CONTENTS

	Preface	iiix
1	Introduction	I
1-1	The Environment	1
1-2	The Impact of Humans upon the Environment	2
1-3	The Impact of the Environment upon Humans	4
1-4	Improvement of Environmental Quality	6
1-5	The Role of the Environmental Engineer	7
	References	8
Part 1	Water	
2	Water Quality: Definitions, Characteristics,	_
	and Perspectives	11
2-1	The Hydraulic Cycle and Water Quality	12
	PHYSICAL WATER-QUALITY PARAMETERS	14
2-2	Suspended Solids	15
2-3	Turbidity	17
2-4	Color	18
2-5	Taste and Odor	20
2-6	Temperature	22
	CHEMICAL WATER-QUALITY PARAMETERS	23
2-7	Chemistry of Solutions	23
2-8	Total Dissolved Solids	28
2-9	Alkalinity	31
2-10	Hardness	35
2-11	Fluoride	36
2-12	Metals	37
2-13	Organics	38
2-14	Nutrients	44

vi CONTENTS

	BIOLOGICAL WATER-QUALITY PARAMETERS	46
2-15	Pathogens	47
2-16	Pathogen Indicators	50
	WATER QUALITY REQUIREMENTS	54
2-17	In-Stream Standards	54
2-18	Potable Water Standards	55
2-19	Wastewater Effluent Standards	56
	Discussion Topics and Problems	57
	References	62
3	Water Purification Processes in Natural Systems	63
	PHYSICAL PROCESSES .	64
3-1	Dilution	64
3-2	Sedimentation and Resuspension	65
3-3	Filtration	66
3–4	Gas Transfer	66
3-5	Heat Transfer	71
	CHEMICAL PROCESSES	73
3-6	Chemical Conversions	73
	BIOCHEMICAL PROCESSES	74
3-7	Metabolic Processes	75
3-8	Microorganisms in Natural Water Systems	79
	RESPONSE OF STREAMS TO BIODEGRADABLE	
	ORGANIC WASTE	83
3.9	Dissolved-Oxygen Balance	83
3-10	Dissolved-Oxygen Model	85
3-11	Organic Discharge and Stream Ecology	94
	APPLICATION OF NATURAL PROCESSES IN	
	ENGINEERED SYSTEMS	98
3-12	Physical Processes	98
3-13	Chemical Processes	99
3-14	Biological Processes	99
	Discussion Topics and Problems	100
	References	103
4	Engineered Systems for Water Purification	104
4-1	Historical Overview of Water Treatment	105
4-2	Water-Treatment Processes	107
	WATER-TREATMENT PROCESSES:	
	THEORY AND APPLICATION	109
4-3	Aeration	110
4-4	Solids Separation	113
4-5	Settling Operations	123
4-6	Coagulation	131
4-7	Softening	151

4-8 4-9	Filtration Disinfection	165 182
4-9	OTHER WATER-TREATMENT PROCESSES	190
4.10		
4-1U	Dissolved Solids Removal Discussion Topics and Problems	190 198
	References	204
5	Engineered Systems for Wastewater Treatment	
	and Disposal	207
5-1	Wastewater Characteristics .	208
5-2	Effluent Standards	211
5-3	Terminology in Wastewater Treatment	212
	PRIMARY TREATMENT	217
5-4	Screening	217
5-5	Comminuting	220
5-6	Grit Removal	221
5-7	Flow Measurement	224 224
5-8	Primary Sedimentation SECONDARY TREATMENT	229
- 0		
5-9 5-10	Growth and Food Utilization Suspended-Culture Systems	230 234
	Activated Sludge	234
	Ponds and Lagoons	248
	Attached-Culture Systems	255
5-14	Secondary Clarification	268
5-15	Disinfection of Effluents	277
	SLUDGE TREATMENT AND DISPOSAL	278
5-16	Sludge Characteristics	279
	Sludge Thickening	281
	Sludge Digestion	285
5-19	Sludge Disposal	292 294
6 30	ADVANCED WASTEWATER TREATMENT Nutrient Removal	294
	Solids Removal	301
J-2.	WASTEWATER DISPOSAL AND REUSE	302
5-22	Wastewater Disposal	303
	Wastewater Reuse	306
	Discussion Topics and Problems	314
	References	322
6	Environmental Engineering Hydraulics Design	324
	WATER DISTRIBUTION SYSTEMS	324
6-1	Methods of Distributing Water	324
6-2	Distribution Reservoirs	326
6-3	Distribution Systems	331

viii CONTENTS

6-4	Distribution System Components	33
6-5	Capacity and Pressure Requirements	33
6-6	Design of Distribution Systems	33
6-7	Hydraulic Analysis of Distribution Systems	33
6-8	Cross-Connections in Distribution Systems	34
6-9	Construction of Water Distribution Systems	34
6-10	Pumping Required for Water Supply Systems	34
	WASTEWATER COLLECTION	34
6-11	Types of Collection Systems	34
6-12	Types of Sewers	34
6-13	Collection System Appurtenances	35
6-14	Basic Considerations in the Design of Sewers	35
6-15	Design of Sanitary Sewers	36
	Preparation of Contact Drawings and Specifications	36
	Construction of Sewers	37
6-18	Maintenance of Sewers	37
6-19	Design of Stormwater Sewers	37
	WATER AND WASTEWATER PUMPING	37.
6-20	Pumps	37:
	Pump Drive Units	37
	Pump Application Terminology and Usage	37
	Pump Operating Characteristics and Curves	38
6-24		39
6-25	Pump Stations for Water and Wastewater	39
	HYDRAULIC ANALYSIS OF WATER AND	
	WASTEWATER TREATMENT	39
	Treatment Plant Design	39
6-27	Preparation of Hydraulic Profiles	39
	Discussion Topics and Problems	40
	References	41:
Pai	rt 2 Air	
7	Air Quality: Definitions, Characteristics, and	
•	Perspectives	41
	•	
	AIR POLLUTION—PAST, PRESENT, AND FUTURE	41
7-1	Historical Overview	41
7-2	Global Implications of Air Pollution	42
7-3	Units of Measurement	42
7-4	Sources of Pollutants	42
	CLASSIFICATION OF POLLUTANTS	42
7-5	Particulates	43
7-6	Hydrocarbons	44
7-7	Carbon Monoxide	44
7-8	Oxides of Sulfur	449

CONTENTS IX

7-9	Oxides of Nitrogen	455
7-10 7-11	Photochemical Oxidants Indoor Air Pollution	461 463
7-11	AIR-QUALITY MANAGEMENT CONCEPTS	464
	Discussion Topics and Problems	477
	References	480
8	Meteorology and Natural Purification Processes	483
	ELEMENTAL PROPERTIES OF THE ATMOSPHERE	483
8-1	Scales of Motion	484
8-2	Heat	486
8-3	Pressure	491
8-4	Wind	493
8-5	Moisture	495 495
8-6	Relative Humidity	493
	INFLUENCE OF METEOROLOGICAL PHENOMENA ON	495
	AIR QUALITY	493 496
8-7	Lapse Rates and Dispersion	496 498
8-8 8-9	,	498
-	Moisture and Dispersion	499
	Modeling	499
	EFFECTS OF AIR POLLUTION ON METEOROLOGICAL	
	CONDITIONS	507
8-12	Changes on the Mesoscale and Microscale	508
8-13	Changes on the Macroscale	509
	Discussion Topics and Problems	510
	References	512
^	For the A.C. stone for A.'s Delli Att. Control	***
9	Engineered Systems for Air Pollution Control	514
9-1	Atmospheric Cleansing Processes	514
9-2	Approaches to Contaminant Control	516
	CONTROL DEVICES FOR PARTICULATE CONTAMINANTS	518
9-3	Gravitational Settling Chambers	520
9-4	Centrifugal Collectors	523
9-5	Wet Collectors	528 533
9-6 9-7	Fabric Filters (Baghouse Filters) Electrostatic Precipitators (ESP)	536
<i>y-1</i>	•	
	CONTROL DEVICES FOR GASEOUS CONTAMINANTS	540
9-8	Absorption	540 545
9-9 9-10	Absorption Condensation	557
9-11		559
9-12	• ***	563

X CONTENTS

	Discussion Topics and Problems References	565 567
Par	t 3 Solid Waste	
10	Solid Waste: Definitions, Characteristics, and	
	Perspectives	573
	TYPES OF SOLID WASTES	573
10-1	Municipal Wastes .	574
10-2	Industrial Wastes	574
10-3	Hazardous Wastes	575
	SOURCES OF SOLID WASTES	575
10-4	Sources of Municipal Wastes	575
10-5	Sources of Hazardous Wastes	576
	PROPERTIES OF SOLID WASTES	576
10-6	Physical Composition	576
10-7	Chemical Composition	582
10-8	Changes in Composition	588
	SOLID-WASTE MANAGEMENT: AN OVERVIEW	588
10-9	Materials Flow in Society	588
10-10	· · · · · · · · · · · · · · · · · · ·	589
10-11		590
10-12		590
10-13	Materials Recovery	591
10-14		592
10-15	,	592
	Discussion Topics and Problems	592
	References	593
11	Engineered Systems for Solid-Waste Management	594
11-1	Functional Elements	594
	SOLID WASTE GENERATION	594
11-2	Typical Generation Rates	595
11-3	Estimation of Solid-Waste Quantities	598
11-4	Factors That Affect Generation Rates	598
	ON-SITE HANDLING, STORAGE, AND PROCESSING	598
11-5	On-Site Handling	599
11-6	On-Site Storage	599
11-7	On-Site Processing of Solid Wastes	601
	COLLECTION OF SOLID WASTES	601
11-8	Collection Services	601
110	Types of Collection Systems	605

11-10 11-11	Determination of Vehicle and Labor Requirements Collection Routes	607 615
	TRANSFER AND TRANSPORT	618
11-13	Transfer Stations Location of Transfer Stations Transfer Means and Methods	620 622 622
	PROCESSING TECHNIQUES	626
11-16	Mechanical Volume Reduction Thermal Volume Reduction Manual Component Separation	627 627 627
	ULTIMATE DISPOSAL	628
11-19 11-20	Landfilling with Solid Wastes Design and Operation of Landfills Landfarming Deep-Well Injection Discussion Topics and Problems References	628 638 646 647 648 652
12	Engineered Systems for Resource and	
	Energy Recovery	653
	PROCESSING TECHNIQUES	653
12-1 12-2 12-3 12-4	Mechanical Size Alteration Mechanical Component Separation Magnetic and Electromechanical Separation Drying and Dewatering MATERIALS-RECOVERY SYSTEMS	654 656 656 657
12-5 12-6	Materials Specifications Processing and Recovery Systems	657 657
12-7	System Design and Layout	659
	RECOVERY OF BIOLOGICAL CONVERSION PRODUCTS	659
12-8 12-9	Composting (Aerobic Conversion) Anaerobic Digestion	660 663
	RECOVERY OF THERMAL CONVERSION PRODUCTS	665
12-10 12-11 12-12 12-13 12-14	Incineration with Heat Recovery Use of Refuse-Derived Fuels (RDF)	665 670 671 671 672
	RECOVERY OF ENERGY FROM CONVERSION PRODUCTS	672
12-15 12-16 12-17	Energy-Recovery Systems Efficiency Factors Determination of Energy Output and Efficiency	673 674 675

XII CONTENTS

A B C D

MATERIALS- AND ENERGY-RECOVERY SYSTEMS	675	
Discussion Topics and Problems	677	
References	677	
Appendixes		
Quantities and Units	679	
Conversion Factors	683	
Properties of Water and Air	693	
Water Quality Standards	696	
Indexes	1.1	
Name Index	11	
Subject Index		
3		