Access shafts, dewatering, 505–507
Acetobacter, 204
Acids
  formulation, usage, 209
  mixing, 212
  treatment program, impact, 212
  wastes, contaminants, 222
Acre-foot, usage, 4
Acrylonitrile-butadiene-styrene (ABS), usage, 198
Acrylate grouts, 422, 425–426
  permanence, 425–426
  set appearance / consistency, 425
  syneresis, resistance, 425
  usage, limitation, 422
  water-like viscosity, level, 422
Acrylate-based grouts, marketing, 422
Acrylonitrile-butadiene-styrene (ABS), 238
Activated carbon, components, 227–228
Additives, usage, 465
Adenosine triphosphate (ATP) determination, 216
Adjusting valve
  throttling, 324
  usage, 323–324
Aeolian deposit, ground behavior, 496–497
Aerobacter, 204
Air
  entrainment, impact, 543
  hydraulic conductivity, impact, 505
  stripping, effectiveness, 228–229
  surging, air lift pumping (alternation), 295
  vents, requirement, 549
Air compressors, usage, 442
Air lift
  pumping, 192–193
  pipe sizes, 192–193
  pumping, alternation, 295
  submergence, 192
Air-handling capacity in cubic feet per minute (ACFMs), 190
Air-handling capacity in liters per minute (ALMs), 190
Air / water
  relationship, characteristic, 505
  separation, 326
Algae, 205
Alkalinity, measurement, 201
Alluvial deposits, 12
Alternate Dispute Resolution (ADR), UTRC development, 585
Aluminum piping, 238
  resistance, 198
Aluminum sulfate, usage, 226
Anaerobic bacteria, 204–205
Analytical models, 85
  availability, 173
  usage, 66
Anionic polymers, usage, 226
Anisotropic soils, 33
Anisotropy, 61–63
Annular space, filling, 286
Anodic / cathodic regions, electrical potential difference, 195–196
Anticipated groundwater movement, project summary, 535–536
Aquifer storage recovery (ASR), 539
  sites, data, 540
Aquifers, 5
  anisotropy, 89
  cross-contamination, prevention, 161
  hydrology, 52
  low transmissivity, 229–230
  parameter, case history, 122–124
  sand, sample (obtaining), 287
  specific capacity, 75–76
  transmissivity, usage, 263–264
  types, 153
  variability, 497–498
Arkansas River, challenge, 256
Arsenic, nondesirability, 222
Artificial recharge, 539
  design objectives, 540–541
Auger microtunneling, 504
Auger-drilled wells, filter pack installation (difficulty), 279
Automated data acquisition systems, usage, 442
Automatic mops, 326
Automatic transfer switches (ATS), 566
Automatic vacuum breakers, 190
Available lift, 310
Backfill
  alternatives, 379
  dewatering, recommendation, 481
  impact, 162–163
  initiation, 377–378
  mixing, 377
Bacteria
  exponential growth rates, 202
growth, 204
  presence, 196
  removal, completion (impossibility), 212–213
Bacterial analysis, 218
Bacteriological activity, anticipation, 206
Bacteriology, 195
Bag filtration, usage, 227
Barrier boundaries, 65
  impact, 131
Battered wellpoints, 265
  installation, 264
  necessity, 320
Bays, surface hydrology, 141
Beaches, characteristics/description, 14
Beams, installation, 315
Bedding material, problems, 264
Beginning tunnels, predrainage, 506
Bentonite, 465
Bentonite slurry, properties, 377
Bentonite-cement grout
  development, 427
  usage, 428
  void-filling applications, 481–482
Berlin (Germany) hydrology, 391
Berlin (Germany) slurry wall/grout blanket
  case history, 391–393
  cutoff
    construction, 391–392
    performance, 392–393
Berm
  drainage problem, 263
  ground, holding (inability), 264
Bernoulli equation, usage, 336
Bibliographies, 620–621
Bicarbonates, hardness, 199–200
Biofilm
  antagonism, 201
  bacteria, type, 201–202
  impact, 200–202
Biological activity, total amount (estimation), 216
Biological incrustation, 198
  impact, 200–205
  treatment, 210
Bleed, nonimpact, 482
Blind holes
  drilling, 351
  vulnerability, 351–352
Blow counts, levels, 164
Blown fuse, problem, 563
Blows, concern, 259–260
Boils
  concern, 259–260
  loss, 318
  size, danger, 260
Borehole
  advance methods, 155–158
  discrete length testing, 176–177
  flushing, 176
  seepage tests, usage, 169–178
  tests, advantages/limitations, 178
Borings, 154–164
  contamination, 161–162
  depth, 162–163
  drilling, methods, 155–158
  major projects, 182
  usage, 154
  Bottle effect, 505
  Boulders, presence, 153
Brackish aquifers, freezing (success), 531
Brake horsepower (BHP), 190
Bremerton Drydock, case history, 254–255
Bridge slot wellscreens, 284–285
Bridge slots, open area (availability), 285
Brine distribution piping, 519
Brine freezing, 515–516
Bucket augers, 156, 394
  drilling, 268–270
  method, versatility/effectiveness, 269
Building foundations, pressure relief, 572
Bull’s liver, 497
Buried drains, long-term effect, 264
Cable tool rigs, 279
Calibration, 94–95
  model design step, 90
California pipe method, 603
Capacity ratio ($R_q$), estimation, 342–343
Capillarity, 27
Carbon dioxide
  concentration, 195, 208
  nondesirability, 223
  occurrence, 196–197
Carbonate alkalinity, 211
Carbonates, hardness, 199–200
Cartridge filtration, usage, 227
Cased borehole drilling techniques, 274
Cased-hole drilling technique, usage, 320
Casing, 279–285
  advancing, dual rotary drilling (usage), 277
  effectiveness, 318
  water cascade, impact, 327
Casing (mg/l), 217–218
Cast-in-place concrete bearing piles, construction, 390
Cationic polymers, usage, 226
Caving, prevention, 269
Cement quantity, injection, 402
Cement replacement, usage, 375
Cementation, 31
Cement-based grouts, 464
Cement-bentonite (C-B), 367
  slurry preparation, 372
  usage, 396
Cementitious grouted soil, unconfined compressive strength, 416
Cementitious materials, injection methods, 399
Cement-water (c/w) ratio, 374
Central Artery/Tunnel (Boston, Massachusetts) mass freeze
  case history, 517–521
  system design/installation, 517–520
  system operation/monitoring, 520
  system performance, 520–521
Changed Condition clause, 590–591
Check valve, requirement, 297
Chemical corrosion, 196
Chemical equilibrium, temperature changes (impact), 206
Chemical grouts, 417–432
Chemical precipitation, 543
Chemically grouted soil, strength, 416
Chemistry analytical results, samples (usage), 225
Chloride
  concentration, 195
occurrence, 197
Chlorides, nondesirability, 223
Chlorination, 220–221
Chlorine
availability, 213
bleach, usage, 272
gas, usage, 213–214
level, providing, 214
misuses, 214
oxidizer, effectiveness, 213
treatment, 212–214
usage, 214
Circuit breakers, usage, 562
Clay bed, excavation approach, 263
Clay-entrained drilling mud, 272
Clayey sands, 40–41
plasticity, 41
Clays
behavior, 529–530
existence, absence, 365–366
low plasticity, behavior, 497
minerals, 11
plasticity/cohesion, 35
visual/manual classification, 41–42
Clean sands/gravels, 40
Clean Water Act, 591
Clear water, head (usage), 269
Closing window, 452
Compressed air
collar, 442
tunneling, 504–505
Compressible silts/clays, consolidation, 46
Compressible soil layer, dewatering (case history), 49–50
Compressive strength testing, 471
Computer model construction, model design step, 90
Computer programs, rewards/risks, 139–140
Concentric dewatering systems, 80–81
Conceptual model, 90–91, 104–105
development, model design step, 90
Conductor pipe, air release, 192
Cone Penetration Test (CPT), 164–167
method, drawback, 167
Cone penetrometer, conical tip angle, 166
Cone penetrometer test (CPT), 118, 436, 438
Confined aquifer, 5, 153
pumping, 55–56
venting, 505
well (inclusion), radial flow, 66–68
Constant rate pumping test, infeasibility, 138
Construction dewatering discharge, 231
Constructive fraud, impact, 589–590
Contaminants
density, 533
encounter, frequency, 222–223
field screening, 161
migration control, diaphragm wall emplacement (case history), 450–451
solubility, 532–533
Contaminated groundwater, 222
freezing, 532–533
health/safety, 234
recovery, dewatering techniques (usage), 228–232
regulating authorities, impact, 234, 237
treatment design, considerations, 225–226
wellpoint system
long-term system installation, 235–236
pilot test, 235
usage, case history, 235–236
Contaminated site, design options, 223–225
Contamination, 161–162
isolation/recovery, dynamic barrier usage (case history), 236
nature, 247
transfer, prevention, 161
Continuous pumping, maintenance, 138
Continuous slot wellscreen, 283–284
Continuous-flight augers, 279
Contract indications, 592–593
Contractor’s recirculating self-priming pump, 187, 189
Contractor’s self-priming pump, 187
Contractor’s submersible pump, 185, 557
Control panel, selection, 298
Copenhagen Metro Project, case history, 551–553
Coral, 17–19
Cored samples, unconfined compressive strength testing, 448
Corrosion
incrustation, occurrence, 196
types, 195–196
Corrosive groundwater conditions, 196–198
dewatering, 198
Creep, strength, 530
Crenothrix, 203
Cross borehole ground penetrating radar (GPR), 455
Cross passages, 506–507
Crosshole seismic studies, usage, 180
Cumulative drawdown, 76–77
method, 88
Curtain grout solution, usage, 427–428
Curtain grouting, advancement, 470–471
Cut and Cover Tunnel Project, case history, 281–282
Cutoff
effectiveness, limitation, 363
efficiency, 358
methods, 253
penetration, effectiveness, 358
stratum
identification, 375–376
penetration, adequacy, 375
terminology, 358
Cutoff walls
construction, 407
design intent, 454
engineering properties, 402
usage, 224, 399–400
Dam foundation, buried drains (intolerance), 264
Darcy’s law, hydraulic gradient, 42
Data loggers, 116
popularity, 128
Deep jet grouting, 452
Deep soil mining (DSM), 398–405
advantages / limitations, 405
attention, 404
construction
considerations, 404–405
sequence, 399–400
development, 403–404
equipment / plant, 401–402
laboratory mix preparation / testing, 404–405
mixing methods, 398–399
quality control, 404–405
soil applicability / depth, 403–404
soil-cement mix design / engineering properties, 402–403
viability, 405
Deep wells
bacteriological problems / incrustation, sensitivity, 207–208
construction, 8
pressure relief, case history, 302
slurry trenching, combination, 258
systems, 267
unit cost, involvement, 251–252
usage, 499
wellpoints, combination, 257
Deflocculant, usage, 426
Delayed storage release, 131–132
Boulton analysis, 138–140
Demand charge, representation, 571
Dense non-aqueous phase liquids (DNAPLs), 222, 533
Deposit analysis, 218–219
Deposition process, 11
Design river stage, selection, 143
Dewatering
analysis, unit systems, 53–54
design, analytical methods (usage), 66
devices, 195
discharge, disposal, 145–150
engineer, options, 224–225
estimation, partially penetrating deep wells (usage), 406
fittings, 238–241
geotechnical investigation, 152
investigation / objectives, 152–153
preliminary studies / investigations, 153–154
groundwater treatment, integration, 231–232
installation, completion, 587
method, consideration, 256
minimum systems, 586
mistakes, 315
models, 84–87
operations, drainpipe characteristics, 356–357
origins, 6
performance specifications, 585–586
pipe, 238–241
projects, pumping tests, 129
pumps
selection, 185
types, usage, 185–189
service, galvanized construction (usage), 284
side effects, 50–51
investigation, 182–183
specifications, 584
purpose, 584–585
submittals, 586–587
technology, development, 6–9
Dewatering costs, 577
data, 577
estimate format, 577
installation / removal costs, 578–579
mobilization costs, 578
operation / maintenance costs, 579–581
Dewatering systems
electrical design, 556
equilibrium balance, disruption, 205
fouling, 195
incrustation, impact, 205–208
planning / design / installation, 147
pumps, capability, 231–232
Dewatering wells
destabilization, causes, 303–304
development, 291
installation, 271
selection criteria, 297
Differential settlement, 47
Differing Site Conditions, 591
claim, response, 594–595
clause, 590–592
Difficult ground, 528
Dilatometer Test (DMT), 164
Direct current, stray currents, 195
Direct push machines, development, 158
Directional drilling techniques, 512
effectiveness, 352
Discharge
column, sizing, 299
location, material discoloration / deposition, 208
point
selection, 322
total height, 192
Discharge piping
losses, 241
oversizing, 207
usage, 321–322
Disconnect switch, usage, 561
Discs, usage, 445
Dispute avoidance, 584
Dispute resolution, 584
Disputes Review Board (DRB), 595
Dissimilar metals, contact, 196
Dissolved oxygen
concentration, 195, 208
occurrence, 198
Dissolved volatile organics, reduction, 228
Distance-drawdown plots, 132
Distribution systems, 566–570
Disturbed ground, 528–529
Ditches
drainage problem, 263
usage, 261
Double-ended holes, susceptibility (reduction), 352
Double-fluid jet grouting, usage, 442
Down-the-hole drilling, air lift action (impact), 276
Down-the-hole hammers, 275–276, 394
Drainage blankets, 572
Drainage trench, flow (line source origination), 69–70
Drainpipe, usage, 261
Drains, 259
usage, 261
Drawdown
achievement, 72
increase, 302
duration, 126–128
tubes, limitation, 326
Drill heads, variations, 349
Drill rig, usage, 441
Drill steel, inside diameter, 270
Drill steel, jet grout monitor (incorporation), 441
Drilled horizontal wells, 349–355
   equipment, 349, 351
   installation techniques, 351–353
   installation techniques/equipment, 349
materials, 353–355
Drilling
   fluids, 271–273
   groundwater observations, 158–159
   methods, 155–158
wastes, containment/disposal, 161
Drop tube, necessity, 547–548
Drumlin, 15
Dry unit weight, 27
Drydocks, intermittent pressure relief, 572
Dual rotary drilling, 274–275
   typical usage, 275
Duplex drilling, implication, 274
Dynamic barriers, 232
Earth pressure balance (EPB) microtunneling, 504
Earth pressure balance (EPB) tunneling, 500–501
Earth pressure balance machine (EPBM), 492
tunneling, soil conditions, 501
Eccentric duplex percussive drilling, 275
Ejectors
   advantages, 252, 336
   bacteriological problems/incrustation, sensitivity, 207–208
   body, construction, 340
   efficiency, 339–340
   groundwater quality, relationship, 345, 349
   headers, 344–345
   losses, 243
   installation, 345
nozzle
   design, 340–344
   sizing, 339
operation, 339
principle, 336–337
pumping stations, 338–339
   construction, 338–339
pumps, operating pressure, 341
return header, usage, 243
risers, 344
self-priming device, 337
soil stabilization, relationship, 349
swings, 344
systems, 252, 336
   iron deposition/iron bacteria growth, sensitivity, 207
   power consumption, 340
venturi
   design, 340–344
   sizing, 339
Electric generators, 564–566
Electric logging, usage, 180
Electric motor
   sizing, 298
   winding, losses (heat generation), 557
Electric probe (battery operation), 115
Electric submersible pump, usage, 328
Electrical circuits, grounding, 570

Electrical conductor, length, 567
Electrical current, metallic connection (presence), 196
Electrical energy, cost, 570–571
Electrical motors, usage, 556–561
Electrical resistance tomography (ERT), 455
Electromotive series, 196
Electronic pump protector, usage, 306
Electro-osmosis
   dc current, usage, 252
   effectiveness, 45
End-stops, removal, 389–390
Energy charge, 571
Environmental applications, freezing (usage), 514
Environmental containment, deep slurry trench (case history), 380–382
Equilization, recommendation, 226
Equilibrium, 66
   formula, equivalence, 68
Equivalent isotropic permeability ($K_i$), 61
Equivalent isotropic transmissivity ($T_i$), 71
Equivalent pipe length, calculation, 241
Equivalent radius of influence ($R_0$), 64
Equivalent radius ($r_e$), 70–71
Erosion, impact, 150
Escrow bid documents, 594
Esker, 15
Estuaries, characteristics/description, 14
Evapotranspiration, 3
Excavated trenches, variations, 356
Excavation/backfill separation, end-stop (usage), 378
Excavations
   conditions, preparation, 259
   methods, proposals, 247
   nonattempt, 263
   open pumping, 46
   rainfall, 144–145
   size/depth, 247
   water (handling), open pumping (usage), 248–249
Exclusion methods, 253
   usage, 224
Exposed frozen ground, insulation/protection, 522
Externally regulated generators, 565
Face opening, limitation, 501
Face stability, 497
Fault, 16
Ferric sulfate, usage, 226
Fertilizers, contaminants, 222
Field investigations, 154
Filled ground, 528
Filter packs, 285–291
   installation, difficulty, 279
   nominal thickness, 289–290
   quality control, 289
   selection, 296
   sizing, 546
Filter piezometer, value, 298
Filter sands, 320–321
Filtering, resistance (increase), 426
Filters
   $D_{50}$ size, 290–291
   material
      sizing, 299
      uniformity, 286–287
      optimum grain size, 287
   placement, 290
   sample problem, 290
Filters (Continued)

selection
criteria, 287

Prugh method, 290

specification, impracticability, 288–289

Filtration, usage, 227

Final head (h), 72

Fine soils, description, 40

Fine-grained soils, 22
classification, 38–39
drainage, 44–46
pore pressure piezometers, 117–118
stabilization, wellpoints (usage), 329–331

Finite difference models, 85

Finite element method (FEM), 533

Finite element models, 85

FLAC, 533

Flavobacter, 204

Floculation, usage, 226

Flood plain, 12

Flood zone maps, usage, 154

Flow channels, grouting, 475

Flow conditions, development, 483–484

Flow lines, series, 79

Flow net analysis, 79–80

Flowpath

access, 479
points, 484
chemical grout, usage, 476, 479
direct communication, 484
identification, 475–476
location, 484
size, variation, 480–481
Flowmeter, recommendation, 299
Flowpaths, grouting, 474–489
Fluidifying additive, usage, 426
Flyash, 465
stabilization success, 329–330

Follow-on tunneling operations, 471

Foot valves, requirement, 337–338

Footing drains, providing, 574

Formation loss, 78

Foundations
slabs, drainage blankets, 574
type/depths, 247

Fractured rock, packer tests, 174

Fraud, impact, 589–590

Friction
impact, 308, 310
loss, 597–602
electrical equivalent, 567

Frozen earth, viscoelasticity, 530

Frozen ground
concreting, 522–528
excavation, 522
strength, 530

Frozen shafts, quality control, 525–527

Fuel adjustment, 571

Fuel oil grease and maintenance (FOGM) materials, 577

Gallionella, corrosive enzyme (secretion), 196

Gallionella ferruginea, 203

Galvanic corrosion, 195–196
development, 196

Galvanized wellscreens, avoidance, 207

Gamma-ray logging, usage, 180

Gases
concentration, 208
entrainment, impact, 543

General subgrade, depth, 254

Generators, types (availability), 565

Geochemical reaction, 543

Geologic interface, wellpointing, 319–320

Geologic seal, property, 510

Geologic studies, 153

Geologic time frame, 11

Geophysical methods, 180

Geotechnical Baseline Report (GBR), 593–594

Geotechnical Design Summary Report (GDSR), 594

Geotechnical engineering, bibliography, 620

Geotextiles, usage, 262

Glacial lakes, 15–16

Glacial outwash, 15

Glacial till, 15

Glaciers, 14–16

Go devils, usage, 389

Graded filters, usage, 291

Gradient correction, 310

Granular activated carbon (GAC) adsorption, 544
effectiveness, 227–228

Granular soils
gravity drainage, 43–44
hydraulic conductivity, 164
determination methods, availability, 178–179

granularity, 164

stand-up time, limitation, 507

Gravel
usage, 262
visual/manual classification, 40–41

Gravel bed, placement, 264

Gravel bedding, 261–262

Gravel tremie, 82–83

Gravimetric studies, usage, 180

Grid system design, 235

Ground
behavior, 495–497
fracturing potential, 444
movement potential, artificial freezing (impact), 534–537
penetrametry, 412–415
penetration, difficulty, 318–319
permeabilities, variation, 414–415
support, methods (proposals), 247

Ground freezing, 508
applications, 509–515
connections, providing, 512
design, 533–534
groundwater movement, impact, 534
history, 511

intent, 518
methods/equipment, 515–528
pipe installation/deviation, 521–522
principles, 508–509
soils, relationship, 528–533
theory/application, simplicity (deception), 509

Ground penetrating radar (GPR), 455
Ground Zero slurry wall stabilization, case history, 277–278

Groundwater
adjacent supplies, protection, 183
analysis, 215–216
bacteriology, 195
bibliography, 620
body
  long-term changes, 181–182
  structures, permanent effects, 181–182
chemical testing, 180
chemist knowledge, 216
chemistry, 153, 195
  impact, 374
conductive electrolyte, action, 196
collection considerations, 3
  previous experience, 154
contamination, 153
  impact, 374
control, formulations, 449
control method
  combination, 253–258
  selection, 247
cutoff structures, 358
dispute, 585
equilibrium, disturbance, 199
  exclusion, 247
field testing, 208–209
flow, vertical component, 170
gradient, reduction, 484
levels / gradients, 153
measurement / monitoring, piezometers (usage), 111
models, program selection, 91
movement, project summary, 535–536
pressure differential, 414
quality, ejectors (relationship), 345, 349
  supplies, problems, 182
testing, 208–209
treatment
  costs, 231
  elements, 226–229
  requirement, 208
  system designer, construction activity knowledge, 232
velocities, 205–206
Groundwater control-permeability testing, verification, 456
Groundwater / vapor extraction / treatment, project summary, 573–574
Grout
  additives, advances, 465
  behavior, 464
delivery systems, types, 469
durability / permanence, 416–417
environmentally compatibility, 417
flow properties, bleed / pressure filtration characteristics, 464
flow rate / stage, plots, 471
injection, 469–470
  performing, open-ended / perforated pipes (usage), 482
  ratio, 402
materials, 412–415
mixes, pressure filtration characteristics, 471
mixing, 469
  requirements, 434–435
particle size, decrease, 427
pipes, installation, 487
predetermined amounts, injection, 435–436
pump, usage, 469
quality control, 471
seal, usage, 547
stability, 416
  stability / bleed, difference, 471
volume, 400
Grout holes
  drilling, 467–468
  patterns, 465–467
  requirement, 466–467
  water testing, 468–469
Groutability ratio (GR), 426, 463
Grouted ground, triple-barrel coring, 438
Grouted soil, strength, 448–449
Grouted zone, geometry (determination), 432–433
Grouting
  bibliographies, 620
  ground treatment, providing, 414
  materials / mixes, 463–465
  methods, 410, 465–471
  monitoring / control technology, 470–471
  plan development, 476, 479
  success, 481
  process, monitoring, 480
  program, implementation, 519
  test section, performing, 439
  verification, geophysical methods (usage), 438–439
  Guar gum-based drilling fluid, avoidance, 206
Gypsum stack embankments, heat boils (grouting / pressure relief usage combination)
case history, 486–488
  project example, 486–488
Hammer grabs, 394
Hand mining, 494
Hand-erected supporters, usage, 492
Hardness, presence, 225–226
Hazen Williams formula, 597
Head, total loss, 78
Head loss / leakage, 364
Head ratio (R_h), calculation, 340–342
Heat load, groundwater movement (impact), 534
Herbicides, contaminants, 222
Heterogeneous anisotropic conditions, 170
Heterogeneous soils, wellpoint spacing, 313
Heterotrophic plate count (HRC), 216
High hydraulic conductivity, backoff (sealing), 411
High permeability zones, delineation, 468–469
High-capacity wellpoints, availability, 311
High-density polyethylene (HDPE), 238, 240–241
  coefficient of thermal expansion / contraction, 240
  pipe diameters, 597–602
  piping, 239
usage, 283, 353
High-end grouting practice, 471
High-frequency / variable-moment vibratory hammers, availability, 360
Highly organic soils, classification, 39
High-pressure jetting, usage, 379
High-torque continuous flight augers, usage, 394–395
Hillview Reservoir
  case history, 346–348
  dewatering system, usage, 347
  ejector system construction, 347
Historical fills, 517, 520
Historical maps, usage, 154
H-O-A switch, automatic position, 563
Hoisting equipment, impact, 270
Holepuncher
effectiveness, 318
usage, 318
Hollow stem augers (HSAs), 155
Hollow stem augers (Continued)
direct contact, 158
usage, 279
Homogeneous ground conditions, wellpoint installation, 317
Horizontal directionally drilled (HDD) wells, 349–355
equipment, 349, 351
installation techniques, 351–353
installation techniques/equipment, 349
materials, 353–355
Horizontal drains, contaminant recovery, 231
Horizontal peripheral freezes, 511–512
Horizontal Tunnel Freeze (Syracuse, New York), case history, 513–514
Horizontal variability, 64
Horizontal wellpoints, 265–266
usage, 266
Horizontal wells
contaminant recovery, 231
development, 353
Horizontal wellscreens
permanence, ability, 354–355
robustness, increase, 353
Horizontal-Flow Barrier (HFB), 93
Hydraulic conductivity ($K$), 29–35, 71–72
evaluation, borehole seepage tests (usage), 169–178
suggestion, 280
units, 30
Hydraulic gradient ($h/L$), 30
Hydraulic submersible pumps, 185
Hydrochloric acid (HCl), usage, 210
Hydrofracturing, 437
Hydrogen sulfide
collection, 195, 208
gas, production, 197
nondesirability, 222–223
occurrence, 197
treatment, 230
Hydrographs, form, 142
Hydrologic cycle, groundwater (relationship), 3–6
Hydrophilic urethanes, 476
hydrophobic urethanes, contrast, 477–478
Hydrophobic urethanes, 476
Hyperbaric medicine, 505
Impermeable clay, aquiclude, 63
Impermeable layer (dewatering), wellpoint spacing (usage), 313–315
Impermeable stratum, encounter, 317
In situ test methods, 164–167
Incrustation, 198–199
dissolving, acids (usage), 210
field analysis, 209
potential, 206–207
remediation, 210
Initial head ($H$), 72
Injection ports, distance, 479
Injection system, wellpoint system (usage), 233
Inner drawdown tube, usage, 310
Inorganic reactants, usage, 418
Intact sheet piling, head loss/leakage, 364
Interface problems, 314
Interior wells, addition, 255–256
Interlock leakage
importance, 362–364
sealants, application, 363–364
Intermediate clay layer, water entry, 263
Internally regulated generators, 565
Iron
fouling, degree, 207
precipitation, 206
presence, 225–226
Iron bacteria, 202–204
growth, 203–204
quantity/presence, 204
Iron-fixing bacteria, 202
Iron-oxidizing bacteria, 202
Irregular boundaries, 89
Isolation valve, recommendation, 297
Jacob distance-drawdown plot, 129–130
Jacob nonequilibrium formula, 68
Jet grout columns
achievement, 441
topping off, 451
Jet grout wall, effectiveness, 454
Jet grouting, 439–456
applications, 440
column diameter, variation, 446
construction considerations, 449, 451
design
considerations, 445–452
process, 446
equipment, 441–442
jetting, axis (variations), 446
mixing/batching equipment, 441
operational parameters, 443–444
process, 444–445
work sequence, 444–445
soil suitability, 440–441
strength requirements, verification, 455–456
systems, 442–444
verification, 452–456
Jetting, high-energy development method, 295295
Jetting pumps, 189, 267–268
Joint sealants, importance, 360–362
Kettle, 15
Laboratory analysis, example, 216–221
Laboratory test data, 74
Lagging, installation, 315
Lakes
characteristics/description, 12–13
surface hydrology, 141
Lamellas, usage, 445
Laminar flow, presumption, 30
Langelier Saturation Index, 216
Large circular open excavations, 511
Large-diameter borings, 163–164
Large-diameter open-face shield-driven tunnels, 491–492
Large-diameter slurry tunneling systems, usage, 500
Lateral seepage, problem, 261
Leak, nondesirability, 223
Leaking utility, 264
problem, 264–265
recharge, 498
Lenox Avenue Subway, water infiltration, 453
Lenox Avenue Subway Reconstruction Project
case history, 332–334
collection, schedule, tightness, 334
dewatering conditions, difficulty, 333
free-draining sands, usage, 333
geotechnical study, 332
hydrogeological study, 332
project alignment, 333
replacement work, 334
wellpoint system, suction limitations, 333
Lens (permeable gravel), usage, 264
Leptothrix, 203
Levee Floodgate construction project, case history, 302
Light acid treatments, 206
Light non-aqueous phase liquids (LNAPLs), 222
Limestone, 17–19
NATM tunnels, 552
Line source, 64
Liquid nitrogen (LN2) freezing, 516, 521
Liquid ring vacuum pump, 190, 192
Local model, 110
Lock and Dam 26
project background, 146
monitoring, 147
system load variation, quantification, 147
Loess, 14
Long term hydraulic barrier, case history, 576
Long-term dewatering systems, 572
instrumentation/controls, 575–576
maintenance, access, 572, 574–575
methods, 572
procedures, 575–576
types, 572
wellpoints, usage, 574
Louered wellscreens, manufacture, 284–285
Low-capacity pumped wells, contaminant recovery, 231
Low-capacity wells, systems, 304–306
Lowered wellscreens, 284–285
Low-flow wells, problems, 305
Low-yield deep wells, continuous pumping, 305
Low-yield wells, testing, 137–138
Magnetic contactor, usage, 562
Manganese, presence, 200
Man-made contaminants, list, 222
Man-made ground, 19–21
Man-made water sources, grouting, 475
Man-placed water sources, grouting, 475
Mass freezing, 512, 514
Mass-transfer packing, 228
Mathematical models, 85
Maximum aquifer penetration, case history, 281–282
Meadow mat, 14
Mechanical packers
placement, 479–480
usage, 479
Medium-diameter shield-driven tunneling/pipe jacking, 492–494
Membrane filter index (MFI), 542
Metal wellscreens (failure), corrosion (impact), 304
Metals, contaminants, 222
Methane, non-desirability, 223
Method of fragments, 79–80
Microfine cement grouts, 428
Microtunneling, 502–504
Mineral acid, quantity, 211
Mineral incrustation, 198
results, 199–200
treatment, 210
Minimum aquifer penetration, case history, 281–282
Mix water, quality, 272
Mixed aquifer, well (inclusion) radial flow, 69
Mixed media, filtration (usage), 227
Mixed-face ground conditions, 497
Mixing shafts, rotation, 399
Mixing tools, verticality, 404
Model
calibration, 97–98
design/application, steps, 90
Modeling
problems, 95
program selection, model design step, 90
MODFLOW
features, 93–94
introduction, 91–94
model input/construction, 91–92
simulation capabilities, 91
solution/model output, 92–93
MODFLOW-SURFACT, 93
MODPATH, 93–94
Motor controls, 561–564
component malfunction, problem, 563
problems, 563
Moyno pumps, 469
Mud pump capacity, 270
Mud rotary method, 270–271
Multi-Node Well (MNW), 93
Multiple-shaft mixing systems, 401–402
Multistage wellpoint systems, 310
long wellpoints, usage (case history), 314
Murray Hydro Station, case history, 255–257
National Electric Code (NEC), mandates, 566
Natural aquifer
characteristics, 61
equivalent isotropic transmissivity, 53
Natural ground, piping paths/flow channels, 483–489
Natural groundwater gradient, 232
Natural polymers, chemical modification, 274
Natural soil, retention (percentage), 286
NAVFAC DM-7 recommendations, 366
Neat cement grout
formulation problems, 464
usage, 473
Need/purpose, definition (model design step), 90
Negative skin friction, 47
Net positive suction head (NPSH), 327
New Austrian Tunneling Method (NATM), 491
tunneling methods, application (increase), 524, 528
New York City Water Tunnel Number 3 (Shaft 298), moving
groundwater (project summary), 535
Noncontaminated areas, flow reduction, 232
Non-ionic polymers, usage, 226
Nonplastic silt, flyash (comparison), 329–330
Non-recirculated clean water, usage, 268
Non-slam type water hammer, valves (checking), 244
Non-steady state analyses, 89–90
Non-steady state programs, 91
Nozzles
design, 340–344
diameter (d), calculation, 343–344
Numerical groundwater models, usage, 66
Numerical modeling, consideration, 103–104
Numerical models, 85–86
consideration, 87–90
Observation wells, 167–169
installation, primary objective, 168
Ocean beaches, surface hydrology, 141
Odex, usage, 275
Oil/water separation, recommendation, 226
Once-through freshwater supply, 207
Onsite personnel, health/safety procedures, 162
Open borehole drilling techniques, 271
Open cell matrix, 477
Open drip proof (ODP), 557
Open pumping, 259
  predrainage, contrast, 247–250
  problems, 249–250
  proceeding, decision, 248
Open pumping process, 247
Open-ended grout pipes, installation, 484
Operating level, measurement (means), 298
Ordinary piezometers, 111–113
Ordinary Portland cement
  grout, 426–428
  usage, 402
Organic reactants, usage, 418
Organic silts, 11–12
Organic soils, 22
Organic waste, contaminants, 222
Ostionera, 18
Overexcavating, procedure, 405
Overload relays, usage, 562
Overpumpage factor, 433
Owner-designed dewatering systems, 586
Oxides of metals, formation, 200
Packer tests, advantage, 177
Panel driving, preference, 359
Panels, usage, 445
Parametric analyses, 95
  model design step, 90
Partial penetration, 72–73, 90, 98–101
  usage, 48
Partially full level pipe, 603
Partially hydrolyzed polyacrylamide (PHPA), usage, 272
Particulate grouts, 426
Peat, 11–12
Penetrations, dewatering, 505–507
Penn Forest Dam, case history, 473
Percent silicate grout, 417
Perched aquifer, 153
Perched water layers, encounter, 312
Perched water table, 5
Percussion, usage, 274
Peripheral freezes, 509–512
  formation, 510
  quality control, 525–527
Permeability reduction, achievement, 415
Permeation grouting, 264, 410–439
  application, 410
  methods, 432–436
  effectiveness, 411–412
  usage, 410–411
  verification, 436
  methods, 436–439
Permeation grouting/dewatering combination, case history, 423–425
Permeation grouts, properties, 415–417
Permeation-grouted soil, strength, 416
Permitting process, 237
Pesticides, contaminants, 222
Petroleum products, contaminants, 222
  pH, 208
  adjustment, necessity, 226
  change, 208
  measurement, 201
Phosphoric acid, 210–211
Phreatic surface, 5
Pick-up points, 232
Piezocone dissipation tests, 177–178
  components, 177–178
Piezometers
  additions, 207
  arrays, 125–126
  construction, 113–115, 167–168
  data, obtaining, 115–117
  geotechnical program installation, 168–169
  installation, 525
  direct push technologies, 118–120
  primary objective, 168
  performance, verification, 115
  usage, 167–169
  location, 169
Piezometric monitoring, 448
Pilot pipe technique, 504
Pipe jacking, 492–494
  construction shafts, requirement, 494
  operation, dewatering requirements, 494
Piping channels, 43
Piping paths, grouting, 475
Piping systems, 238
Piston pumps, usage, 441–442
Plasticity index (Iw), 35
Pleistocene epoch, 14–16
Postgrouting, 471
  difficulty, 474
  fragility, 239
  usage, 198
  wellscreens, fragility, 303
Pool stage, 143–144
Poorly-graded soil, 23
Porosity, 26
Postgrouting, 471
  difficulty, 474
Porous rock, fractured tests, 174
Power factor, 564
Polyethylene rope suspension cable, fastening, 298
Polymer drilling fluids
  heaviness, 272
  usage, 206
Polymer slurries, usage, 386–387
Polymeric drilling fluid additive, usefulness, 271
Polypropylene rope suspension cable, fastening, 298
Polypropelene rope suspension cable, fastening, 298
Polyurethane grouts
  expansion rate, 477
  rigid/flexible foams, contrast, 477
  systems, components (counting confusion), 477
Polyurethanes, hydrophilic/hydrophobic materials, 476
Polyvinyl chloride (PVC), 238–239
  coefficient of thermal expansion/contraction, 240
Polyvinyl chloride (PVC), 238–239
  coefficient of thermal expansion/contraction, 240
  fragility, 239
  usage, 198
  wellscreens, fragility, 303
Pore pressure
  control, 44–46
  relief, 252
Porosity, 26
Pore pressure
  control, 44–46
  relief, 252
Potable water, contact, 478
Practical vacuum, 308
Precipitation, 144–145
data/topography, 153
Preconsolidation, 48–50
Prediction analyses, 95
model design step, 90
Predrainage, 247
methods, 250–253
open pumping, supplementation, 253, 257
Predrained water level, impact, 262
Predrilling, effectiveness, 268
Prepacked wellscreens, 285
Pressure balance tunnel machines, 500–502
Pressure-gauge connection, recommendation, 299
Pressure relief wells, 300
Pressure-meter Test (PMT), 164
Pressurized face tunnel machines, 500–502
Progressive trench excavation
model prediction, 105
transient analysis, 102–105
Proximate boundaries, 89
Prugh method, 290
Pseudomonas, 204
Pulldown, impact, 270
Pumping
decision/dilemma, 247
equipment, vacuum, 307–308
rate, 128
systems, installation, 572
well
accessibility, 574
design, 122–125
Pumping tests, 121, 448
admissibility, 121–122
analysis, model requirement, 102
data, 74
analysis, 129–132
initiation, 133
modeling, order, 101–102
monitoring, 128–129
planning, 122
usage, 181
Pumps
failure, cause, 305
NPSH requirement, meeting, 327
options, consideration, 225
performance curves, 189–190
removal, 211, 212
sizing, 297–298
testing, 193–194
type, 185
types, usage, 185–189
warranty (voiding), sand content (presence), 300–301
Quicksand, 42
Radioactive salts, contaminants, 222
Radius of influence ($R_0$), 64–65, 66, 71
Rainfall
quantity, pumping, 260–261
steadiness, 144
Real systems, analyses, 336
Real-time borehole locating/survey system, necessity, 352
Recharge
applications, 539–540
man-made source, problems, 482–483
operations, permits, 550, 554
pilot test program, usage, 541
piping systems, 548–549
results, 170
wellpoint systems, 548
wells, 546–548
Recharge boundaries, 64–65
impact, 130–131
Recharge systems
construction, 545–549
effectiveness/performance, instrumentation (requirement), 541
operation/maintenance, 550
Recharge water
chlorination, 545
problems, 541–543
sources, 543–544
treatment, 544–545
Recharge wells
filter sand, impact, 550
location, case history, 548
Recharge wells, plugging, 541–543
air/gas entrainment, impact, 543
calculator for dissolved gases, 544–545
treatment, 544–545
Recharge wells
air/gas entrainment, impact, 543
dissolved gases, 544–545
recirculation bypass valve, convenience, 297
Recovery
calculations, 56–57
duration, 126–128
Rectangular suppressed weir, 605
Refrigeration plant, capacity, 516
Reinfiltration, 145, 149–150
Reinforced shoes, usage, 359
Reinjection, 233–234
Relative density, 26–27
Remote sensing, usage, 153–154
Reservoirs, surface hydrology, 141
Resistance temperature detectors (RTDs), 525
Reverse circulation method
costs/difficulties, 274
water head dependence, 271, 274
Reverse circulation rotary drilling, 271, 274
Revert, usage, 271–272
Risk allocation, 584
common law rule, 589
Rivers
characteristics/description, 12
surface hydrology, 141–144
Rock, 16–17
cores, obtaining, 160–161
coring, 160–161
flour, 497
groundwater flow, control, 161
jointing/fracture orientation, 466
packer tests, 174–177
strata, hydraulic conductivity, 153
very high-flow solution channels/fractures, grouting, 484
water testing, 468
Rock curtain grouting, 456, 461–474
grouting materials/mixes, 463–465
grouting methods, 465–471
tunnel grouting, 471–474
Rock grouting
equipment, 469
groove, 559
holes, drilling, 467–468
performing, 466
Rock quality designation (RQD), 161
Rotary drilling
  circulating fluid, usage, 270–271
  groundwater level, masking, 158–159
  suitability, 156
Rotary rigs, holes (drilling ability), 270
Rotosonic drill (sonicore), 156–157
Ryznar Stability Index, 216
Saline groundwater
  conditions, freezing, 530–531
  presence, 531
Salts, occurrence, 197–198
Samples
  laboratory analysis, 178–180
  preservation, 164
Sandbags, usage, 262
Sand-free, term (usage), 303
Sands
  behavior, 529–530
  deposit, particle sizes (considerations), 496
  drains, 252
  filtration, usage, 227
  movement
    designer specification, 303
    measurement, problems, 303
  pumping
    conditions, 303
    wells, usage, 300–304
  visual/manual classification, 40–41
Sanitary seal, recommendation, 299
Screen entrance velocity ($V_s$)
  minimization, 207
  safe values, selection, 280
Secant pile wall method, 390–398
  advantages/limitations, 398
  concrete mix design, 395–396
  construction
    consideration, 397–398
    sequence, 390, 393
    types, usage, 393
    equipment/plant, 393–395
    guide walls, necessity, 397
    quality control, 397–398
    soil applicability/depth, 396–397
Secant piles
  construction, auger methods (usage), 397–398
  suitability, 396–397
  vertical alignment, importance, 397
Secondary permeability, 16
Seepage forces, 42–43
Segmented linings, 501–502
Seismic methods, usage, 180
Self-destroying additives, 269
Self-hardening slurries, 374–375
Self-jetting wellpoint, 310
  screens, fabrication, 310–311
  suitability, 318
Semi-volatile organic compounds (S-VOCs), 222
Sequential excavation method (NATM) tunneling, 491
Sequentially excavated tunnels (SEMs), 504
Service installation charge, 571
Set time, 415–416
Settlement
  control, recharge (case history), 553–554
  dewatering, impact, 46–48
  effective stress, impact, 182
  risk, doubt, 182
Settling/clarification, usage, 226–227
Sewers, usage, 150
Shafs
  construction, ground freezing, 510–511
  dewatering, 505–506
Shallow applications, slotted screens (HDPE usage), 283
Shallow aquifers, wellpoint systems (suitability), 250–251
Shallow excavation, clay/rock penetration, 257
Shallow penetrating recharge trenches, effectiveness, 546
Shield-driven tunnels, 497
Shock chlorination, 214
Short circuit, protection, 362
Short vertical sheeting, 264
Short-flight augers, 279
Short-screen wellpoints, availability, 311–312
Shrouds, installation (avoidance), 206
Silica fume, 465
Silt density index (SDI), 542
Silts
  plasticity/cohesion, 35
  visual/manual classification, 41–42
Silty clays, 11–12
Silty sands, 40–41
  aquitard, 63
  plasticity, 41
Single wellpoint systems, 310
Single-fluid jet grouting, usage, 442
Single-pipe ejectors, 336–338
  alternative, 337
Single-shaft mixing equipment, usage, 399
Single-shaft mixing systems, 401–402
Site conditions, differences, 588–595
Site reconnaissance, 154
Sixty-third Street Connector
  case history, 456–461
  deep bottom seals, 460
  design test program, 456–457
  implementation, 458–459
  jet grouting, 460
  permeation grouting, 460
  quality assurance/control, 459
  test cell center, excavation, 457
Sleeve port pipe, 433
Slime-forming bacteria, 204
Slip-type couplings, strapping, 244
Slope stability, problems, 259
Slope stabilization, sandbags/gravel/geotextiles (usage), 262
Slotted PVC wellscreens, spacing, 283
Slug tests, 172–173
  advantage, 173
Slurry
  loss, occurrence, 381
  microtunneling systems, 504
  mixing, 372
  quality, monitoring, 377, 388
Slurry diaphragm panel
  concrete, usage, 383–384
  excavation, 382–383
  continuousness, 387–388
  verticality/alignment, examination, 388
  joints, 389
  sounding, 388–389
  stability, maintenance, 382
Slurry diaphragm walls, 379–390
advantages / limitations, 390
cleaning, 383
cement mix design, 387
construction, 382–384
considerations, 387–390
continuation, 384
innovations, 385–386
tools, development, 385
equipment / plant, 384–387
quality control, 387–390
soils, applicability / depth, 387
Slurry mixing equipment / plant, similarity, 386
Slurry trenches, 367–379
advantages / limitations, 378–379
construction, 368–371
considerations, 375–378
self-hardening slurries, usage, 371
similarity, 388
equipment / plant, 371–372
quality control, 375–378
S-B backfill, usage, 368
suitability, 369
Slurry tunneling systems, 500
Small-diameter shield-driven tunneling / pipe jacking, 492–494
Smaller-diameter wells, advancement, 275
Sodium aluminate, usage, 226
Sodium silicate, combination, 418–419
Sodium silicate grouts, 417–422
formulation, 421–422
gel times, 419–422
longevity, 421
syneresis, 520
two-part mix, 418
viscosity, 417–418
Sodium silicate–ground soil
hydraulic conductivity, reduction (achievement), 420
strength, 421
Soft ground tunneling
groundwater control, 491
methods, dewatering (usage), 491–495
Soil cutters, monitoring / adjustment, 386
Soil–based backfills, 367
mix design / properties, 372–374
Soil–bentonite (S–B), 367
trench, soil mixture, 369–371
Soil–bentonite (S–B) backfill
compressibility / strength, 373
hydraulic conductivity, 370–371, 373
mixing, 372
Soil-cement geometries, 445
Soil-cement mixtures, compressive strength, 403
Soil-cement product, design geometry variation, 446
Soil-cement walls, hydraulic conductivity, 402–403
Soil-cement–bentonite (S–C–B), 367
backfill
mixtures, components, 373–374
placement, 371
trench, construction, 371
Soils, 22
borehole seepage tests, usage, 169–172
borehole testing, 172
characteristics
evaluation, 497
Heuer’s list, 495–496
conditions, 259
cuttings, containment / disposal, 161
density / uniformity, 31
descriptions, 39–40
details, 163
dry unit weight, 27
effective pore size, 31
flow channels, occurrence, 483
formation, 11
geologic seals, 510
geology, 10
gradation, 22–26
range, 288
groutability, 413
hydraulic conductivity, 153, 414
initial hydraulic conductivity, 413
jet grouting, suitability, 440–441
low hydraulic conductivity, 499–500
dewatering, 304–305
mineral composition, 11–12
movement problem, cause, 302
penetration method, 399
piping paths, occurrence, 483
removal, 46
samples, recovery, 178
sampling, 159–160
stabilization, ejectors (relationship), 349
steel sheet piling, depth, 364–365
stratification, 31, 33, 421
stress, 42–43
structure, 22
surveys, 153
thermal properties, 529
variability, 421, 505
visual / manual classification, 40–42
yield, 288
Soil-to-grout particle sizes, ratio, 426
Soldier pile tremie concrete (SPTC) wall, 384, 389
Soldier piles, standup time, 263–264
Solution cavity, high flow, 484, 489
Solutions grouts, 417–432
Solvents, contaminants, 222
Sonic drill, 156–157
equipment, usage, 519
Sonic drilling, 276, 278–279
accomplishment, 278
advantages, 278–279
variations, availability, 278
Specialty dewatering subcontractor quotations, 581–583
Specific capacity (q_s), 58–60
Specific gravity, 26–27
Specific retention, 27–29
Specific yield, 27–29, 53, 55
Sphaerotilus, 203
Split-spoon sampler, usage frequency, 160
Soil examination, 376–377
return, 444
Stagnant water, iron presence, 208
Stainless steel
corrosion, resistance, 198
corrosive groundwater attack, 198
Stainless steel rope suspension cable, fastening, 298
Standard Penetration Test (SPT), 164
Standup time, 263–264
injection, permeation grouting (usage), 264
Starter tunnels, dewatering, 505–507
Steady state programs, 91
Steel casing / drilling mud, 155–156
Steel piping, 238
Steel screens, assembly, 284
Steel sheet pile
- cofferdam
  - design, 365–366
  - open pumping risk, 366
  - installation, 359–360
- types / properties, 360–362
Steel sheet piling, 358–367
- advantages / limitations, 367
- design considerations / quality control, 365–367
- equipment, 359–360
Steel sheeting
- availability, 360, 362
- nonrecommendations, 364
Step drawdown tests, 136–137
Stepped Lugeon testing, 468
Storage
- delayed release, 65
- depletion, 73–75
- storage coefficient \((C)\), 53, 55
Storebaelt (Great Belt) Link Railway, case history, 502–503
Stratification, 31, 33
Stratified aquifers, 88
  - proposed tunnel
    - conceptual model, 107–108
    - feasibility (3D model), 106–110
    - local model, dewatering simulation, 108–110
Stratified soil structure, impact, 330–331
Stratified soils, 61–63
- problems, 288
- strong acids, hazards, 211
- structures, grouting, 474–489
Submerged unit weight, 27
Submergence, 192
  - ratio, 192
Submersible electric pump, lifespan / recommendation, 298
Submersible pump, low-flow-protection (providing), 305–306
Subsurface conditions, 111
Subsurface stratigraphy, 152
Suction head, measurement (impracticability), 189
Suction lifts, 307–310
Suction piping, size importance, 321
Suction wells, 251, 311
Sulfamic acid, 210
Sulfate-reducing bacteria, 204–205
Sumps, 259
- characteristics, 260
- cleaning / maintenance, 260
- construction, 260–261
- nonusage, 206
- size, determination, 260
- waterflow, 260
Super plasticizer, 465
Superposition, 76–77
Surface hydrology, 141
Surface water, nonusage, 544
Surfactants, introduction, 210
Surge arrestor valve, installation, 244
Surge block, usage, 295
Suspended solids
- presence, 225–226
- problems, 541–542
Suspension grouts, 426
Swab, usage, 295
Swing connection, importance, 312–313
Switchgear systems, 566–570
System load variation, quantification, 147
Tectonic movements, 19
Tensiometer, usage, 44
Terminal moraine, 15
Terminating tunnels, predrainage, 506
Terraces, 12
Test pits, 163–164
Theoretical vacuum, 307–308
Thermal conductivity, measurement, 529
Thermography
  - data, problems, 180
  - usage, 180
Thermoplastic insulated cables, value, 566
Thermoset rubber, value, 566
Third-party damage, dewatering (impact), 587–588
Thixotropic set time testing, results, 471
Three-dimensional (3-D) model, 102–105
  - partial penetration, 98–101
  - vertical flow, 101–102
Three-dimensional (3-D) programs, 91
Throttle valve, recommendation, 297
Throttling valves, installation, 207
Tidal corrections, 132–134
Time-drawdown plot, 131
Topographic maps, usage, 154
Torrential rains, occurrence, 143
Total dissolved solids (TDS), 195
Total dynamic head (TDH), 189
Total petroleum hydrocarbons (TPHs), 222
Total refrigeration load, elements, 516
Totally enclosed fan-cooled (TEFC) construction, 557
Track-mounted drill rigs, fixed leads, 393–394
Trajectory method, 603–604
Transient analyses, 89–90
Transit system reconstruction project, case history, 124
Transmissivity \((T)\), 53, 71–72
Transportation process, 11
Traveling hammerhead mill, usage, 381
Treat options, consideration, 225
Treatment tanks, intermittent pressure relief, 572
Trees (urban parks), concern, 183
Tremie seals, 405–408
Trench bottom, examination, 381
Trench cutters, 385
Trench drains
  - disadvantages, 357
  - pumping, 357
Trench excavation
  - continuousness, 375
  - model grid / simulation, 105
Trench walls, sloughing (prevention), 377
Trench work, wellpoint systems (usage), 331–335
Trenched-in drain installation, advantages, 357
Trencher drains, 355–357
Trenchers, capability, 356
Trenching machines, mounting, 355–356
Triangular spacings, usage, 460
Tributaries, 12
Trolley lifting system, 425
Trip circuit breaker, problem, 563
Tripped overload relay, problem, 563
True piezometers, 111–113
True power, supply, 564
Tube a manchette (TAM)
- grout pipes, 460
- pipe, 433–434
Tubex, usage, 275
Tunnel boring machine (TBM), 491
Tunneling machine, launching/retrieval, 506
Tunneling techniques, built-in groundwater control (usage), 500–504
Tunnels
- dewatering design, 497–499
- excavation, 512
- grouting, 471–474
- linings, 494–495
- predrainage, methods, 499–500
- support, horizontal jet grouting (usage), 442
Turbine submersible pumps, 185, 187, 556
Two-dimensional (2-D) model, 95–97
Two-dimensional (2-D) programs, 91
Two-pipe ejectors, 336–338
- simplicity, 338
Type N grout, 417

Ultrafine cement, usage, 419
Ultrafine cement grouts, 428–432
- bentonite, addition (avoidance), 429–430
- injection flow rate, monitoring, 436
- particle size, maximum, 429
- permeability, increase, 429
- problems, 430
- set time, factors, 430
- thickening comparison, 430
Ultrafine cement-grouted ground, 430
Unconfined aquifer, 57–58, 153
Underground Technology Research Council (UTRC), Technical Committee on Contracting Practices, 585
Underwaterable ground, fracture grouting (case history), 437–438
Undisturbed sampling, usefulness, 160
Unified soil classification system (USCS) (ASTM D-2487), 35–39
Uniform soil, 23
Unit weight, 26–27
Unsaturated flow, 27
Unsaturated soils, freezing, 531–532
Unstratified sands, trench excavation (dewatering problems), 335
Untreated timber piles, 183
Upstage grouting, 469
Utility maps, usage, 154

Vacuum, presence (nonrecommendation), 300
Vacuum pumps, 190–192
Vacuum wellpoints, 45
Vacuum wells, 252, 300
Vane Shear Test (VST), 164
Variable frequency drives (VFDs), 558–561
- advantages, 560–561
Variable limestone investigation, packer testing usage (case history), 179
Varved silt, behavior, 497
Varved soil structure, impact, 330–331
Varved structured, creation, 13
Velocity head, inclusion, 241
Venturis
- design, 340–344
- diameter ($d$), calculation, 343–344
Verification, 94
- model design step, 90
Vertical drains
- consideration, 45
- effectiveness, 252

Vertical flow, 81–82, 89, 101–102
Vertical gradients, case history, 170
Vertical hollowshaft motor, 557
Vertical lineshaft pumps, 187
- usage, 187
Vertical pipes, 604–605
Vertical sheeting, 264
Vertical wellpoint pumps, 326–328
- casing, 328
- convenience, 328
- variation, 328
Very low-density polyethylene (VLDPE) membrane, placement, 381
Vibrated beam method, 379
Viscosity, 415
- measurement, 478
- modifier, 465
- V-notch weir, 605
Void ratio, 26
Volatile organic compounds (VOCs), 222, 544
- variety, 573
Volatile river
- groundwater cutoff, case history, 406–407
- interaction, 142–143

Wash boring, 158
Wash rotary drilling, 155
Water, 22
- conditions, 259
- content, 26
- existing structure origin, 150–151
- flow
  - friction losses, 597–602
  - measurement, 603–619
  - trajectory method, 603–604
- hammer, 243–244
- damaging effects, 244
- head, variation, 505
- leaks, grouting, 474–476
- levels, stabilization (time length), 159
- main source, chlorine testing (inadvisability), 265
- quality, 150
  - analysis, inorganic parameters, 215
  - quantity (estimation), treatment, 225
- samples, obtaining, 216
- source
  - introduction, 481–483
  - source, identification, 475
Water horsepower (WHP), 189
Water supply
- aquifer, long-term harm, 50
- records, 153
- yield, temporary reduction, 50
Water table
- decrease, 303
- distance plots, 138
- lowering, 572
Water table aquifer, 5, 57–58
- complexity, 136
- transmissivity, 144
- well (inclusion), radial flow, 68–69
Water to cement ratio, 465
Water treatment
- analysis/control report, 217–221
- considerations, 221
- recommendations, 219–221
Water volume
acceptance, 495
impact, 262
removal, 497
Watertight watertubs, 510
Weak soils, presence (geology, usage), 182
Wedge shapes, usage, 445
Well construction
details, 295–299
illustration, 297
methods, 267–279
testing, 267
Well development, 291–295
air surging/air lift pumping, alternation, 295
chemical additives, usage, 293
mechanical process, 293
types, 294–295
pump, usage, 294–295
repetition, 293
Wellheads
construction, 206
fittings, construction, 206
Wellpoint dewatering, jet grout diaphragm wall usage (case history), 453–455
Wellpoint header lines
arrangement/location, 322
losses, 241–243
sizing, 321–322
Wellpoint pumps, 187
arrangement/location, 322
components, 307
usage, 321–322
vacuum unit, mechanism, 192
Wellpoint systems, 250, 307
active systems, length, 332–333
capability, 302
contaminant recovery, 231
improvement, 251
length, 331–333
multiphase contaminants, 232–233
suitability, 250–251
tuning, 323–326
anticipation, 325–326
usage, 233
Wellpoints
close spacing, case history, 318
depth, 315–317
design, 310–313
discharge, arrangement/location, 322
double row, simulation, 105
headers, usage, 321–322
installation, 307, 312, 318–320
spacing, 313–315
flow considerations, 313
usage, 313
usage, 314
vacuum, impact, 575
Wells
acid treatment, 210
acidization process, 211–212
addition, providing, 267
agitation, 212
anodic/cathodic areas, 195
borehole edge, groundwater velocities, 205–206
capacity ($Q_w$), 77–79
chlorination procedure, suggestions, 214–215
diameter/yield, contrast, 299
disinfection, chlorine treatment, 212–214
fouling, field evaluation, 208–209
holding capacity, 306
hydraulic conductivity, 78–79
installations, 255
methods, 267–279
intermittent flow, impact, 294
length ($l_w$), 77–78
location, 498
loss, 134–136
wellscreen design/diameter, impact, 279
maintenance, 209–215
events, frequency (determination), 209–210
manifolding, 241
operating levels, increase, 208
overnight standing, 212
penetration, drawdown, 303–304
plugging, problems, 541–543
problems, incrustation (impact), 199
pumps, static discharge head, 189
radial flow, 66–69
radius ($r_w$), 78
rehabilitation, 209–215
degrees, 209
surging, 212
process, development, 291
system, 70–71
treatment
acids, 210–211
chemicals, circulation, 209
usage, 252
yields, decrease, 208
Wellscreens, 279–285
availability, 279–280
design/diameter, impact, 279
material, sizing, 299
screen openings, actual velocity, 280
selection, 296, 546
criteria, 280
usage, 207
water/air jets, application, 295
Wet samples, unconfined compressive strength testing, 448
Wetlands
concern, 183
ecology, disruption, 50–51
Wetted screen, length, 137
Wide-open joints/cracks, sealing, 480
Wind deposits, 14
Wire mesh wellscreens, 285
Wood lagging, standup time, 263–264
Workmen’s Compensation Insurance (WCI), 577
World Trade Center (original construction), case history, 350–351
WWTP plant expansion, case history, 281
Zone of aeration, 3