

# Index

- 4-D process 412
- Aarhus Convention 14
- ABE *see* acetone butanol ethanol
- above-ground MBP landfills 796–7
- absorbable organic halogens (AOX) 73
- absorbed water 717
- absorption cooling 377–8
- absorption processes *see* sorption processes
- acetogenesis 584–5, 589–90, 596–7, 701, 775
- acetone butanol ethanol (ABE) fermentation 647
- acid gas neutralization 403–10
  - mass flows/balances 425–9
  - solid residues 433–4, 437, 441–3, 454, 457
- acid neutralization capabilities (ANC) 437, 441, 446–8
- acid rock drainage (ARD) 762
- acid scrubbing 404–5, 425–8, 433–4, 635
- acidic phase 776, 782
- acidification 121–2, 176–8
- acidity 761, 763, 767–9
  - see also* pH effects
- actinomycetes 517
- activated carbon 869–72, 890, 894
- activated sludge 883–5, 890, 893
- active biomass 611
- active gas management 845–6, 847–9
- actual combustion temperatures 373
- adiabatic temperatures 373
- adsorbable organic halogens (AOX) 859–60, 863, 890–2
- adsorption processes *see* sorption processes
- advection processes 817–19
- advertising material 193–4
- aerated lagoons 881–3
- aerated pile composting 555–6
- aeration 541–6, 553–6
- aerobic conditions 774, 877–88, 891
- aerosols 575
- AF *see* aggregated annualization factor
- afterburning chambers 385
- aftercare of landfills 693, 932–3, 941–5
- ageing processes 446–8, 742
- agglomeration techniques 345
- aggregated annualization factor (AF) 44
- aggregates 246–9, 464–9
- agricultural applications 612, 665–82
- air classifiers 332–7, 967
- air emissions
  - anaerobic digestion 624–6
  - composting 573–5
  - incineration 393–4, 417–18, 480–1, 482
  - limit values 393–4, 417–18
  - mechanical biological treatment 633–5
  - monitoring 925–6
- air intrusion phase 776
- air pollution control (APC) technologies
  - emissions 397, 417–18
  - solid residues 430, 432–6, 440–4, 445–6, 453–4, 456–7, 459–60
- airbed classifiers 336–7
- alkaline scrubbing 405–6, 425–8
- alkalinity
  - characterization of waste 74
  - landfilling 761, 763, 767–9
  - leachates 859, 881
  - see also* pH effects
- allocation 123–4, 140
- ALT-MAT field testing program 470
- aluminum
  - incineration 423
  - landfilling 765
  - mechanical treatment 355, 357
  - production 236–7
  - remanufacturing 237–9
  - solid fuels from waste 489–90
  - solid residues 448
- ammonia
  - anaerobic digestion 620–1
  - composting 574–6, 598–9
  - landfilling 701
  - leachates 859–60, 863–6, 869, 878–81, 886–92

## 1002 Index

- anaerobic digestion
  - acetogenesis 584–5, 589–90, 596–7
  - biogas 583–5, 587, 591–5, 611–13, 615–16, 618–27
  - definitions 583–6
  - digest residue 583, 586, 611, 612, 615–17, 626
  - economic factors 604, 607
  - energy balances 584, 612, 622–4
  - environmental factors 624–6
  - examples of facilities 614–17
  - fermentation 584–5, 587–8
  - hydrolysis 584–5, 586–7
  - inhibitory factors 597–9
  - landfilling 790–1
  - leachates 877–8, 881, 882, 888–91
  - life cycle assessment 156, 167, 172
  - mass balances 618–20
  - mechanical biological pretreatment 790–1
  - methanogenesis 584–5, 590–1, 596–7
  - odor problems 612–13, 615, 617
  - operating parameters 595–9, 604–6
  - planning and design 601–4
  - pretreatment of waste 607–10, 614–16
  - process 583–600
  - reception of waste 606–7, 614–15
  - small, low-tech solutions 602–3
  - storage and feeding systems 610–11
  - systems 606–13
  - technology 601–17
  - unit process inventories 626–7
  - use and disposal of end products 603–4, 612, 615–17, 653, 667
  - waste types 602–3, 605
- ANC *see* acid neutralization capabilities
- animal feed 998
- animal slurries 667
- annualization 31, 44
- AOX *see* adsorbable organic halogens
- APC *see* air pollution control
- applied stress 737
- ARD *see* acid rock drainage
- Arthrobacter* spp. 522
- asbestos 964
- Aspergillus* spp. 522, 529
- asphalt 469, 471–2
- assessment criteria 120–2
- attributional life cycle assessment 118–19
- authorization procedures 913
- autoclaving 957
- automatic turning machines 555–6
- auxiliary burners 385–6
- auxiliary chemical combustion 424
- availability tests 451–2
- backfill for planting 660
- backyard composting 533
- bacteria 516–17, 527–9
  - see also* anaerobic digestion
- bag openers 608
- baled MBP landfills 796–7
- ballistic separators 337–8
- banned substances 963
- barrier layers 831–3, 834
- base maps 903–4
- Basel Convention 13, 53, 55, 56–7
- BAT *see* best available technology
- batch leaching studies 978
- batch leaching tests 453
- batch tests 908–9
- batteries 991–4
- bentonite/bentonite–sand mixtures 802
- benzene 699
- berms 808
- best available technique reference (BREF) notes 57–8
- best available technology (BAT)
  - incineration 418
  - leachates 858
  - regulatory factors 57
  - waste electrical and electronic equipment 966
- bin bags 254–5, 265, 306–7, 309
- bins 255–8, 265, 306
- bioaerosols 575
- biochemical methane potentials 81
- biochemicals 647–9
- biocidal inhibition 597
- biocovers 836–7
- biodegradability 12
  - anaerobic digestion 593, 603
  - collection 255, 262–5, 301
  - composting 539, 653, 655
  - landfilling 735–6, 843–4, 858, 933–4
  - leachates 873
  - plastic 224, 647–9
  - waste minimization and prevention 194–6
- biodiesel 646
- biodrying 629–32
- bioethanol 639–43
- biofiltration 535–7, 613
- biofuels 639–46
  - anaerobic digestion 612
  - biodiesel 646
  - bioethanol 639–43

- biohydrogen 643–6
  - challenges and possibilities 643, 645–7, 649
  - landfilling 854
- biogas
  - anaerobic digestion 583–5, 587, 591–5, 611–13, 615–16, 618–27
  - landfilling 831–4, 836–9
  - mechanical biological pretreatment 791–6
  - see also* landfill gas
- biogenic carbon 168, 696
- biohazards 952–3
- biohydrogen 643–6
- biological degradation 357
- biological drying 357
- biological oxygen demand (BOD)
  - characterization of waste 79
  - landfilling 779, 781
  - leachates 859–61, 876, 878–80, 882–3, 886–92
- biological posttreatment 874, 890
- biological treatment 20
  - activated sludge 883–5, 890, 893
  - aerated lagoons 881–3
  - agricultural applications 665–82
  - benefits 668–9
  - biological properties 672–4
  - chemical properties 674–5
  - combination treatments 891–4
  - constraints 670–1
  - denitrification 878, 881–94
  - dissolved air flotation 885–6
  - economic factors 679–80
  - environmental factors 669, 675–8
  - fertilizer value 674–5
  - fixed film reactors 888–91
  - future developments 680
  - leachates 875–94
  - nitrification 880–94
  - physical properties 672
  - practical utilization 679–80
  - preservative treated wood 975
  - rotating biological contactors 889–91
  - sequencing batch reactors 875–7, 885–8
  - waste parameters 671–5
  - see also* anaerobic digestion; composting; mechanical biological treatment
- biomass-based energy 208
- bioplastics 224
- bioreactor landfills 686, 772–4, 782–5
- biosolids 674–6
- biostatic inhibition 597–9
- biotic carbon 140–1
- biowaste
  - anaerobic digestion 625
  - composting 539, 542, 547, 559–61, 570–2
- biowindows 836–7
- bird nuisance 702, 923
- BOD *see* biological oxygen demand
- boiler ash 432
- boiler systems 386–9, 852–4
- bottle recycling 213
- bottom ash
  - aggregates 464–9
  - bound utilization 469–72
  - California bearing ratio 467–8
  - characteristics and properties 431–2, 435–41, 445, 447, 451–5
  - compaction of waste 466–7
  - durability 467, 468–9
  - environmental factors 472–4
  - hydraulic conductivity and moisture retention 469–70
  - landfilling 763–8
  - particle size distribution 464–7
  - resilient modulus 469
  - treatment 455–9
  - unbound utilization 469–71
  - utilization in construction 463–74
- bottom linings 800–20
  - advection processes 817–19
  - construction 808–13
  - design 804–8
  - diffusion processes 812–17
  - functions 803–4
  - geosynthetic barriers 800, 802–9, 811–12, 815–17, 819
  - monitoring 927
  - natural barrier materials 801–2, 804–9, 811–12, 815–18
  - protection and repair 812
  - sorption processes 819–20
  - transport of leachate through liners 812–20
- bound utilization 469–72
- bovine spongiform encephalopathy (BSE) 998
- box composting 557
- BREF *see* best available technique reference
- brick reuse 246
- Brikollari composting 556
- briquette presses 346
- BSE *see* bovine spongiform encephalopathy
- bucket screens 331
- buffer zones 911
- building construction 912
- building waste 104–6
- build-up agglomeration 345

## 1004 Index

- bulk density 920
- bulk mail 193–4
- bulking agents 540–1, 550–1
- bulky waste
  - collection 284–5, 294
  - residential waste 86, 92, 94
- bunkers 606–7
- butanol production 647
- byproducts 58–9
  
- C&D *see* construction and demolition
- C/N *see* carbon/nitrogen
- calcium-based scrubbers 407–10, 425–6, 433–4
- calcium residues 447
- California bearing ratio (CBR) 467–8
- calorific values 80
- Campbell equation 722
- Campbell van Genuchten equation 723
- canyon/depression method 917
- capacity needs 899–900, 912
- capillary barriers 835
- capital costs 30
- capital recovery factor (CRF) 31, 44
- capping landfills 933–5
- car batteries 992–3
- carbon degradation 518–21, 527, 535, 543
- carbon dioxide
  - anaerobic digestion 584–5, 587, 592, 595, 620–2
  - biological treatment 668
  - composting 573–5
  - landfilling 687, 696–7, 776, 778–9, 841, 852, 854
- carbon sinks 140–1
- carbon/nitrogen (C/N) ratios 527, 535, 543, 545–6, 550, 577
- carbonation 761
- cardboard 203–10, 351–2
- cascade ball mills 325–6
- catalytic oxidation 613
- cathode ray tubes (CRT) 965
- causality webs 126–8, 132
- CBA *see* cost–benefit analysis
- CBR *see* California bearing ratio
- CCA *see* chromated copper arsenates
- CEA *see* cost-effectiveness analysis
- cell composting 554–5
- cell geometry 918–19
- cement industry case study 481–4
- cement kilns 497, 499, 988
- central vacuum systems 275
- CFC *see* chlorofluorocarbons
- channel composting 554–5
- characterization of impacts 126, 128–30
- characterization of solid waste 63–84
  - analyses and testing 69–81
  - chemical analyses 72–80
  - commercial and institutional waste 97–9
  - concepts 64–5
  - construction and demolition waste 104–9
  - data evaluation 81–3
  - industrial waste 100–3
  - performance testing 81
  - physical analyses 69–72
  - residential waste 85–96
  - sampling 65–9
- chemical analyses 72–80
- chemical mechanical re-pulping 206–7
- chemical oxygen demand (COD)
  - anaerobic digestion 585
  - characterization of waste 74, 79
  - landfilling 779, 781, 783, 792–3
  - leachates 858–61, 863, 868–74, 877–80, 882–4, 886–92
  - plastic 230–1
- chemical pulping 203–4
- chemical scrubbers 613
- chemical treatment
  - batteries 993–4
  - hazardous waste 990
  - preservative treated wood 975
- chlorides 396–7, 404–5, 425–8
- chlorofluorocarbons (CFC) 698, 964
- CHP *see* combined heat and power
- chromated copper arsenates (CCA) 972, 974, 977–9
- citizen responsibilities 15
- CJD *see* Creutzfeldt–Jakob disease
- classification of impacts 121–2, 126, 128
- clay liners 801, 804–9, 811, 815–18, 832–4
- clean production 184
- clean technology 184, 188–90
- clean-up technology 184
- climatic conditions 882
- clinker 482–4
- closed loop recycling 965
- Clostridium* spp. 647
- closure of landfills 932–7
- co-combustion 476–85
  - assignment principles 480–4
  - cement industry case study 481–4
  - criteria 480–1, 482–4
  - facilities 479–80
  - purpose 476–7
  - solid fuels from waste 497, 499

- waste types 477–9
- co-current gasification 509
- co-disposal 751
- co-treatment 863
- coal fired power plants 497–8
- COD *see* chemical oxygen demand
- collapse of components 744
- collection
  - biodegradable waste 255, 262–5
  - compaction of waste 266–8
  - crew size and truck capacity 290
  - delivery systems 311–13
  - economic factors 34–6, 46–7, 253, 291–4, 305, 316–18
  - environmental factors 281, 285–7, 305
  - equipment and vehicles 253–76
  - fee schemes 291–4
  - frequency 289
  - hazardous waste 984–5
  - healthcare risk waste 954–6
  - kitchen grinders 276
  - life cycle assessment 164–6, 170–2
  - occupational health 254–5, 263, 287–8
  - organization 288–91
  - public attitudes 298–9, 308–9
  - public awareness programs 294–5
  - public/private responsibility 288
  - quality management and customer relations 290–1
  - receptacles for waste 254–66, 306
  - recycling 255, 258–9, 261–2, 282, 285, 293, 297–301
  - regulatory issues 288, 297
  - route planning 289
  - segregation potential, efficiency and purity 302–5
  - siting and design issues 315–16
  - source segregation 257, 262–6, 278, 293, 296–310
  - special technologies 275–6
  - system performance 303–4
  - systems and organization 277–95
  - transfer stations 311–18
  - transport 285–7, 314–15
  - vacuum systems 275–6
  - waste collection systems 277–85, 306–7
  - waste collection vehicles 266–75, 290, 306
  - waste engineering 17–18, 19
- collection centers 19, 280, 282–3, 285, 305
- collection packaging 954–5
- collection points 265, 280, 282, 300, 304
- color development 578
- column leaching studies 453, 978
- combined heat and power (CHP) 389–90, 498, 851
- combined residue streams 434
- combustion air 372, 385
- combustion products 395–9, 404, 407, 411–16
- combustion temperatures 373
- commercial waste 97–9
  - collection 294
  - composition 98–9
  - data application 98
  - unit generation rates 97–8
- commingled MRFs 352–6, 361
- common ion effects 762
- common sense approach 11
- compaction of waste 345–7
  - collection 266–8
  - incineration 466–7
  - landfilling 737, 742, 778, 809, 915–16, 918–19
  - waste transfer stations 313
- company level waste prevention 187
- compliance tests 908–9
- composite liners 805–7
- composting
  - anaerobic digestion 612
  - biofiltration 535–7
  - carbon degradation 518–21, 527, 535, 543
  - classification of technologies 547–9
  - curing, refinement and storage 652–5
  - declaration, guidelines and marketing 655–9
  - definitions 515–16
  - degradation rates 518–19, 521, 524
  - design and space considerations 551
  - developing countries 538
  - economic factors 38–9, 45, 560–4, 651–2
  - electrical conductivity 657–9, 660
  - enclosed technologies 547–9, 554–6
  - energy release and temperature development 523–5
  - environmental factors 535–8, 560–4, 573–5
  - examples of facilities 559–65
  - fate of mass 519–20
  - feedstocks 534–5
  - landfilling 790–1, 838–9
  - life cycle assessment 154–5, 166–7, 170–1
  - mass balances 569–73
  - maturity of compost 577–9
  - mechanical biological pretreatment 790–1
  - microbial biomass 516–17
  - nitrogen degradation 521–2, 527, 535, 543, 572–3
  - odor problems 523, 535–7, 548, 551, 573–5, 577
  - open technologies 547–9, 551–4
  - operating parameters 524, 525–6, 529–31, 534–5, 539–46
  - pathogens 527–31, 542
  - pre- and post-processing technologies 547–51, 570
  - process 515–32

## 1006 Index

- composting (*Cont.*)
  - process control 545–6
  - quality management 576–80
  - reactor technologies 556–9
  - regulatory factors 579–80, 655–9
  - respiration tests 521, 578
  - sanitization 529
  - socioeconomic factors 538
  - stoichiometry 518
  - succession 516–17
  - sulfur degradation 522
  - systems 545–51
  - technology 533–68
  - unit process inventories 575–7
  - use and disposal of end products 539, 560–5, 576–80, 651–64, 667, 675
- compressibility tests 81
- compression 744, 746
- concrete waste 246, 248–9
- condensates 573–4, 635
- consequential life cycle assessment 118–19
- consolidation 744–5
- constant head permeameters 810–11
- constraint maps 903–4
- constructed wetlands 874–7
- construction and demolition (C&D) waste 104–9
  - buildings 104–6
  - composition 105–6
  - deconstruction of buildings 244
  - excavations 107–8
  - landfilling 699
  - mechanical treatment 359
  - recycling 243–9
  - reuse of bricks 246
  - roads and pavements 106–7
  - sorting plants 244–5
  - unit generation rates 104–5
  - upgrading 244–6
- construction quality assurance (CQA) 812
- consumer price indexes 32
- container composting 557
- container systems 266–7, 273–4
- contaminated soils 107–8, 705, 826
- continuously stirred tank reactor (CSTR) model 691
- controlled landfills 686
- conventional reactor landfills 772–82
- cooling white goods 964
- coordination chemistry 449–50, 762
- corrosion, incineration 388–9
- corrosion problems 855
- cost–benefit analysis (CBA) 30, 46, 114
- cost-effectiveness analysis (CEA) 30, 46, 114
- counter-current gasification 508–9
- CQA *see* construction quality assurance
- crane trucks 274
- crawler tractors 915–16
- creosotes 972
- Creutzfeldt–Jakob disease (CJD) 998
- CRF *see* capital recovery factor
- critical exposures 676, 678–9
- critical reviews 134
- cross-border transport 55, 56–7
- cross-current air classifiers 336–7
- cross-flow filtration 867–8
- CRT *see* cathode ray tubes
- CSTR *see* continuously stirred tank reactor
- cullet recycling 213, 216
- curbside collection 278–81
- curing of compost 652–3
- customer relations, collection 290–1
- cutters/shredders 322–3, 325
- cyclones 400
- DAF *see* dissolved air flotation
- daily cover 920
- daily soil covers 777
- damage modeling 126, 128
- Damkoehler numbers 758
- dangerous goods *see* hazardous waste
- Darcy's Law 720, 810
- dark fermentation 644–6
- data application 98, 102–3
- data collection 124–5
- data evaluation 81–3
- data quality 125
- databases 125–6
- declaration parameters 655–6
- decommissioning of landfills 937
- decomposition settlement 744
- deconstruction of buildings 244
- deep well injection 987, 989
- degradable plastics 224
- degradation rates 518–19, 521, 524
- delivery systems 311–13
- demolition waste *see* construction and demolition waste
- denitrification 783, 878, 881–94
- density separation 341–2
- density of waste 736–9
- deposit-refund systems 48
  - glass recycling 213
  - plastic recycling 232
  - waste minimization and prevention 198–9

- design processes
  - anaerobic digestion 601–4
  - capacity sectionizing and time-phasing 912
  - classification of waste 908–9
  - collection 315–16
  - composting 551
  - earth works and soil balancing 912–13
  - geotechnology 738–9, 741, 743–4, 747–51
  - incineration 382–6
  - landfilling 804–8, 821–4, 898, 899, 907–13
  - landscaping and final use 910
  - layout and facilities 910–12
  - material recovery facilities 360–1
  - mechanical biological pretreatment 795–7
  - mechanical treatment 360–1
  - permits and authorization 913
  - technology 909–10
  - transfer stations 315–16
  - waste acceptance criteria 908–9
- detection limits 82
- detergents 677
- detoxification 975, 990
- dewatering processes 626
- diffuse air emissions 626
- diffusion processes 812–17
- diffusion-controlled leaching 454
- diffusivity 596
- digest residue 583, 586, 611, 612, 615–17, 626
- dilution of vent air 613
- dioxins 229
- dioxins *see* polychlorinated dibenzoparadioxins/furans
- direct evaporation 866
- direct material input (DMI) 6–7
- direct microbial conversion (DMC) 641–2
- disc screens 331
- discounting 32–4
- disk screens 609
- dissolution 761
- dissolved air flotation (DAF) 885–6
- dissolved organic carbon (DOC)
  - incineration 450–1, 454–5
  - landfilling 756, 762–3, 765, 769, 779, 781
- distillation 643
- distribution processes 119–20
- divided bins/containers 261–2, 306
- DMC *see* direct microbial conversion
- DMI *see* direct material input
- DOC *see* dissolved organic carbon
- dose-response approach (DRA) 42
- double lining systems 805–7
- downstream emissions 25
- downstream system boundaries 138–9
- DRA *see* dose-response approach
- drainable voids 717–19
- drainage layers 831–4
- drainage systems 911
- drug metabolites 677
- dry digestion 605, 615–16, 620, 625
- dry scrubbers 407–10, 425–8, 433–4, 441–3, 453–4
- dry stabilization 487
- dry tombs 686, 827
- dry wastes 540
- dump trucks 915–16
- durability 467, 468–9
- dust nuisance 575, 702, 922
- dust removal 397–403
- dynamic dilution olfactometry 699–700
- dynamic stability 746–7
- earth works 912–13
- EASEWASTE model 144, 150–2, 155–6, 162, 166–9, 178, 669
- economic factors 9, 13, 29–51
  - anaerobic digestion 604, 607
  - assessment methods 30, 46
  - biological treatment 679–80
  - co-combustion 476
  - collection 253, 291–4, 305, 316–18
  - composting 538, 560–4, 651–2
  - fee schemes 291–4
  - healthcare risk waste 958–9
  - incineration 499–500
  - instruments 46–9, 53
  - landfilling 837–8, 905–6, 944–5
  - life cycle assessment 157–9
  - private costs 29, 30–40
  - recycling 207–8, 214–17, 226–30, 239–40, 243
  - regulatory issues 53, 55
  - solid fuels from waste 499–500
  - waste electrical and electronic equipment 965
  - waste minimization and prevention 188
  - welfare costs 40–6
- economies of scale 36
- economizer ash 432
- ecotoxicity 122, 176–8
- eddy current separators 338–40, 967
- EDIP method 121, 130–1
- EDV *see* electrodynamic venturi
- EIA *see* environmental impact assessment
- electrical conductivity 657–9, 660
- electrical power only incineration 389–90
- electricity generation 162–4, 175, 851–2

## 1008 Index

- electrodynamic venturi (EDV) 403
- electron beam irradiation 413
- electronic noses 700
- electrostatic precipitators (ESP) 400–1, 406
- elemental balances 571–3, 620
- embankments 808
- emission accounts 23–5
- emission prices 45
- enclosed composting technologies 547–9, 554–6
- enclosed flares 849–50
- end of waste criteria 59
- endpoint modeling 126, 128
- energy balances 390–1, 584, 612, 622–4
- energy budgets 22–3
- energy conversion 389–90
- energy recovery 375–8, 386–9, 510–11
- energy release 523–5
- energy substitution 175
- energy systems 162–4, 175
- energy-using products (EuP) 962
- engineering *see* waste engineering
- Environmental Assessment of Solid Waste Systems and Technologies (EASEWASTE) model 144, 150–2, 155–6, 162, 166–9, 178, 669
- environmental factors 9
  - anaerobic digestion 624–6
  - batteries 994
  - biological treatment 669, 675–8, 680
  - co-combustion 476–7
  - collection 281, 285–7, 305
  - composting 535–8, 560–4, 573–5
  - economic factors 13, 29, 40–2
  - food waste 999
  - incineration 369, 393–420, 472–4
  - landfilling 686–8, 695–708, 767–9, 826–7, 838, 905–6, 921–3
  - mechanical biological treatment 633–5
  - polyvinylchloride 997
  - pyrolysis and gasification 511
  - recycling 209–10, 216–18, 230–2, 240–1, 247–9
  - regulatory issues 55
  - tires 996
  - waste electrical and electronic equipment 967–8
  - waste engineering 22–3, 28
  - see also* life cycle assessment
- environmental impact assessment (EIA) 113, 115, 128
- environmental risk assessment (ERA) 113, 115, 128
- EPS *see* expanded polystyrene
- ERA *see* environmental risk assessment
- erosion control 661, 804
- errors 81
- Escherichia coli* 667, 673
- ESP *see* electrostatic precipitators
- ethanol production 639–43, 647
- EuP *see* energy-using products
- European Union (EU) Waste Directive 53–4
- European Waste Catalogue (EWC) 59
- eutrophication 122, 177
- evaporation processes 865–6, 894
- evapotranspiration 710, 713–14, 728, 835–6, 943
- event waste 195–6
- EWC *see* European Waste Catalogue
- excavation waste 107–8
- excavations 808
- excavators 915–16
- expanded polystyrene (EPS) 221–2, 226–7
- explosion hazards 702–3, 922
- external costs 42–3, 44–6, 55
- extraction systems 847–8
- extrusion molding compaction 346–7
- fabric filters 401–2
- falling head permeameters 810–11
- FBC *see* fluidized bed combustion
- federal regulations 14
- fee schemes 291–4
- feeding systems 610–11
- feedstocks 534–5
- fencing 911
- fermentation
  - anaerobic digestion 584–5, 587–8, 775
  - biochemicals 647
  - biofuels 641–6
- fertilizer value 674–5
- Fick's laws 812–15
- field capacity 718
- filling sequences 915–18
- filter systems 871
- final storage quality 689
- final use planning 937–41
- fire hazards 702–3, 922
- fixed film reactors 888–91
- flame retardants 967–8
- flaring systems 849–51
- flat matrix presses 347
- flat rate fees 47
- flexible membrane liners (FML) 802
- float–sink methods 341–2
- floating surface aerators 887
- flotation 341
- flue gas cleaning systems 393, 397–416
  - acid gas neutralization 403–10, 425–9

- dust removal 397–403
- energy recovery 390
- mass balances 424–9
- mechanical biological treatment 633–5
- pyrolysis and gasification 510
- solid residues 433–4
- flue gas properties 373, 378–9
- flue gas recirculation 384–5
- fluidized bed combustion (FBC) 381–2, 497–8, 988–9
- fluidized bed gasification 509
- fluorescent tubes 965–6
- flushing bioreactor landfills 772–4, 783, 784–5
- fly ash 378
  - composition 437, 441–3
  - dust removal 398–400
  - flue gas cleaning systems 407
  - landfilling 766–8
  - leaching properties 451–4
  - mass flows/balances 423, 425–6
  - treatment 457, 459–60
  - types and quantities 432–4
- FML *see* flexible membrane liners
- food waste
  - collection 301
  - composting 535, 538, 653, 657
  - environmental factors 999
  - management options 998
  - special wastes 997–9
  - waste minimization and prevention 198
- forced aeration 541–6, 553–6
- forestry land applications 668–71
- fouling 388–9
- foundation failures 747
- foundation layers 831–3, 834
- free acid/base inhibition 598–9
- Freundlich isotherms 870–1
- front-loading collection trucks 258, 271–3
- fuel cells 854–5
- fuel combustion 162–4, 175
- fuel consumption 285–7
- full service collection 278–9
- functional units 117–18
- fundamental variation 64
- fungi 517, 527–9, 579
- furans *see* polychlorinated dibenzoparadiioxins/furans
- garage facilities 912
- garden waste 86, 90–4
  - collection 285, 294, 309
  - composting 534–5, 547, 561–3, 571, 653, 657
  - landfilling 839
  - mechanical treatment 352
- gas chromatography (GC) 593–4, 700–1
- gas collection 611
  - layers 831–3, 834, 845–6
  - see also* biogas; landfill gas
- gas volume 368–9, 371–2
- gasification 502–12
  - benefits and drawbacks 503
  - definition 20
  - energy recovery 510–11
  - environmental factors 511
  - flue gas cleaning systems 510
  - material recovery 511
  - parameters and properties 505–8
  - pressure 508
  - processes 503–4, 505
  - technologies 508–10
  - temperature and heating rates 507–8
  - waste properties 506–7
- GC *see* gas chromatography
- GCL *see* geosynthetic clay liners
- GDP *see* gross domestic product
- geographic information systems (GIS) 903–4
- geographical factors 901
- geological factors 901
- geomembranes 802, 804–7, 812, 815, 819, 832–4
- geonets 803–4, 806, 823
- geosynthetic barriers 800, 802–9, 811–12, 815–17, 819
- geosynthetic clay liners (GCL) 802–5, 808–9, 811, 816, 832, 834
- geosynthetic drainage materials 821
- geotechnology 734–54
  - analytical methods 737–8, 740–6
  - case histories 748–51
  - classification of waste 734–6
  - density and unit weight of waste 736–9
  - design considerations 738–9, 741, 743–4, 747–51
  - hydraulic conductivity 741–4
  - landfilling 905–6
  - leachates 763, 765
  - settlement 744–6, 751, 927–8, 933–5, 939, 943
  - shear strength 739–41, 749
  - stability 746–51
  - waste heterogeneity and structure 738–9
- geotextiles 803, 806, 832–3
- germination tests 579
- GHS *see* Global Harmonized System
- Giroud's equation 823
- GIS *see* geographic information systems

## 1010 Index

- glass
  - collection 285
  - mechanical treatment 344
  - recycling 211–19, 262–4, 299–300, 965
  - remanufacturing 213–14
- Global Harmonized System (GHS) 57
- global impacts 120
- global positioning systems (GPS) 925, 928
- global warming
  - landfilling 696–7
  - life cycle assessment 121, 129–30, 170–5, 177
  - recycling 218
- glucose degradation 644–5, 648
- glucose fermentation 587–8
- goal definitions 117
- GPS *see* global positioning systems
- graphical evaluations 903–4
- grate siftings 432
- gravity separation 608–9
- green boxes 308–9
- greenhouse gases 23–4, 696–7
- grinders 607
- gross domestic product (GDP) 6–7, 42
- gross intrinsic value (GVI) 968
- groundwater
  - landfilling 704–6, 826, 926–7, 943
  - life cycle assessment 178
  - pollution monitoring 926–7
- growing media 656, 663
- guidelines for usage 656–9
- GVI *see* gross intrinsic value
- gypsum 407, 423, 434, 463
  
- hammer mills 323–4
- hand sorting 609
- hazardous substances 962–3, 967–8, 974
- hazardous waste 982–90
  - characterization 982–4
  - collection 285, 297, 302, 984–5
  - definition 4–5
  - landfilling 691, 756, 826
  - packaging and labeling 985–6
  - quantity per capita 983–4
  - regulatory factors 985–7
  - regulatory issues 55
  - residential waste 86
  - sources 983
  - transport 986–7
  - treatment and disposal 987–90
  - waste management systems 9
- HDPE *see* high density polyethylene
  
- head on the liner 927
- healthcare risk waste 951–9
  - collection 955–6
  - definition 952–3
  - economic factors 958–9
  - internal handling 953–6
  - sources and quantities 952–3
  - transport 955–6
  - treatment 956–8
- heat output
  - anaerobic digestion 612
  - composting 523–5
  - landfilling 851–2
- heating values 80, 367–72, 477–8
- heating white goods 964
- heavy metals
  - anaerobic digestion 621
  - biological treatment 675–7
  - co-combustion 477–8
  - composting 579
  - incineration 406, 414, 417, 423, 426–8, 441–3
  - landfilling 765–7, 769, 781, 785, 819–20
  - leachates 859–60, 868–9, 878
  - solid fuels from waste 495
  - waste electrical and electronic equipment 967
- HELP model 727–9
- high density polyethylene (HDPE) 221–3, 225–7
- high pressure steam boilers 378
- high-rate degradation 545
- horizontal-flow reed beds 875–6
- horizontal gas extraction systems 848
- horticultural applications 651–64
- hot water boilers 387
- household goods 49
- household hazardous chemicals 86, 92–5
- household waste 85–6, 87–90
  - collection 284, 291–3, 298–302, 305
  - mechanical treatment 353, 360
- human toxicity 122, 156, 176–8
- hydration, landfilling 761
- hydraulic conductivity
  - incineration 469–70
  - landfilling 721–2, 741–4, 810–11, 818, 823–4, 835
- hydrocyclones 342
- hydrogen peroxide injection 413
- hydrogen production 643–6, 777
- hydrogen sulfide 598–9
- hydrogeological factors 902
- hydrology 709–33
  - changes in water content 715–19
  - chemical and microbial consumption 710, 714

- evapotranspiration 710, 713–14, 728
- gas production 710, 714, 726
- HELP model 727–9
- leachates 709–11, 730
- managed water input 710, 714–15
- models of landfills 726–9
- MODFLOW model 729
- precipitation 710–11
- surface water inflow 710, 711–12
- surface water runoff 710, 712–13, 728
- SUTRA model 728–9
- top covers 727, 830–1, 835–6
- waste heterogeneity and structure 724–6
- water balance 709–19, 727
- water flow 719–26, 728–9
- hydrolysis 584–5, 586–7, 641–3
- hygienization 609, 615–16
- ID *see* induced draught
- impact assessment *see* environmental impact assessment;
  - life cycle impact assessment
- impact potentials 128, 132, 170–5
- in-house collection 19
- in-place density 736
- incineration
  - absorption cooling 377–8
  - acid gas neutralization 403–10, 425–9, 433–4, 437, 441–3, 454, 457
  - ageing processes in solid residues 446–8
  - air emission limit values 393–4, 417–18
  - anaerobic digestion 613
  - auxiliary chemicals 424
  - cement industry case study 481–4
  - chemical composition of solid residues 434–44
  - chemistry of combustion process 421–4
  - co-combustion 476–85, 497, 499
  - coal fired power plants 497–8
  - combustion air 372, 385
  - combustion products 395–9, 404, 407, 411–16
  - combustion technology 379–86
  - definition 20
  - design and layout 382–6
  - dust removal 397–403
  - economic factors 37, 39, 45, 499–500
  - energy balance 390–1
  - energy conversion 389–90
  - energy recovery 375–8, 386–9
  - environmental factors 369, 393–420, 472–4
  - flue gas cleaning systems 390, 393, 397–416, 424–9, 433–4
  - flue gas properties 373, 378–9
  - fluidized bed furnaces 381–2
  - fouling and corrosion 388–9
  - fuel properties of waste 366–74
  - furnace characteristics 384–6
  - gas volume 368–9, 371–2
  - hazardous waste 987, 988–9
  - healthcare risk waste 956–7
  - heating values 367–72
  - historical development 366
  - inorganic material combustion 423, 436–9, 441–4
  - leachates 446, 448–56, 472–3
  - life cycle assessment 139, 140, 157–9, 165, 168–9, 171–3, 176–8
  - mass balances 421–9
  - mass flows 397, 424–6
  - metals 238, 241
  - moving grate furnaces 365–6, 380, 382–6
  - organic material combustion 421–2, 439–40, 444
  - physical and geotechnical properties of solid residues 444–6
  - plant capacity 374
  - plastic 228–31
  - polyvinylchloride 997
  - preservative treated wood 976–9
  - pretreatment 379–80
  - process and technology 365–92
  - public attitudes 366
  - Rankine cycle 376, 389
  - regulatory factors 393–4, 416–18
  - rotary kiln furnaces 380–1
  - solid fuels from waste 486–501
  - solid residues 378, 430–62, 763–8
  - stack 416–17
  - treatment of residues 455–60
  - unit process inventories 428–9
  - utilization of solid residues 463–75
  - waste electrical and electronic equipment 963, 967
- indirect evaporation 866
- individually transported containers 259–61
- induced draught (ID) fans 397–8
- industrial waste 100–3
  - collection 294
  - composition 102
  - data application 102–3
  - mechanical treatment 359
  - sources 100–1
  - unit generation rates 101–2
- industrial waste management systems 9
- industry responsibilities 15
- inert waste 756, 769, 826
- infection vectors 8

## 1012 Index

- infiltrometers 811
- inflation 32
- infrastructures 911–12
- inhouse waste handling 9
- initial aerobic phase 774
- initial methanogenic phase 776, 782
- inner cycles 481–2
- inorganic content 80
- inorganic macrosubstances 781
- inorganic material combustion 423, 436–9, 441–4
- input-specific emissions 25
- insect nuisance 702, 923
- institutional waste 97–9
  - composition 98–9
  - data application 98
  - unit generation rates 97–8
- integrated pollution prevention and control (IPPC) 15, 53
- integrated product policy (IPP) 190–1
- integrated solid waste management (ISWM) model 143, 147–9, 153–5
- integrated waste management (IWM) 137, 533
- Integrated Waste Management-2 (IWM-2) model 142, 145–6
- internal collection 955
- international regulations 13–15, 53
- international toxic equivalents (TEQ) 395–6
- interpretation phase 133–4
- interspecies hydrogen transfer 590
- inventory analysis 124–6
- IPP *see* integrated product policy
- IPPC *see* integrated pollution prevention and control
- iron
  - landfilling 765, 789
  - mechanical treatment 357
  - production 234–5
  - remanufacturing 237–9
  - solid fuels from waste 489–90
  - solid residues 448
- iso-pressure curves 847
- ISWM *see* integrated solid waste management
- items 65
- IWM *see* integrated waste management
- IWM Canada model 142, 145
- IWM-2 *see* Integrated Waste Management-2
- jaw crushers 326
- John Deere presses 346
- junk mail 193–4
- ketone production 647
- kitchen grinders 276
- Kjeldahl nitrogen 891
- Kyoto Protocol 14
- L/S *see* liquid/solid
- labeling, hazardous waste 985–6
- lagoon-based SBR 886–7
- land use 122, 130
- landfill gas (LFG)
  - active gas management 845–6, 847–9
  - aftercare 942
  - biofuels 854
  - boiler systems 852–4
  - corrosion problems 855
  - direct usage 853–4
  - electricity and heat production 851–2
  - emissions and time frames 686–7, 693, 851
  - environmental factors 696–9, 702–3
  - extraction systems 847–8
  - extraction and utilization 841–57
  - final use of landfills 939–40
  - flaring systems 849–51
  - fuel cells 854–5
  - hydrology 710, 714
  - management systems 845–9
  - mechanical biological pretreatment 791–4
  - modeling LFG production 841–4
  - monitoring 925–6
  - natural gas distribution network 854
  - passive gas management 846
  - pump and regulation systems 848–9
  - reactor landfills 774–9
  - top covers 831–4, 836–9
  - utilization systems 851–5
  - vegetation damage 935–6, 942
- landfilling
  - aftercare 693, 932–3, 941–5
  - anaerobic digestion 610, 612
  - batteries 992
  - biological pretreatment 790–1
  - bottom liners 927
  - bottom linings 800–20
  - capacity needs 899–900, 912
  - case histories 748–51
  - chemical reactions 760–2
  - classification of waste 734–6, 908–9
  - closure 932–7
  - compaction of waste 915–16, 918–19
  - composting 549
  - concepts and challenges 685–94
  - construction and demolition waste 243, 248–9
  - daily cover 920

- decommissioning 937
- density and unit weight of waste 736–9
- design 795–7, 898, 899, 907–13
- economic factors 37–8, 45, 837–8, 905–6, 944–5
- electricity and heat production 851–2
- emissions 139, 154–5
- end of aftercare 944–5
- environmental factors 686–8, 695–708, 767–9, 826–7, 838, 905–6, 921–3
- equipment 915
- failure modes 747–51
- filling sequences and waste placement 915–18
- final storage quality 689
- final use 910, 937–41
- fire and explosion hazards 702–3, 922
- flaring systems 849–51
- gas extraction and utilization 841–57
- geotechnology 734–54, 905–6, 927–8, 933–5
- glass 216
- hazardous waste 987, 988
- healthcare risk waste 958
- historical development 685–6
- hydraulic conductivity 741–4
- hydrology 709–33, 830–1, 835–6
- landscaping 902–3, 910, 940–1
- life cycle assessment 128–9, 139–41, 154–5, 165–6, 167–8, 170–2, 176–8
- mass balances 784–5
- mass flows 692
- mechanical biological pretreatment 788–99
- mechanical biological treatment 628, 632–4
- mechanical pretreatment 789–90
- mechanical treatment 356–7
- methane utilization 154
- mineral waste landfills 755–71
- models of landfills 726–9
- moisture content 737, 777, 795–7, 809, 929
- monitoring and maintenance 782–3, 914, 923–9, 941–5
- multibarrier concept 688
- nuisances 702, 921–3
- odor problems 696, 699–701, 791–2, 849, 922
- operation 795–7, 914–23
- ozone depletion 696, 698
- paper and cardboard 210
- permanent installations 936–7
- planning 898–901
- plastic 230
- political frameworks 900–1
- polyvinylchloride 997
- preservative treated wood 977–9
- public attitudes 906–7
- public health issues 702, 921
- reactor landfills 686, 772–87
- regulatory factors 690–2, 756–7, 789, 822–3, 826–7, 851, 900, 908–9, 913, 932–3, 942–5
- safety and security 921
- settlement 744–6, 751, 927–8, 933–5, 939, 943
- shear strength 739–41, 749
- site-specific risk assessments 689–90
- siting 898, 900–7
- solid fuels from waste 486–7
- solid residues 444–6
- specific weight 920
- stability 746–51
- storm water management 921
- technical control options 767–9
- temperature control 777, 929
- time frames 686–8
- top covers 830–40, 845
- transport of leachate through liners 812–20
- vegetation damage 703, 935–6, 942
- waste acceptance criteria 690–2, 908–9
- waste characteristics 794–5
- waste electrical and electronic equipment 963
- waste engineering 18, 20
- waste input control 921
- water balance 709–19, 727
- water flow 719–26, 728–9
- see also* landfill gas; leachates
- LandGem model 842
- landscaping applications 651–64
- landscaping of landfills 902–3, 910, 940–1
- large containers 258–61
- large events 195–6
- LCA *see* life cycle assessment
- LCA-IWM model 144, 148–50
- LCC *see* life cycle costing
- LCRS *see* leachate collection and removal system
- LDCRS *see* leakage detection, collection and removal systems
- LDPE *see* low density polyethylene
- leachate collection and removal system (LCRS) 800–1, 803, 820–6
  - construction and operation 824–6
  - design 821–4
  - materials 803–4, 820–1
  - regulatory factors 822–3, 826–7
  - saturation and clogging 824–6
- leachates
  - activated sludge 883–5, 890, 893
  - aerated lagoons 881–3
  - aerobic treatment 877–88, 891

## 1014 Index

- leachates (*Cont.*)
- aftercare 942–3
  - ageing processes 446
  - anaerobic treatment 877–8, 881, 882, 888–91
  - availability tests 451–2
  - biological treatment 877–94
  - characteristics and composition 859–61
  - chemical reactions 760–2
  - co-treatment with sewage 863
  - combination treatments 891–4
  - composting 535, 572–4
  - construction and demolition waste 248
  - contaminated soils 107–8
  - coordination chemistry 449–50
  - denitrification 878, 881–94
  - description and prediction of behaviour 762–3
  - diffusion-controlled leaching 454
  - dissolved air flotation 885–6
  - dissolved organic carbon 450–1
  - emissions and timeframes 686–8, 693
  - environmental factors 472–3, 704–6, 767–9
  - evaporation processes 865–6, 894
  - final use of landfills 939–40
  - fixed film reactors 888–91
  - flow variations 860
  - hydrology 709–11, 730
  - kinetic versus equilibrium approach 757–8
  - leaching tests 81, 451, 908–9
  - liquid/solid ratios 758–9
  - mechanical biological pretreatment 792–6
  - mechanical biological treatment 635
  - membrane processes 866–8, 886
  - mineral waste landfills 757–69
  - monitoring 925
  - nitrification 880–94
  - organic contaminants 454–5
  - oxidation processes 871–4, 890, 893–4
  - pH effects 446, 449
  - polishing plants 875–7, 885–6, 893
  - precipitation 868–9
  - preferential flow 759–60
  - preservative treated wood 977–9
  - properties 763–7
  - quality management 688–90
  - reactor landfills 774–8, 779–82
  - recirculation 836
  - redox potentials 449
  - rotating biological contactors 889–91
  - sequencing batch reactors 875–7, 885–8
  - on site treatment 861–3
  - solid residues 446, 448–56, 472–3
  - sorption processes 869–72, 890
  - stripping processes 863–5, 894
  - temporal variations 758–9, 861
  - top covers 836
  - transport through liners 812–20
  - treatment 858–97
  - water percolation and temporal variations 452–4
  - wetlands and reed beds 874–7, 885
- LeachXS model 763, 765
- leakage detection, collection and removal systems (LDCRS) 805
- legislative issues *see* regulatory issues
- LFG *see* landfill gas
- LHV *see* lower heating value
- life cycle assessment (LCA) 12–13
- all potential environmental impacts 175–8
  - allocation 123–4, 140
  - applications in waste management 137–60
  - assessment criteria 120–2
  - attributional 118–19
  - biological treatment 669, 680
  - case studies 152–9
  - consequential 118–19
  - data collection and processing 124–6
  - development and principles 113–15
  - environmental assessment tools 114–15
  - functional units 117–18
  - future developments 159
  - goal and scope definition 116–24
  - impact assessment 126–33
  - impact categories 121–2, 126, 128
  - interpretation phase 133–4
  - inventory analysis 124–6
  - landfilling 782
  - limitations 134
  - methodology 116, 138–41
  - models of waste management 141–52, 161–79
  - paper recycling 209–10
  - potential global warming impacts 170–5
  - preservative treated wood 979
  - recycling 139–40, 166, 170–1, 209–10, 216–18, 230–2, 240–1, 247–9
  - reporting and critical reviews 134
  - sensitivity analysis 133–4, 173–6
  - solid residues 473–4
  - system boundaries 118–20, 137–9, 146–53, 161–4, 178
  - technological scope 122–3
  - technologies of waste management 164–9
  - time scales 122, 139
  - waste electrical and electronic equipment 968
  - waste management systems 169

- welfare costs 41
- life cycle costing (LCC) 30, 46, 115
- life cycle impact assessment (LCIA) 126–33
  - characterization 126, 128–30
  - classification 121–2, 126, 128
  - normalization 126, 130–1
  - weighting 126–8, 131–3
- lighting equipment 965–6
- lignocellulose 587, 639–43
- liquid digest 611, 612
- liquid emissions 573–4
- liquid/solid (L/S) ratios 758–9, 767–8
- lithosphere 438
- litter nuisance 702, 922
- littering 9
- local impacts 120
- loss on ignition (LOI) 378, 439–40, 456
- low density polyethylene (LDPE) 221–3, 225–7, 229
- low permeability soils 801
- low pressure steam boilers 387–8
- lower heating value (LHV) 421–2
  
- magnetic iron 789
- magnetic separation 338, 608, 967
- managed water input 710, 714–15
- Manning's equation 824
- manometric analysis 593
- manual sorting 70–1, 226, 342–4, 966–7
- manually handled receptacles 254–8
- manufacturing processes 119
- market factors *see* economic factors
- market failure 43, 55
- marketing 659
- mass balances 421–9
  - anaerobic digestion 618–20
  - composting 569–73
  - landfilling 784–5
  - mechanical biological treatment 629, 632
  - waste engineering 21
- mass flows 397, 424–6
  - co-combustion 481–2
  - landfilling 692
  - life cycle assessment 166–7
- mass reduction 67
- mat composting 553
- material flow analysis (MFA) 5–7, 115, 208
  - co-combustion 481–2, 484
  - recycling 216, 217, 227, 229
  - waste engineering 21
- material fractions 19, 65, 70–80
  - commercial and institutional waste 98–9
  - construction and demolition waste 105–6
  - industrial waste 102
  - mechanical treatment 351–2
  - residential waste 89–90, 91–3
  - solid residues 464–5
  - source segregation 299
- material recovery facilities (MRF) 349–62
  - commingled MRFs 352–6, 361
  - definition 349–50
  - economic factors 40–1
  - facility design 360–1
  - historical development 350
  - mass and energy balance 358
  - mechanical–biological treatment 356–60
  - mixed waste MRFs 356–7
  - pyrolysis and gasification 511
  - single MRFs 351–2
  - types 351–60
- material structure 541–2
- maturity of compost 577–9
- MBP *see* mechanical biological pretreatment
- MBS *see* mechanical biological stabilization
- MBT *see* mechanical biological treatment
- MEA *see* multilateral environmental agreements
- mechanical biological pretreatment (MBP) 169, 628–9, 635–7
  - biological pretreatment 790–1
  - design and operation 795–7
  - gas production 791–6
  - landfilling 788–99
  - leachates 792–6
  - mechanical pretreatment 789–90
  - regulatory factors 789
  - waste characteristics 794–5
- mechanical biological stabilization (MBS) 169, 628
- mechanical biological treatment (MBT) 356–60, 628–38
  - air emissions 633–5
  - biodrying 629–32
  - environmental factors 633–5
  - life cycle assessment 165, 168, 169, 172–3, 176–8
  - mass balances 629, 632
  - pretreatment of waste 628–9, 635–7
  - solid fuels from waste 486–90, 493
  - stabilization 628
  - technology 628–31
  - unit process inventories 636–7
  - wastewater treatment 635
- mechanical pretreatment 966–7
- mechanical pulping 203
- mechanical re-pulping 206

## 1016 Index

- mechanical treatment 20
  - air classifiers 332–7
  - ballistic separators 337–8
  - cascade ball mills 325–6
  - commingled MRFs 352–6, 361
  - compaction of waste 345–7
  - cutters/shredders 322–3, 325
  - density separation 341–2
  - eddy current separators 338–40
  - facility design 360–1
  - flotation 341
  - hammer mills 323–4
  - impact crushers 324–5
  - jaw crushers 326
  - magnetic separators 338
  - manual sorting 70–1, 226, 342–4
  - mass and energy balance 358
  - material recovery facilities 349–62
  - mixed waste MRFs 356–7
  - occupational health 343
  - optical sorting 340–1
  - preservative treated wood 975
  - screens 329–32
  - separation processes 70–1, 226, 327–44
  - single MRFs 351–2
  - size reduction 321–6
  - unit processes 321–48
- membrane processes 866–8, 886
- mercury removal 404–5, 406, 425–8, 494
- mesophilic digestion 517, 605, 624
- metalloids 675–7
- metals
  - mechanical treatment 355, 357
  - recycling 234–42, 301
  - remanufacturing 237–9
- methane
  - anaerobic digestion 584–5, 587, 591–5, 618–23
  - composting 573–6
  - oxidation 836–9
  - potentials 591–4
  - utilization 154
  - see also* landfill gas
- methanogenesis 584–5, 590–1, 596–7, 645, 775–7, 782–3
- MFA *see* material flow analysis
- microbial biomass 516–17
- microbial competition 530–1
- microfiltration 867, 883, 894
- microwave treatment 958
- midpoint modeling 126–8
- mineral waste landfills 755–71
  - chemical reactions 760–2
  - environmental factors 767–9
  - kinetic versus equilibrium approach 757–8
  - leachates 757–69
  - liquid/solid ratios 758–9
  - preferential flow 759–60
  - regulatory factors 756–7
  - technical control options 767–9
  - temporal variations 758–9
  - waste types 755–7
- mineralogy of incineration residues 434–6
- missing values 83
- mixed waste 356–7, 769, 778
- mixing of compost 653–5
- mixing tank systems 871
- mobile vacuum systems 275–6
- MODFLOW model 729
- modified SCR 413
- modified waste bins/containers 261
- Mohr–Coulomb failure criteria 739
- moisture content
  - anaerobic digestion 618
  - characterization of waste 72, 74
  - composting 526, 530, 535, 540–1, 545–6, 550, 570–3
  - landfilling 737, 777, 795–7, 809, 929
- moisture retention curves 469–70
- moisture/temperature/gas (MTG) sensors 923–4
- MOLOK system 266–7, 274
- monetary costs 29
- monitors 965
- mono-combustion 498–9
- monofills 755
- Montreal Protocol 13
- motorgraders 915–16
- moving grate furnaces 365–6, 380, 382–6
- MRF *see* material recovery facilities
- MSW *see* municipal solid waste
- MSW-DST *see* municipal solid waste decision support tool
- MSWM *see* municipal solid waste management
- MSWMS *see* Municipal Solid Waste Management System
- MTG *see* moisture/temperature/gas
- mulch compost 656, 660
- multi-point allocation 140
- multibarrier concept 688
- multicompartment trucks 275
- multicriteria evaluations 903–6
- multilateral environmental agreements (MEA) 55
- municipal regulations 14–15
- municipal solid waste decision support tool (MSW-DST) 143, 147–9

- municipal solid waste management (MSWM) systems 9, 10
- Municipal Solid Waste Management System (MSWMS)
  - Assessment Tool 144, 148–50
- municipal solid waste (MSW)
  - anaerobic digestion 603
  - biological treatment 668, 677, 679
  - co-combustion 477–9, 484
  - composting 534, 538–9, 547, 550, 563–5
  - incineration 377, 380, 434, 437, 441–5, 450, 453, 457, 463
  - landfilling 699, 718–19, 735, 737–41, 745–8, 757, 759, 762–9, 788–9, 792–4
  - life cycle assessment 155–6, 162–4
  - pyrolysis and gasification 505–7
  - solid fuels from waste 486–7, 493
  - special wastes 991
- nanofiltration 866–8
- national regulations 14
- natural barrier materials 801–2, 804–9, 811–12, 815–18
- natural drainage materials 821
- natural gas distribution network 854
- NCV *see* net calorific value
- negative sorting 343–4
- net calorific value (NCV) 488
- net present value (NPV) 33–4
- nitrates/nitrites 886–9, 891–2
- nitrification 880–94
- Nitrobacter* spp. 522
- nitrogen degradation 521–2, 527, 535, 543, 572–3, 781, 792–3
- nitrogen oxides 395, 412–16, 573–6
- noise nuisance 81
  - composting 538
  - landfilling 702, 921–2
  - transfer stations 316
- nonhazardous waste 4–5, 691, 756, 826
- nonmonetary costs 29
- nonpacking plastic 225
- nonvolatile solids (NV) 519–20
- normalization 126, 130–1
- NPV *see* net present value
- nutrient cycles 666–7, 705–6, 777
- nutrient demands 527, 543, 595
- nutrient enrichment 122, 177
- nutrient-rich compost 539
- NV *see* nonvolatile solids
- OCA *see* opportunity cost approach
- occupational health
  - collection 254–5, 263, 287–8
  - landfilling 921
  - mechanical treatment 343
- odor problems
  - anaerobic digestion 612–13, 615, 617
  - biological treatment 671
  - collection 263, 289
  - composting 523, 535–7, 548, 551, 573–5, 577
  - landfilling 696, 699–701, 791–2, 849, 922
- off gas *see* biogas
- OMC *see* optimum moisture content
- on site leachate treatment 861–3
- one-stage digestion 606
- one-way diapers 196–7
- open composting technologies 547–9, 551–4
- open dumps 685–6
- open flares 849–50
- open-loop recycling 139–40
- operating hours 315–16
- operation stages 120, 795–7, 824–6, 914–23
- operational stability 316
- opportunity cost approach (OCA) 43
- optical color sorting 214–15
- optical sorting 340–1, 967
- optimism, avoiding 748
- optimum moisture content (OMC) 809
- ORCHESTRA model 763, 765
- organic carbon *see* dissolved organic carbon; total organic carbon
- organic loading rates 605
- organic material combustion 421–2, 439–40, 444
- organic matter 74, 79, 530
- organic micropollutants 677–8
- organic pollutants 579–80
- organic solvents 184
- organic waste 353, 356–7
- organic waste research (ORWARE) model 142, 145–7
- organizational waste 197–8
- ORWARE model 142, 145–7
- oscillating screens 330
- outer cycles 482
- outliers 83
- overburden 742, 911
- oxidation processes 871–4, 890, 893–4
- oxygen control 777
- oxygen demand 526–7, 530, 541–6, 553–6
- ozone depletion
  - landfilling 696, 698
  - life cycle assessment 121, 177
- ozone injection 413
- ozonolysis 873–4

## 1018 Index

- packaging
  - hazardous waste 985–6
  - healthcare risk waste 954–5
  - mechanical treatment 353–6
  - recycling 225, 301
  - waste minimization and prevention 195–6, 198
- packed column scrubbers 403–4
- PAH *see* polycyclic aromatic hydrocarbons
- pans 915
- paper
  - bin bags 254–5, 265, 309
  - collection 285
  - incineration 422
  - mechanical treatment 344, 351–2
  - production, waste minimization and prevention 189
  - recycling 203–10, 300
  - remanufacturing 205–7
- parasites 527–9
- particle size distribution 71, 321–6, 398, 464–7
  - composting 541–2, 551
  - landfilling 735, 789
  - pyrolysis and gasification 507
  - see also* size reduction
- particulate organic matter (POM) 762
- passive gas management 846
- pathogens 8
  - anaerobic digestion 597
  - biological treatment 670–1, 673
  - composting 527–31, 542
- pavement waste 106–7
- pay as you throw (PAYT) 47–8, 291–3
- PCB *see* polychlorinated biphenyls; printed circuit boards
- PCC *see* pulverized coal combustion
- PCDD/F *see* polychlorinated dibenzoparadioxins/furans
- PCP *see* pentachlorophenol
- PE *see* polyethylene
- peak hour operations 315–16
- pellet presses 346–7
- pentachlorophenol (PCP) 973, 975–7
- percolation tests 908–9
- performance matrices 904–6
- performance testing 81
- permanent installations 936–7
- permeameters 810–11
- permits 913
- persistent organic pollutants 55
- pesticides 678, 874
- PET *see* polyethylene terephthalate
- pH effects
  - anaerobic digestion 598–9
  - characterization of waste 74
  - composting 544, 546
  - landfilling 761, 763, 767–9
  - leachates 446, 449, 880–1
  - pharmaceutical wastes 677
  - PHB *see* poly(3-hydroxybutyric acid)
  - photochemical ozone formation (POF) 121, 177
  - physical analyses 69–72
  - physical planning 901
  - physicochemical treatment 990, 993–4
  - PIC *see* prior informative consents; products of incomplete combustion
  - picking analysis 70–1
  - pipe systems 821, 825
  - planning processes
    - anaerobic digestion 601–4
    - collection 289
    - final use of landfills 937–41
    - landfilling 898–901
    - landscaping 940–1
    - waste engineering 28
  - plant capacity 374
  - plastic
    - bin bags 254–5, 265, 307, 309
    - biochemicals 647–9
    - biodegradable 647–9
    - incineration 422
    - mechanical treatment 355–6
    - recycling 220–33, 301
    - remanufacturing 222–6
    - waste electrical and electronic equipment 967
  - POC *see* points of compliance
  - POF *see* photochemical ozone formation
  - points of compliance (POC) 690–1
  - police filters 411
  - polishing plants 875–7, 885–6, 893
  - political frameworks 55, 900–1
  - polluter pays principle (PPP) 15, 53
  - poly(3-hydroxybutyric acid) (PHB) 648–9
  - polychlorinated biphenyls (PCB) 73
    - biological treatment 667, 677
    - incineration 411, 444
    - preservative treated wood 972–3, 976
    - waste electrical and electronic equipment 964, 967
  - polychlorinated dibenzoparadioxins/furans (PCDD/F)
    - 395–9, 404, 407, 411–13, 416, 426–8, 444
    - landfilling 699
    - leachates 868
    - pyrolysis and gasification 511

- polycyclic aromatic hydrocarbons (PAH) 73
  - biological treatment 677
  - incineration 395, 398, 411, 440, 444
- polyethylene (PE) 220–7
- polyethylene terephthalate (PET) 221, 222, 225–7, 232
- polystyrene (PS) 220–2, 225–7
- polyvinylchloride (PVC) 227–9, 488, 493, 996–7
- POM *see* particulate organic matter
- positive sorting 343–4
- post-processing technologies 547–51, 570
- PPP *see* polluter pays principle
- PR *see* producer responsibility
- pre-processing technologies 547–51, 570
- precious metals 962, 967–8
- precipitation 710–11, 761, 868–9, 943
- preferential flow 759–60
- preheating of waste 611
- preservative treated wood 971–81
  - active ingredients 972
  - characterization 973–5
  - hazardous potential 972–3
  - treatment and disposal 975–9
- press separation 609
- pressurized screens 331–2
- pretreatment of waste
  - anaerobic digestion 607–10, 614–16
  - biofuels 641
  - incineration 379–80
  - mechanical biological treatment 628–9, 635–7
- prevention *see* waste minimization and prevention
- pricing market goods 42
- printed circuit boards (PCB) 964, 965, 967
- prior informative consents (PIC) 55
- private costs 29, 30–40
- process-specific emissions 25
- process steam and power 390
- procurement 197–8
- producer responsibility (PR) 15, 56, 962–3
- product associated disposal fees 48–9
- product inhibition 599
- product quality 481, 482–3
- products of incomplete combustion (PIC) 395
- protection layers 831–3
- PS *see* polystyrene
- psychrophilic digestion 596–7
- psychrophilic bacteria 517
- public access 912
- public attitudes
  - incineration 366
  - landfilling 906–7
  - source segregation 298–9, 308–9
- public awareness programs 294–5
- public collection points 265, 280, 282, 300, 304
- public facilities 197–8
- public health issues 8
  - biological treatment 670–1
  - collection 263, 289
  - composting 542
  - healthcare risk waste 952
  - landfilling 702, 921
- pulp production 203–5
- pulpers 608
- pulverized coal combustion (PCC) 497–8
- pump systems 821, 848–9
- PVC *see* polyvinylchloride
- pyrolysis 502–12
  - benefits and drawbacks 503
  - definition 20
  - energy recovery 510–11
  - environmental factors 511
  - flue gas cleaning systems 510
  - material recovery 511
  - parameters and properties 505–8
  - pressure 508
  - processes 503–5
  - technologies 508–10
  - temperature and heating rates 507–8
  - waste properties 506–7
- quality management 655–6
  - biological treatment 678–9
  - co-combustion 481, 482–3
  - collection 290–1
  - composting 576–80
  - landfilling 689, 812
  - solid fuels from waste 491–6
- quantitative risk assessments 690
- quotes for environmentally weighted recyclability (QWERTY) 968
- radiative sterilization 958
- railroad transport 314
- random sampling 65–6
- Rankine cycle 376, 389
- ranking procedures 904–6
- raveling settlement 744
- raw material extraction 119
- RBC *see* rotating biological contactors
- RBTS *see* reed bed treatment systems
- RCM *see* replacement cost method
- RDF *see* refuse-derived fuel
- reactor composting technologies 556–9

## 1020 Index

- reactor landfills 772–87
  - bioreactor landfills 686, 772–4, 782–5
  - controlling factors 777–8
  - conventional landfilling 772–82
  - degradation processes 774
  - flushing bioreactors 772–4, 783, 784–5
  - gas production 774–9
  - leachates 774–8, 779–82
  - monitoring and maintenance 782–3
  - phases in life cycle 774–6
  - semiaerobic bioreactors 772–4, 783–5
- rear-loading collection trucks 268–71
- receptacles for waste 254–66, 306
  - biodegradable waste 255, 262–5
  - large containers 258–61
  - manually handled 254–8
  - recycling 255, 258–9, 261–2
  - underground 265–6
- recovery
  - batteries 993–4
  - tires 995
  - waste electrical and electronic equipment 962, 966, 968
- recycling 9, 11
  - batteries 992–3
  - closed loop 965
  - collection 255, 258–9, 261–2, 282, 285, 293, 297–301
  - construction and demolition waste 243–9
  - economic factors 39–41, 45, 207–8, 214–17, 226–30, 239–40, 243
  - environmental factors 209–10, 216–18, 230–2, 240–1, 247–9
  - fee schemes 293
  - glass 211–19, 262–4, 299–300
  - grading and categorization 205–6
  - life cycle assessment 139–40, 166, 170–1, 209–10, 216–18, 230–2, 240–1, 247–9
  - metals 234–42, 301
  - open-loop 139–40
  - paper and cardboard 203–10, 300
  - plastic 220–33, 301
  - polyvinylchloride 997
  - production rates 203–5, 211–12, 215, 220–2, 234–7, 239
  - public attitudes 298–9
  - remanufacturing 205–7, 213–14, 222–6, 237–9
  - source segregation 297, 298–301
  - symbol and numbering systems 225
  - tires 994–6
  - upgrading 244–6
  - waste electrical and electronic equipment 965–8
  - waste engineering 18, 20
  - waste minimization and prevention 185–6, 189, 198–9
  - recycling stations *see* collection centers
  - recycling, utilization and landfilling (RUL) 18, 20
  - redox potentials 449
  - redox reactions 762
  - reed bed treatment systems (RBTS) 874–7, 885
  - refinement of compost 653–5
  - refining processes 967
  - refuse-derived fuel (RDF) 20, 486–501
    - characterization 491–2
    - classification 494–6
    - co-combustion 477–8, 497, 499
    - coal fired power plants 497–8
    - definition 486
    - economic factors 499–500
    - landfilling 789
    - life cycle assessment 163–5, 168, 169
    - mechanical biological treatment 628–32
    - mechanical treatment 346–7, 358
    - mono-combustion 498–9
    - physical and chemical properties 491–4
    - production 487–90
    - quality management 491–6
    - test instructions 496
    - utilization 497–500
  - regenerative thermal oxidation (RTO) 633–5
  - regional impacts 120
  - regional regulations 14–15
  - regulation systems 848–9
  - regulatory factors 52–9
    - air emission limit values 393–4, 417–18
    - BREF notes 57–8
    - byproducts and waste 58–9
    - co-combustion 477
    - collection 288, 297
    - composting 579–80, 655–9
    - end of waste criteria 59
    - hazardous waste 985–7
    - incineration 393–4, 416–18
    - institutions and roles 13–15
    - instruments 53
    - landfilling 690–2, 756–7, 789, 822–3, 826–7, 851, 900, 908–9, 913, 932–3, 942–5
    - producer responsibility 56
    - responsibility for waste management 56
    - shipment of waste 56–7
    - waste electrical and electronic equipment 962–3
    - waste minimization and prevention 188–90
  - relative permeability 723, 725

- remanufacturing 205–7, 213–14, 222–6, 237–9
- renewable resources 133
- replacement cost method (RCM) 43
- reporting 24, 134
- re-pulping 206–7
- residence level waste prevention 187–8
- residential waste 85–96
  - bulky waste 86, 92, 94, 284–5, 294
  - collection 284–5, 291–4, 298–302, 305, 309
  - composition 89–90, 91–3
  - composting 534–5, 547, 561–3, 571, 653, 657
  - definition 85–6
  - developing economies 86–7
  - food waste 653, 657
  - household hazardous chemicals 86, 92–5
  - landfilling 839
  - mechanical treatment 352–3, 360
  - unit generation rates 85–9, 90–1
  - see also* garden waste; household waste
- residue streams 434
- resilient modulus 469
- resource consumption 133
- resource recovery 9, 11
- respiration tests 81, 521, 578
- return of investment factor (ROIF) 44
- return systems 9, 48
  - glass recycling 213
  - plastic recycling 232
  - waste minimization and prevention 198–9
- reuse
  - construction and demolition waste 246
  - contaminated soils 107–8
  - glass recycling 213
  - plastic 232
  - preservative treated wood 975
  - tires 994–6
  - waste minimization and prevention 196–7
- revegetation 935–6
- revenues 31, 40–1
- reverse osmosis plants 865, 866–8, 891–4
- ring matrix presses 347
- risk assessments 689–90
- risk screening 690
- road construction 911, 920–1, 995
- road transport 314
- road waste 106–7
- ROAD-RES model 473–4
- rodent nuisance 702, 923
- ROIF *see* return of investment factor
- roll-off containers 259–60, 266–7, 273–4
- rotary air classifiers 334–6
- rotary kiln furnaces 380–1, 988
- rotary kiln gasification 509–10
- rotating biological contactors (RBC) 874, 889–91
- rotating drum composting 557–8
- rotational failures 747
- route planning 289
- RTO *see* regenerative thermal oxidation
- RUL *see* recycling, utilization and landfilling
- run off 573–4
- Saccharomyces cerevisiae* 640, 642–3
- sacks 254–5, 265
- Salmonella* spp. 529
- sampling 65–9
  - number of samples 67–9
  - sample size 66
  - strategies 65–6
  - subsampling 66–8
- sanitary landfills 686
- sanitization 529
- satellite vehicles 273
- saturated flow 719–20, 728–9
- SBR *see* sequencing batch reactors
- scale economies 36
- scales 912
- scarce resources 968
- Schwanecke's equation 371
- scope definitions 117–24
- SCR *see* selective catalytic reduction
- scrap metal 237–40
- scrapers 915
- screens 329–32
- secondary combustion zones 385
- section geometry 778
- selective catalytic reduction (SCR) 415–16
- selective noncatalytic reduction (SNCR) 386, 413–14
- self-healing tests 578
- semiaerobic bioreactor landfills 772–4, 783–5
- semidry scrubbers 407–10, 425–8, 433–4, 441–3, 453–4
- sensitivity analysis 133–4, 173–6
- separate hydrolysis and fermentation (SHF) 641–2
- separation layers 804
- separation processes 327–44
  - air classifiers 332–7
  - anaerobic digestion 608–9
  - ballistic separators 337–8
  - density separation 341–2
  - eddy current separators 338–40
  - flotation 341
  - healthcare risk waste 953–4
  - magnetic separators 338

## 1022 Index

- separation processes (*Cont.*)
  - manual sorting 70–1, 226, 342–4
  - optical sorting 340–1
  - recovery, purity and efficiency 327–8
  - screens 329–32
  - solid fuels from waste 487
  - solid residues 457–8, 459
  - waste electrical and electronic equipment 966–7
    - see also* material recovery facilities; source segregation
- sequencing batch reactors (SBR) 875–7, 885–8
- settlement 744–6, 751, 927–8, 933–5, 939, 943
- sewage sludge
  - biological treatment 667, 670–1, 673–5
  - co-treatment with leachates 863
  - landfilling 838–9
- SFA *see* substance flow analysis
- shear strength 739–41, 749
- shear wave velocity 746
- SHF *see* separate hydrolysis and fermentation
- shipment of waste 55, 56–7
- shredding 322–3, 325
  - anaerobic digestion 607
  - batteries 994
  - landfilling 778
  - waste electrical and electronic equipment 966
- side-loading collection trucks 271–2
- sieve separation 608
- signage 911
- silicon residues 447–8
- simultaneous saccharification and fermentation (SSF)
  - 641–2
- single component liners 804–7
- single MRFs 351–2
- single step waste prevention 186
- sintering 458–9, 465
- site-specific risk assessments 689–90
- siting processes
  - collection 315–16
  - evaluation/selection procedure 903–6
  - geographical and geological factors 901
  - hydrogeological factors 902
  - landfilling 898, 900–7
  - landscaping and volume estimation 902–3
  - physical planning 901
  - public attitudes 906–7
  - waste transfer stations 315
- size reduction 321–6
  - anaerobic digestion 608
  - cascade ball mills 325–6
  - composting 655
  - cutters/shredders 322–3, 325
    - hammer mills 323–4
    - impact crushers 324–5
    - jaw crushers 326
      - sampling 67
  - skips 258–9
  - slag 426–7
  - sliding failures 747, 749–51
  - small household appliances 964–5
  - small source handling 955
  - SNCR *see* selective noncatalytic reduction
  - societal substance flow 481, 484
  - socioeconomic factors 538
  - SOD *see* stratospheric ozone depletion
  - sodium hydrogen carbonate-based scrubbers 407–8, 410
  - software tools 125–6
  - soil
    - air phase 776
    - balancing 912–13
    - biology 672
    - contamination 107–8, 705, 826
    - fertility 672
    - functionality 670
    - improvers 659–60
    - investigations 808
    - mechanics 715–19
    - structure 672
      - see also* geotechnology
  - solid digest 611, 612
  - solid recovered fuel (SRF) 486–501
    - characterization 491–2
    - classification 494–6
    - co-combustion 477–8, 497, 499
    - coal fired power plants 497–8
    - definition 486
    - economic factors 499–500
    - mechanical biological treatment 628–32
    - mono-combustion 498–9
    - physical and chemical properties 491–4
    - production 487–90
    - quality management 491–6
    - test instructions 496
    - utilization 497–500
  - solid residues 378, 430–62
    - ageing processes 446–8
    - air pollution control technologies 430, 432–6, 440–4, 445–6, 453–4, 456–7, 459–60
    - anaerobic digestion 610
    - California bearing ratio 467–8
    - chemical composition 434–44
    - combined residue streams 434
    - compaction of waste 466–7

- durability 467, 468–9
- environmental factors 472–4
- flue gas cleaning systems 433–4
- hydraulic conductivity and moisture retention 469–70
- inorganic material combustion 436–9, 441–4
- landfilling 763–7
- leachates 446, 448–56, 472–3
- mineralogy 434–6
- organic material combustion 439–40, 444
- particle size distribution 464–7
- physical and geotechnical properties 444–6
- pyrolysis and gasification 511
- resilient modulus 469
- treatment 455–60
- types and quantities 431–4
- utilization in construction 463–75
  - see also* bottom ash; fly ash
- solid resistance compaction 345–6
- solid waste, definition 3–5
- solidification processes 458, 459–60
- sorption processes 762
  - landfilling 819–20, 855
  - leachates 869–72, 890
- Sortec system 355–6
- source packaging 954
- source segregation 19
  - collection 257, 262–6, 278, 293, 296–310
  - construction and demolition waste 243, 244
  - criteria 297–302
  - guidelines 308–9
  - hazardous waste 302
  - healthcare risk waste 953–4
  - life cycle assessment 164–5, 168, 169
  - material recovery facilities 361
  - public attitudes 298–9, 308–9
  - purpose and advantages 297
  - receptacles for waste 306
  - segregation efficiencies 304–5
  - segregation potentials 302–4
  - segregation purities 305
  - special fractions 301
  - system performance 303–4
  - waste collection systems 306–7
  - waste collection vehicles 306
- spatial variations 64, 87
- special fractions 301
- special wastes 294
  - batteries 991–4
  - food waste 997–9
  - healthcare risk waste 951–9
  - polyvinylchloride 996–7
  - preservative treated wood 971–81
  - tires 994–6
  - waste electrical and electronic equipment 234, 960–70
    - see also* hazardous waste
  - specific weight 920
  - spontaneous combustion 542
  - SSF *see* simultaneous saccharification and fermentation
  - stability of landfills 746–51
  - stabilization processes 458, 459–60, 487, 628
  - stable methanogenic phase 776, 782
  - stack 416–17
  - stainless steel 239
  - standardization 69
  - starch/sucrose energy crops 639–40
  - start-up burners 385–6
  - static pile composting 552–3
  - statistical analysis 81–3
  - steel
    - mechanical treatment 355
    - production 234–5
    - remanufacturing 237–9
  - sterilization processes 957–8
  - storage
    - anaerobic digestion 610–11
    - composting 655
    - healthcare risk waste 955–6
    - landfilling 911
  - stored toxicity 178
  - storm water management 921
  - strategic waste prevention 186–7
  - stratified random sampling 65
  - stratospheric ozone depletion (SOD) 121
    - landfilling 696, 698
    - life cycle assessment 177
  - stripping processes 863–5, 894
  - Student's *t*-test 67, 69
  - subbase preparation 808
  - subsampling 66–8
  - subsidiary containers 258–9
  - subsidies 49, 604
  - substance flow analysis (SFA) 115, 481, 484
  - substances 19, 65
  - succession 516–17
  - suction hoods 335
  - suitability maps 903–4
  - sulfate 448, 775, 777
  - sulfur degradation 522
  - surface layers 831–3
  - surface spreading 472

## 1024 Index

- surface water
  - inflow 710, 711–12
  - landfilling 826, 943
  - pollution 705, 826
  - runoff 710, 712–13, 728, 795–6
- sustainability 11–12
- sustainable procurement 197–8
- SUTRA model 728–9
- synthrophic consortia 590
- system boundaries 118–20, 137–9, 146–53, 161–4, 178
- systematic random sampling 66
  
- tank-based SBR 887–8
- Tanner's diagram 367
- taxes 31, 40, 48
  - life cycle assessment 157–9
  - waste minimization and prevention 188
- TDR *see* time domain reflectometry
- TDS *see* total dissolved solids
- technical guidelines 53
- technological scope 122–3
- TEF *see* toxic equivalency factors
- televisions (TV) 965
- temperature control
  - anaerobic digestion 596–7, 612
  - composting 523–6, 529, 530, 542–3, 545–6
  - landfilling 777, 929
- temporal variations 64
  - collection 277–8
  - landfilling 758–9
  - leachates 452–4, 861
  - life cycle assessment 128–9
  - residential waste 87–8, 91–2
- temporary roads 920–1
- temporary storage 955
- TEQ *see* international toxic equivalents
- test instructions 496
- theoretical methane potentials 591–2
- thermal disposal 976–7
- thermal treatment *see* gasification; incineration; pyrolysis
- thermal treatments, solid residues 458–9, 460
- thermal utilization 976
- thermophilic digestion 517, 605, 625–6
- thermoplastics 220–1
- Thermoselect process 506–7
- thermosets 220–1
- tile waste 246
- time domain reflectometry (TDR) 927
- time-phasing 912
- time scales 122, 139
- tipping places 606–7
  
- tires 994–6
- titanium dioxide 55
- TKN *see* total Kjeldahl nitrogen
- TMR *see* total mass requirement
- TOC *see* total organic carbon; total organic content
- top covers 830–40
  - alternative concepts 834–9
  - barrier layers 831–3, 834
  - capillary barriers 835
  - components 831–4
  - drainage layers 831–4
  - economic factors 837–8
  - environmental factors 838
  - evapotranspiration cover concept 835–6
  - foundation layers 831–3, 834
  - gas collection layers 831–3, 834, 845–6
  - hydrology 830–1, 835–6
  - leachate recirculation 836
  - methane oxidation 836–9
  - models 727
  - placement 933–5
  - protection layers 831–3
  - surface layers 831–3
- topsoils 653–5, 660–3
- total average landfill density 736–7
- total dissolved solids (TDS) 453–4
- total Kjeldahl nitrogen (TKN) 781
- total mass requirement (TMR) 968
- total organic carbon (TOC)
  - characterization of waste 74, 79
  - incineration 375, 378, 395, 422, 439–40, 448, 456
  - landfilling 756, 769, 779, 781
  - leachates 870–3, 878
- tower composting 558–9
- toxic equivalency factors (TEF) 395–6
- trace organics 780–1, 878–9
- tradable permits 49
- trans-esterification 646
- transfer stations 19, 311–18
  - delivery systems 311–13
  - economic factors 316–18
  - landfilling 912
  - siting and design issues 315–16
  - transfer systems 313
- translational failures 747
- transport
  - collection 285–7, 314–15
  - economic factors 36
  - equipment and vehicles 253
  - hazardous waste 986–7
  - healthcare risk waste 955–6

- life cycle assessment 164–6, 170–2
- packaging 955
- regulatory issues 55, 56–7
- waste engineering 17–18, 19
- triglycerides 646
- trommel screens 329–30
- truck wash facilities 912
- tunnel composting 556–7
- turf products 656, 661–3, 995–6
- TV *see* televisions
- two-stage digestion 606
  
- ultrafiltration 866–8, 883–4, 893–4
- unaddressed advertising 193–4
- unbound utilization 469–71
- uncertainty variation 64
- underground receptacles 265–6
- underground sources of drinking water (USDW) 989
- unit generation rates 65
  - commercial and institutional waste 97–8
  - construction and demolition waste 104–5
  - industrial waste 101–2
  - residential waste 85–9, 90–1
- unit process inventories (UPI) 26–7
  - anaerobic digestion 626–7
  - composting 575–7
  - incineration 428–9
  - mechanical biological treatment 636–7
  - recycling 204, 212, 214, 222–3, 236–7
- unit weight of waste 736–9
- unmanaged waste 9
- unsaturated flow 720–4, 728–9
- upgraded C&D waste 244–6
- UPI *see* unit process inventories
- upstream emissions 25
- upstream system boundaries 138–9
- urban constructions 660–2
- usage guidelines 656–9
- USDW *see* underground sources of drinking water
- utilities supply 912
- utility theory 905
  
- vacuum systems 275–6
- valuable substances 962, 967–8
- value markets 652
- van Genuchten equation 722
- variable costs 31
- vegetation damage 703, 935–6, 942
- vehicle fuel *see* biofuels
- venturi aerators 888
- venturi scrubbers 402–3
  
- vermicomposting 553–4
- VFA *see* volatile fatty acids
- vinyl chloride 699, 778–9
- viruses 527–9
- viscosity 596, 744
- vitrification 458
- VOC *see* volatile organic compounds
- volatile fatty acids (VFA) 74, 587, 589, 598–9, 777
- volatile organic compounds (VOC) 121
  - anaerobic digestion 621
  - hazardous waste 989
  - landfilling 696, 699
- volatile solids (VS) 74, 79, 519–21, 535, 570–2, 619, 622
- volume estimation 902–3
- volume markets 652
- volume/space issues 8
- volumetric analysis 593
- volumetric water content 715–19
- voluntary agreements 53, 188–9
- VS *see* volatile solids
  
- waste acceptance criteria 690–2, 908–9
- waste ageing 742
- waste categories 19, 64
- waste characterization *see* characterization of solid waste
- waste collection vehicles 266–75
  - compaction of waste 266–8
  - crane trucks 274
  - crew size and truck capacity 290
  - front-loading collection trucks 258, 271–3
  - multicompartment trucks 275
  - rear-loading collection trucks 268–71
  - roll-off containers 273–4
  - satellite vehicles 273
  - side-loading collection trucks 271–2
  - source segregation 306
- waste composition 162, 173–5
- waste density 71–3
- waste electrical and electronic equipment (WEEE) 234, 960–70
  - characterization 960–2
  - composition 962
  - economic factors 965
  - environmental factors 967–8
  - quantities 960–1
  - regulatory factors 962–3
  - treatment categories 963–6
  - treatment technologies 966–7
- waste engineering 17–28
  - collection and transport 17–18, 19
  - emission accounts 23–5

## 1026 Index

- waste engineering (*Cont.*)
  - energy budgets 22–3
  - material flow analysis and mass balances 21
  - other aspects 28
  - recycling, utilization and landfilling 18, 20
  - terminology 17–20
  - treatment 17–18, 19–20
  - unit process inventories 26–7
  - waste generation 17–19
- waste generation 5–7, 17–19
- waste heterogeneity and structure 724–6, 738–9
- waste hierarchy approach 11
- waste input control 921
- waste management principles
  - approaches 11–13
  - criteria 10–11
  - current practice 13
  - definitions 3–5
  - institutions and regulations 13–15
  - issues with solid waste 8–9
  - material flow 5–7
  - systems 9–10
- waste minimization and prevention 183–92
  - advertising material 193–4
  - biodegradability 194–6
  - case studies 193–200
  - clean production and technology 184, 188–90
  - definitions 183–5
  - food waste 198
  - instruments 188–90
  - integrated product policy 190–1
  - large events 195–6
  - life cycle assessment 138
  - public facilities 197–8
  - recycling 185–6, 189, 198–9
  - return systems 198–9
  - reuse 196–7
  - steps and strategies 186–7
  - waste generators' perspective 187–8
- waste placement 915–18
- waste policies 283–4
- waste prevention *see* waste minimization and prevention
- waste quantities 19, 64
- Waste and Resource Assessment Tool for the Environment (WRATE) 144, 151–3
- waste treatment *see* treatment
- waste types 19, 64
- waste wood ash 977
- wastewater emissions 406–7
- wastewater sludge 446, 602, 612
- wastewater treatment
  - biofuels 643–5
  - landfilling 796
  - mechanical biological treatment 635
- water balances 709–19, 727, 942
- water content 715–19
- water flow 719–26, 728–9
- water percolation 452–4
- water soluble nitrate 579
- waterway transport 314
- WEEE *see* waste electrical and electronic equipment
- weighbridges 606
- weighting 126–8, 131–3
- welfare costs 29, 40–6
- wet digestion 605, 614–16, 619, 625–6
- wet mass 570–1, 618
- wet scrubbers 402–7, 424–5, 427–9, 433–4, 441–3, 453–4
- wetlands 874–7
- wheeled bins 255–8
- willingness to accept (WTA) 42
- willingness to pay (WTP) 42
- Windrow composting 551–2
- WISARD model 143, 148, 150
- World Trade Policy 55
- wormeries 553–4
- WRATE model 144, 151–3
- WTA *see* willingness to accept
- WTP *see* willingness to pay
- yard waste *see* garden waste
- zero waste approach 11, 12
- zigzag air classifiers 334–5