

Contents

1	Waste Management	1
1.1	Introduction	1
1.1.1	History of Waste Management	1
1.1.2	Waste Management System	2
1.2	An Outline of Municipal Solid Waste Management (MSWM)	3
1.2.1	Descriptions	3
1.2.2	Solid Waste Management	3
1.2.3	Hierarchy of Waste Management	6
1.2.4	Varieties and Characteristics of Urban Solid Waste	8
1.3	Elements of MSWM	10
1.3.1	Waste Production	10
1.3.2	Waste Handling, Seperation, Storage, and Processing at the Source	11
1.3.3	Solid Waste-Collecting	11
1.3.4	Segregation, Processing, and Transformation of Solid Waste	14
1.3.5	Transportation	15
1.3.6	Disposal	16
1.4	Solid Waste Management in Developing Countries	17
	References	18
2	Landfilling	21
2.1	Introduction on Landfilling	21
2.2	History of Solid Waste Disposal	22
2.3	Terms Definition	24
2.4	Leachate and Gas Generation	28
2.5	Natural Attenuation Landfills	29
2.6	Containment Landfills	30
2.7	Bioreactor Landfill	30

2.7.1	Bioreactor Landfill Definitions	31
2.7.2	Bioreactor Landfill Fundamentals	31
2.7.3	Classification	32
2.7.4	Benefits	33
2.8	Structural Characteristics	33
2.8.1	Seismic Protection	34
2.8.2	Settlement of Landfills	34
2.8.3	Mechanisms of Settlement and Temporal Classification	35
2.8.4	Influencing Factors	35
2.8.5	Effect of Overburden Pressure (Height)	36
2.8.6	Extent of Settlement	37
2.9	Planning	38
2.10	Landfill Site Selection	41
2.10.1	General Principles	44
2.10.2	Criteria for Landfill Siting	47
2.11	Design of Landfills	56
2.12	Landfilling Methods	57
2.12.1	Excavated Cell/Trench Method	57
2.12.2	Area Method	58
2.12.3	Canyon/Depression Method	59
2.13	Other Types of Landfills	59
2.14	Liner Materials	60
2.14.1	Soil and Clay Liners	61
2.14.2	Flexible Membrane Liners	62
2.15	Leachate and Stormwater Management, Collection, and Treatment	65
2.15.1	Leachate Collection Facilities	68
2.15.2	Leachate Removal and Holding Facilities	69
2.16	Landfill Gas Management	73
2.16.1	Movement of Landfill Gases	74
2.16.2	Movement of Principal Gases	76
2.17	Cover Requirements	77
2.17.1	Daily Cover	78
2.17.2	Final Landfill Cover	78
2.18	Landfill Construction	79
2.18.1	Construction Equipment	81
2.18.2	Selection of Landfill Cover	82
2.18.3	Selection of Gas Control Facilities	82
2.18.4	Materials	82
2.18.5	Construction Quality Assurance	84

2.18.6	Quality Assurance/Construction Documentation Report	84
2.18.7	Landfill Operations	85
2.19	Monitoring	92
2.20	Landfill Closure, Post-closure Care, and Remediation	94
2.21	After-uses	97
2.22	Landfill Mining	98
	References	98
3	Leachate Quality	101
3.1	Introduction	101
3.1.1	Primary Leachate	101
3.1.2	Secondary Leachate	102
3.2	Leachate Production Process	102
3.2.1	Aerobic and Anaerobic Biochemical Processes	102
3.3	Chemical Features of Leachate	106
3.4	Carbon, Nitrogen and Phosphorus Proportions at Leachate	112
3.5	Microbiological Structure of Leachate	113
3.5.1	Bacteria	114
3.5.2	Viruses	114
3.5.3	Fungi	114
3.5.4	Parasites	114
3.6	Factors Affecting Leachate Composition	115
3.6.1	Waste Composition	115
3.6.2	pH	115
3.6.3	Redox Capacity	115
3.6.4	Landfill Age	116
3.6.5	Waste Age	116
3.7	Natural Attenuation of Landfill Leachate	117
3.8	Leachate Collection	123
3.9	Environmental Influences of Leachate	124
3.9.1	Influences on Groundwater	124
3.9.2	Consequences of Oxidation and Reduction Changes	124
3.9.3	Organic Loading	125
3.10	Solution for Leachate Issues in Landfill	126
	References	126
4	Leachate Quantity	129
4.1	Introduction	129
4.2	The Exigence of Estimating Leachate Production Rate	130
4.3	Elements Affecting Leachate Quantity	131
4.3.1	Waste Type, Structure (Water Level) and Compressed Congestion	132
4.3.2	Climate Condition Elements	132

4.3.3	Topography	133
4.3.4	Landfill Cover	133
4.3.5	Plant Cover	133
4.3.6	Groundwater Impacts	134
4.4	Leachate Flow Into Soil and into Landfill and Their Variation	134
4.5	Techniques for Measuring Leachate Production Rate	136
4.5.1	Example of Moisture Mass Equilibrium Measurement for Bioreactor Landfills	138
4.5.2	Layer Models	140
4.6	A Computer-Based Method for Estimating Leachate Generation	141
4.6.1	HELP	141
4.6.2	SOILINER	142
4.7	Discussion on Methods, Their Records, and Outcomes	142
	References	144
5	Leachate Management	147
5.1	Introduction	147
5.1.1	Leachate Evaporation	147
5.1.2	Discharge to the Wastewater Treatment Plant	147
5.1.3	Leachate Characteristics	148
5.2	Leachate Treatment	150
5.2.1	Chemical and Physical Methods	150
5.2.2	Biological Treatment	154
5.2.3	Summary	165
5.2.4	Micro-Filtration (MF)	167
5.2.5	Ultra-Filtration (UF)	167
5.2.6	Membrane Bioreactors	167
5.2.7	Nano-Filtration (NF)	168
5.2.8	Reverse Osmosis (RO)	168
5.3	Leachate Recirculating	169
5.3.1	Definition of Leachate Recirculation	170
5.3.2	Recirculation in Landfills	170
5.3.3	Recirculating in Open Dumps	171
5.3.4	Benefits of Leachate Recirculating	171
5.3.5	Leachate Recirculating Stratagems	172
5.4	Mathematical Modeling of Leachate Recirculating	176
5.4.1	Trench Modeling	177
5.4.2	Vertical Infiltration Well Modeling	177
5.4.3	Model Results	177

5.5	Leachate Recirculating Field Testing	178
5.5.1	Leachate Treatment Implications	178
5.5.2	Leachate Quantities	178
5.5.3	Gas Production	179
5.6	Leachate Recirculating System Design	179
5.6.1	Horizontal Trenches	179
5.6.2	Vertical Recharge Wells	180
5.6.3	Design Approach	180
	References	181
6	Natural Treatment Systems	183
6.1	Introduction	183
6.1.1	Slow Rate Method	184
6.1.2	Rapid Infiltration	185
6.1.3	Overland Flow	185
6.2	Designing Method and Fundamental Technology	185
6.2.1	Characteristics of Design	186
6.2.2	Expected Performance	187
6.2.3	Relevant Parameters for Leachate	188
6.2.4	System Interactions	191
6.2.5	Hydraulics of Soil Systems	198
6.2.6	Identifying and Choosing the Site	204
6.2.7	Types of Natural Treatment Systems	208
	References	214
7	Solid Waste Management in Tehran	215
7.1	Introduction	215
7.2	Municipal Waste Management in Iran	216
7.2.1	Tehran	216
7.2.2	Mashhad	221
7.3	Environmental Costs	225
7.4	Composting	225
7.5	Leachate Management in Iran	226
	References	236