate/Nitrite (7-10, 7-17)
- Technology Description (8-41)

Discharge Information
- Discharge Types (3-22, 3-42)
- Quantity of Flow Discharged (3-34, 6-4, 6-5, 6-6, 6-26, 6-27, 6-29, 6-30)
- Raw Wastewater Concentrations - Hazardous Subcategory (5-20, 5-25, 6-17, 6-24, 6-25, 6-50, 6-51, 6-52, 6-53, 6-55, 8-56, 8-58, 11-56, 11-74, 11-76)
- Raw Wastewater Concentrations - Non-Hazardous Subcategory (5-20, 5-22, 5-24, 5-27, 5-30, 6-17, 6-21, 6-23, 6-49, 6-51, 6-52, 6-53, 6-54, 8-54, 8-55, 8-60, 11-54, 11-56, 11-59, 11-61, 11-62, 11-64)
- Sources of Wastewater (3-16, 6-1)

Drained Free Liquids (2-2, 3-1, 3-12, 3-17, 6-1, 6-3)
- Quantity of Flow Generated (3-17, 3-34, 6-14, 6-26, 6-27, 6-29, 6-30)

INDEX

Energy Requirements (5-15, 10-5)

Equalization
- Capital Cost Curve (9-60)
- Costs (9-12, 9-36)
- Evaluated as BAT - Hazardous Subcategory (11-31, 11-84)
- Evaluated as BAT - Non-Hazardous Subcategory (11-29, 11-82, 11-83, 11-85)
- Evaluated as BPT - Hazardous Subcategory (11-20, 11-84)
- Evaluated as BPT - Non-Hazardous Subcategory (11-8, 11-82, 11-83)
- Number of Landfills currently using (3-37, 8-53)
- Technology Description (8-3, 8-61)

Equipment/Truck Washwater (see Truck/Equipment Washwater)

Filtration (8-14)
- Diatomaceous Earth (8-17)
- Fabric Filters (8-21)
- Membrane Filtration (8-18)
  - Reverse Osmosis (8-19, 8-70, 9-78)
  - Ultrafiltration (8-18, 8-69)
- Multimedia Filtration (8-17, 8-68, 9-76, 9-77)
- Number of Landfills currently using (3-37, 8-53)
- Sand Filtration (8-15)

Flocculation
- Capital Cost Curve (9-61)
- Costs (9-13, 9-36)
- O&M Cost Curve (9-62)
- Technology Description (8-5, 8-62)

Floor Washings (2-2, 3-12, 6-1)
- Quantity of Flow Generated (3-18, 3-34, 6-26, 6-27, 6-29, 6-30)

Fluidized Bed Biological Reactor
- Technology Description (8-33, 8-78)

Granular Activated Carbon (see Carbon Adsorption)

INDEX

Gravity Assisted Separation (also see Clarification)
Number of Landfills currently using (8-53)
Technology Description (8-6, 8-62)

Ground Water (see Contaminated Ground Water)

Hazardous Subcategory (2-1, 5-2)
BAT Options (11-31, 11-84)
BPT Options (11-20, 11-84)
Limitations (2-20, 11-23, 11-31, 11-80)
Pollutants Considered for Regulation - Indirect Dischargers (7-27)
Pollutants of Interest (7-30)
Pollutants Selected for Regulation - Direct Dischargers (7-21)
Pretreatment Standards (2-5, 11-32, 11-48)
Raw Wastewater Concentrations (5-20, 5-25, 6-24, 6-25, 6-50, 6-51, 6-52, 6-53, 6-55, 8-56, 8-58, 11-56, 11-74, 11-76)
Subcategorization Approach (5-1, 5-2)
Wastewater Flow and Discharge (6-6, 6-26, 6-30)

Impacts
Air Pollution (7-11, 7-12, 7-13, 7-19, 10-1)
Energy Requirements (10-5)
Solid and Other Aqueous Waste Disposal (10-3)
Non-Water Quality (5-15, 10-1)

Intra-Company/Captive Facilities
Definition (3-2)
Exemption from Guideline (2-10, 3-13)
Number in Landfills Population (3-12, 3-25)

Ion Exchange
Technology Description (8-23, 8-72)

Iron Coprecipitation
Technology Description (8-11)

Laboratory-Derived Wastewater (2-2, 3-1, 3-12, 3-18, 6-1, 6-3, 6-8)

INDEX

Lagoon Systems
- Aerated (8-28, 8-73)
- Aerobic (8-27)
- Anaerobic (8-28)
- Facultative (8-29, 8-74)
- Number of Landfills currently using (8-26)
- Technology Description (8-26)

Land Costs (9-9)

Landfill Gas Condensate (2-2, 3-1, 3-12, 3-17, 6-1, 6-2, 6-13)
- Definition (3-17, 6-2)
- Monitoring Data (6-32)
- Quantity of Flow Generated (3-17, 3-34, 6-13, 6-26, 6-27, 6-29, 6-30)
- Treatment (6-13)

Landfill Leachate (2-2, 3-1, 3-12, 3-16, 6-1, 6-2, 6-8)
- Definition (3-16, 6-2)
- Literature Data (6-12, 6-31)
- Quantity of Flow Generated (3-17, 3-34, 6-11, 6-26, 6-27, 6-29, 6-30, 6-31)

Landfills Industry
- Age (5-11, 5-28, 5-30)
- Area (3-26, 3-27)
- Cells (3-28, 5-6, 5-13)
- General Information (3-14)
- Industry Description (3-1)
- Location of Landfills (3-11, 3-12, 3-24, 5-9)
- Number of Facilities (3-11, 3-12, 3-24)
- Ownership Types (3-1, 3-25, 5-9)
- Population (3-11, 3-24, 3-29, 3-30)
- Regulatory History of the Landfills Industry (3-3)
- Regulatory Types (3-2)
- Waste Received (3-15, 3-31, 3-32, 3-33, 5-3)

Leachate (see Landfill Leachate)

Leachate Collection Systems (3-20, 3-35)

INDEX

Limitations
BPT/BAT/NSPS Limitations - Hazardous Subcategory (2-4, 2-20, 11-23, 11-80)
Facilities and Sample Points Selected (11-74)
Facilities and Sample Points Excluded (11-76)
BPT/BAT/NSPS Limitations - Non-Hazardous Subcategory (2-4, 2-21, 11-11, 11-68)
Facilities and Sample Points Selected (11-62)
Facilities and Sample Points Excluded (11-64)
Calculations of Effluent Limitations (11-6)
Long-Term Averages (11-2, 11-81)
PSES (11-32, 11-34, 11-48)
Variability Factors (11-5)

Long-Term Averages (11-1, 11-2, 11-81)

Monitoring Costs (9-10)

Monofills (5-5, 5-22, 5-24, 11-14)

Multimedia Filtration
As a selection criteria for BPT facilities (11-9, 11-10, 11-16, 11-20, 11-21, 11-22, 11-60, 11-61, 11-83, 11-84)
Capital Cost Curve (9-76)
Costs (9-23, 9-36)
Evaluation as BAT - Hazardous Subcategory (11-31, 11-84)
Evaluation as BAT - Non-Hazardous Subcategory (11-29, 11-83, 11-85)
Evaluation as BPT - Hazardous Subcategory (11-20, 11-21, 11-22, 11-84)
Evaluation as BPT - Non-Hazardous Subcategory (11-9, 11-10, 11-16, 11-83)
O&M Cost Curve (9-77)
Technology Description (8-17, 8-68)
Treatment Performance (8-46, 8-48, 8-54, 8-55, 8-85, 8-86)

National Estimates (3-11, 3-43)

National Risk Management Research Laboratory (NRMRL) Treatability Database (see Pass-Through Analysis)

Neutralization
Number of Landfills currently using (8-53)
Technology Description (8-4, 8-61)

INDEX

Nitrification Systems
In Removal of Nitrate/Nitrite (7-10, 7-17)
Technology Description (8-40)

Non-Hazardous Subcategory (2-1, 5-3)
BAT Options (11-29, 11-82, 11-83, 11-85)
BPT Options (11-8, 11-82, 11-83)
Limitations (2-21, 11-11, 11-29, 11-68)
Pollutants Considered for Regulation - Indirect Dischargers (7-25)
Pollutants of Interest (7-29)
Pollutants Selected for Regulation - Direct Dischargers (7-14)
Pretreatment Standards (2-5, 11-32, 11-34)
Raw Wastewater Concentrations (5-20, 5-22, 5-24, 5-27, 5-30, 6-21, 6-23, 6-31, 6-49, 6-51, 6-52, 6-53, 6-54, 8-54, 8-55, 8-60, 11-54, 11-56, 11-59, 11-61, 11-62, 11-64)
Subcategorization Approach (5-1, 5-3)
Wastewater Flow and Discharge (6-5, 6-27, 6-29, 6-30)

Non-Water Quality Impacts (10-1)

NSPS (1-3, 2-5,)
Costs (9-32, 9-40)
Limitations (2-20, 2-21, 11-31, 11-68, 11-80, 11-83, 11-84)

Off-Site Disposal Costs (9-11, 9-39, 11-23)

Ownership Status (see Landfills Industry)

P-Cresol
Limitations - Hazardous Subcategory (2-20, 11-80)
Limitations - Non-Hazardous Subcategory (2-21, 11-68)
National Estimates of Pollutant of Interest Reductions (11-69)
Pretreatment Standards - Hazardous Subcategory (11-48)
Pretreatment Standards - Non-Hazardous Subcategory (11-43)
Raw Wastewater Concentrations - Hazardous Subcategory (5-20, 6-50, 6-53, 8-56, 8-58,11-56, 11-75, 11-78)
Raw Wastewater Concentrations - Non-Hazardous Subcategory (5-20, 5-22, 5-24, 5-30, 6-49, 6-53, 8-54, 8-55, 8-60, 11-56, 11-62, 11-66)
Treated Effluent Concentrations - Hazardous Subcategory (8-56, 8-58, 11-75, 11-78)
Treated Effluent Concentrations - Non-Hazardous Subcategory (8-54, 8-55, 8-60, 11-62, 11-66)

INDEX

Pass-Through Analysis
Approach (7-22)
BAT Performance Data (7-22, 7-32, 7-34)
Data Editing (7-23)
NRMRL Treatability Database (4-15, 7-22, 7-31)
50-POTW Study Database (4-14, 7-22, 7-31)
Results - Hazardous Subcategory (7-27, 7-35, 11-48)
Results - Non-Hazardous Subcategory (7-25, 7-33, 11-34)

pH (6-18)
Limitations (2-20, 2-21, 11-68, 11-80)
Raw Wastewater Concentrations (6-31, 6-51)

Phenol
Limitations - Hazardous Subcategory (2-20, 11-80)
Limitations - Non-Hazardous Subcategory (2-21, 11-68)
National Estimates of Pollutant of Interest Reductions (11-69)
Pretreatment Standards - Hazardous Subcategory (11-48)
Pretreatment Standards - Non-Hazardous Subcategory (11-44)
Raw Wastewater Concentrations - Hazardous Subcategory (5-20, 5-26, 6-50, 6-53, 11-56, 11-75, 11-78)
Raw Wastewater Concentrations - Non-Hazardous Subcategory (5-20, 5-22, 5-24, 5-27, 5-30, 6-49, 6-53, 11-56, 11-63, 11-67)
Treated Effluent Concentrations - Hazardous Subcategory (8-56, 8-58, 11-75, 11-78)
Treated Effluent Concentrations - Non-Hazardous Subcategory (8-54, 8-55, 8-60, 11-63, 11-67)

Pollutants Considered for Regulation - Indirect Dischargers
Hazardous Subcategory (7-22, 7-27, 7-35)
Non-Hazardous Subcategory (7-22, 7-25, 7-33)

Pollutants Not Selected for Regulation - Direct Dischargers
Hazardous Subcategory (7-15, 7-16, 7-18)
Non-Hazardous Subcategory (7-9, 7-10, 7-13)

Pollutants of Interest
Determination (7-2, 7-7, 7-36)
Hazardous Subcategory List (6-50, 7-30)
Metals (11-54)
Non-Hazardous Subcategory List (6-49, 7-29)

INDEX

Pollutant Reductions (7-3, 11-35, 11-41, 11-43, 11-44, 11-48, 11-69, 11-70, 11-71, 11-72)

Pollutants Selected for Regulation - Direct Dischargers
- Determination of (7-7, 7-37)
- Hazardous Subcategory (2-20, 7-14, 7-21, 11-80)
- Non-Hazardous Subcategory (2-21, 7-8, 7-10, 11-68)

Population (see Landfills Industry)

50-POTW Study (see Pass-Through Analysis)

Powdered Activated Carbon
- Technology Description (8-38, 8-80)

Preliminary Data Summary (4-1)

Pressure Filtration
- Technology Description (8-42, 8-83)

Pretreatment Methods for Wastes Received at Landfills (3-21, 3-36)

Primary Clarification (see Clarification)

PSES (1-3, 2-5, 11-32)
- Hazardous Subcategory (11-48)
- Non-Hazardous Subcategory (11-34, 11-82)
  - Ammonia (11-35)
  - Benzoic Acid (11-41)
  - P-Cresol (11-43)
  - Phenol (11-44)
  - Public Comments (11-45)

PSNS (1-4, 2-5, 11-53)
- Hazardous Subcategory (11-53)
- Non-Hazardous Subcategory (11-53, 11-82)

Public Comments
- PSES (11-45)

INDEX

QA/QC and Other Data Editing Procedures (4-15)

Quantity of Wastes Received (3-15, 3-31, 3-32, 3-33)

Questionnaires (4-3, Appendix A)
- Detailed Monitoring Questionnaire (4-9)
- Detailed Technical Questionnaire (4-6)
- Screener Surveys (4-4)

RCRA
- Subtitle C (3-3)
- Subtitle D (3-6)

Recovering Pumping Wells (2-3, 3-1, 3-12, 3-20, 6-4)
- Definition (3-20, 6-4)
- Quantity of Flow Generated (3-20, 3-34)

Residual Disposal Costs (9-9)

Retrofit Costs (9-9)

Reverse Osmosis
- Capital Cost Curve (9-78)
- Costs (9-24, 9-36, 11-29)
- Evaluated as BAT - Non-Hazardous Subcategory (11-29, 11-41, 11-69, 11-70, 11-81, 11-85)
- Technology Description (8-19, 8-70)
- Treatment Performance (8-51, 8-60, 8-89, 11-69, 11-70, 11-81)

Rotating Biological Contactors
- Technology Description (8-31, 8-76)

Sampling Program
- Analytical Data (5-24, 5-25, 5-27, 6-37, 6-54, 6-55, 8-54, 8-55, 8-56, 8-58, 8-60, 11-56, 11-59, 11-61, 11-62, 11-64, 11-74, 11-76)
- Pollutants Analyzed in EPA Sampling (6-15, 6-33, 6-37)
- Sampling Episodes (4-11, 4-12, 4-23, 4-24, 4-25)
- Sampling Results for Performance of Treatment Processes (8-45, 8-54, 8-55, 8-56, 8-58, 8-60)
- Site Visits (4-10, 4-11, 4-12, 4-23, 4-25)

INDEX

Scope of the Regulation (2-2)

Screener Surveys (see Questionnaires)

Secondary Clarification (see Clarification)

Section 304 (m) (1-4)

Sequencing Batch Reactors
- BPT Facility for Hazardous Subcategory (11-24)
- BPT Facility for Non-Hazardous Subcategory (11-12)
- Number of Landfills currently using (8-26)
- Technology Description (8-39, 8-81)
- Treatment Performance (8-48, 8-49, 8-55, 8-56, 8-86, 8-87)

Sludge Handling (8-41, 8-53)
- Gravity Thickening (8-42, 8-82)
- Pressure Filtration (8-42, 8-83)
- Sludge Dewatering (8-42, 8-53, 9-25, 11-9)
- Sludge Drying Beds (8-43, 8-84, 9-25, 9-36, 9-79, 9-80)
- Sludge Slurrying (8-42)

Solid Waste Disposal Impacts (10-3)

Storm Water
- Contaminated (2-7, 3-1, 3-12, 3-19, 6-1, 6-3)
- Non-Contaminated (non-contact) (2-7, 3-12, 3-19, 6-1, 6-4)
- Quantity of Flow Generated (3-19, 3-34, 6-26, 6-27, 6-29)

Stripping (see Air Stripping)

Subcategories (see Hazardous and Non-Hazardous Subcategories)
- Landfill Subcategories (2-1, 5-2, 5-3)

Subcategorization (2-1, 5-1)
- Age (5-11, 5-28, 5-30)
- Approach (5-1)
- Factors Considered (5-3)
- Landfill Subcategories (2-1, 5-2, 5-16)

INDEX

Waste Types (5-3)
Wastewater Characteristics (5-7)

Treatment Performance (8-45)
Episode 4626 (8-46, 8-54, 8-85)
Episode 4667 (8-48, 8-55, 8-86)
Episode 4721 (8-49, 8-56, 8-87)
Episode 4759 (8-50, 8-58, 8-88)
Episode 4687 (8-51, 8-60, 8-89)

Trickling Filters
Technology Description (8-32, 8-77)

Truck/Equipment Washwater (2-2, 3-1, 3-12, 3-18, 6-1, 6-3, 6-14)
Definition (3-18, 6-3, 6-14)
Quantity of Flow Generated (3-18, 3-34, 6-15, 6-26, 6-27, 6-29, 6-30)

TSS (6-18)
As a selection criteria for BPT facilities (11-16, 11-25, 11-61)
Limitations - Hazardous Subcategory (2-20, 11-80)
Limitations - Non-Hazardous Subcategory (2-21, 11-68)
National Estimates of Pollutant of Interest Reductions (11-69, 11-70)
Raw Wastewater Concentrations - Hazardous Subcategory (5-20, 5-26, 6-50, 6-51, 8-56, 8-58, 11-56, 11-74, 11-76)
Raw Wastewater Concentrations - Non-Hazardous Subcategory (5-20, 5-23, 5-24, 5-27, 5-30, 6-31, 6-49, 6-51, 8-54, 8-55, 8-60, 11-56, 11-61, 11-62, 11-64)
Regulated Pollutant (7-14, 7-21)
Treated Effluent Concentrations - Hazardous Subcategory (8-56, 8-58, 11-74, 11-76)
Treated Effluent Concentrations - Non-Hazardous Subcategory (8-54, 8-55, 8-60, 11-62, 11-64)

Ultrafiltration (also see Filtration)
Technology Description (8-18, 8-69)

Variability Factors (11-1, 11-5)

Waste Receipts (3-15, 3-31, 3-32, 3-33, 5-3)

Wastewater (6-1)
CERCLA Ground Water Data (4-13, 6-18)

INDEX

Characterization (5-7, 6-7, 6-17, 6-31, 6-32, 6-37, 6-49, 6-50, 6-51, 6-52, 6-53, 6-54, 6-55)
Industry Supplied Data (4-13)
Quantity of Flow Generated (3-16, 3-34, 6-4, 6-5, 6-6, 6-26, 6-27, 6-29, 6-30)
Sources (2-2, 3-16, 6-1)
Technology for Treatment of (3-22, 3-37, 5-14, 8-53)
Treatment Performance (8-45)

Wetlands Treatment
Technology Description (8-41)

Zero/Alternative Discharge Treatment
Cost (9-7, 9-11, 9-39, 11-20, 11-23)
Discharge Types (3-22, 3-42)
Evaluated as BAT - Hazardous subcategory (11-31)
Evaluated as BPT - Hazardous subcategory (11-21)
Number of Landfills currently using (6-7, 11-24)
Technology Description (8-44)