# OPERATION AND MAINTENANCE OF WASTEWATER COLLECTION SYSTEMS
## COURSE OUTLINE
### VOLUME II, SEVENTH EDITION

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>LIFT STATIONS</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>EQUIPMENT MAINTENANCE</td>
<td>143</td>
</tr>
<tr>
<td>10</td>
<td>SEWER RENEWAL (REHABILITATION)</td>
<td>259</td>
</tr>
<tr>
<td>11</td>
<td>SAFETY/SURVIVAL PROGRAMS FOR COLLECTION SYSTEM OPERATORS</td>
<td>333</td>
</tr>
<tr>
<td>12</td>
<td>ADMINISTRATION</td>
<td>419</td>
</tr>
<tr>
<td>13</td>
<td>ORGANIZATION FOR SYSTEM OPERATION AND MAINTENANCE</td>
<td>531</td>
</tr>
<tr>
<td>14</td>
<td>CAPACITY ASSURANCE, MANAGEMENT, OPERATION, AND MAINTENANCE (CMOM)</td>
<td>595</td>
</tr>
</tbody>
</table>

### Appendix
- COMPREHENSIVE REVIEW QUESTIONS AND SUGGESTED ANSWERS | 643
- COLLECTION SYSTEM WORDS | 661
- SUBJECT INDEX | 721
SUBJECT INDEX

A

AIDS (Acquired Immune Deficiency Syndrome), 344
Accident investigations, 444, 615
Accident prevention program, 381–391
Accident reports, 371, 372, 444, 615
Accidents, types, 348
Accountability, 538
Acquired Immune Deficiency Syndrome (AIDS), 344
Acrylamide grouts, 296
Administration
accident investigations, 444
benefits, 439
CMOM, 608–619
Also see Management, CMOM
certification, 440, 441
compensation, 439
computers, 471–516
contract equipment, 446, 447
contracts, 442
coordination, mapping, 464
directives, work, 484–488
employee relations, 441
employment, 434–440
equipment and tools, 445–456
facilities, 457–460
government information system (GIS), 502–503
goals, 428
grievances, 442
landscaping, 460
lease equipment, 446
management, equipment, 455, 456
management information systems, 471–488
mapping, 461–470
microfiche copies, maps, 469
mission statement, 428
needs, 427
negotiations, 442
objectives, 428
offices, 459
operating plan, 428
parking, 460
personnel, 431–444
policy statement, safety, 443, 614
principles, 427
probationary period, 439
public relations, 519–522
purchase equipment, 446
recordkeeping, computers, 507–516
report writing, 517–519
SCADA systems, 503–507
safety, 443
salaries, 439
security, 457
storage of materials, 457
training, 440–441, 457
work reports, 474–484
yard, 457
Air bubblers, 53–56
Air compressors, 129
Air release valve, 23–24
Air testing crew, 549
Air valves, 624
Alarms and monitoring, lift stations, 623
Alarms, lift stations, 100, 101, 104–106
Alignment
couplings, 133, 242, 244
motors, 178, 242, 244
Alternating current (AC), 155
Ambient temperature, 74
Amperes, 158
Amps, 154, 155
Anaerobic decomposition, 346
Analog readout, 156
Annual report, CMOM, 632
Annular space, 298, 299
As-built plans (record drawings), 269, 617
Asset management, 615
Assurance, capacity, 618, 631
Atmospheres, safety, 346
Atmospheric testers, 452
Attributes, GIS, 502
Audit report, CMOM, 631
Authority
delegation, 610
legal, 610
organization, 537
Auxiliary equipment, lift stations, 79

B

Ball bearings, 223–241
Ballotting crew, 548
Bar racks, 31
Barminutors, 32
Base radio, 454
Compliance, CMOM, 628
Compressors, maintenance, 249–250
safety, 410
Computer-aided design (CAD), 269, 274, 503
Computerized inventory system, tools and parts, 616
Computerized maintenance management system (CMMS) collection system O&M, 620
equipment-based, 488, 495
information management strategy, 635
pipeline-based, 488, 495–503
Computerized systems, 586
Computers administration, 471–516
geographic information system (GIS), 269, 273, 490, 502–503, 635
management information systems, 471–488
recordkeeping, 507–516
SCADA systems, 40, 96–101, 503–507, 623
work directives, 484–488
work reports, 474–484
Concepts, CMOM, 605
Concrete manholes, 320, 321
Conductors, 156
Confined spaces, 79, 347, 358–361, 412
Connection fees, 612
Construction inspection, 616
inspectors, 469
lift stations, 81–93
organization, 548, 560
Contract equipment, 446, 447
Contracts operators, 442
union, 439, 442
Control of hydrogen sulfide, 622
Controlling, management, 539, 608
Controls lift stations, 32–35, 46–57
motor and electrical, 166
Contusions, 345
Coordinates, mapping, 464
Corrective costs, 612
Corrective maintenance, 564, 621
Corrosion, sewer pipes, 607, 622
Cost analysis, rehabilitation, 284
Cost-effective CMOM program, 610, 632, 636
Cost-effectiveness, rehabilitation, 286, 287
Costs lift stations, 112
preventive and corrective, 612
Couplings alignment, 133, 242, 244
pumps, 242–247
Coupon, 574
Coverage ratio, 610
Crews, organization, 537, 540, 547–549, 558
Cross training, 621
Cured-in-place pipe, 296–297
Current, unbalanced, 158, 172–174
Cycle time, pumps, 28

D
Data collection, rehabilitation, 284, 285
Database, 488, 500
Debris severity, 582
Debt service, 610
Defects, precast manholes, 321
Deficiencies, I/I removal, 617
Deformed and reshaped, trenchless technology, 502
Dehumidifiers, 134
Delegation, authority, 610
Design CMOM, 630
engineering, CMOM, 616
Deterioration, system, 606
Diaphragm pumps, 210–212
Digital readout, 156
Direct current (DC), 154
Directing, management, 539, 608
Directives, work, 484–488
Disconnect switch, 161
Diseases, 342–345
Documented, personnel, 614
Drinking water supplies, 608, 619
Drowning, 347
Dry wells, 14, 32
Dyed water flooding, 280, 626
Dynamic head, 25, 26

E
EMF (electromotive force), 154
Egress, safety, 405
Electric motors, 184
Electric shock, 347
Electrical equipment, 154–167
lift stations, 31, 32–35
safety, 153, 154, 415
Electrical and electronic systems, 621
Electricity, 153–165
Electrode controllers, 53, 54
Electromotive force (EMF), 154
Emergencies, lift stations, 623
Emergency conditions, lift stations, 126
Emergency dispatch center, 623
Emergency maintenance, organization, 575
Emergency operating procedure, 625
Emergency response, CMOM, 629
Emergency service request crew, 547
Employee relations, 441
Employee transportation, safety, 418
Employment, 434–440
Employment policies and procedures, 614
Endangered species, 608
Engineering, design, CMOM, 616–618
Entrain, 22
Environmental controls, safety, 413
Equipment and tools, 445–456, 615
Equipment depreciation record, 510, 511
Equipment inventory record, 510, 511
Equipment maintenance
alignment, motors, 178
amps, 154, 155
bearings, 223–241
centrifugal pumps, 199–201
circuit breakers, 163, 164
close-coupled pumps, 206
compensors, 249–250
couplings, 242–247
diaphragm pumps, 210–212
electrical equipment, 154–167
electricity, 153–165
fuses, 162
ground, electrical, 165
impellers, 213–215
insulation, motors, 170–175
lockout/tagout, 153, 154
lubrication
compressors, 249
equipment, 250–253
motors, 180
magnetic starters, 175–178, 186
mechanical seals, 221–222
meters, 156
motors, 167–188
nameplate data, 154, 167, 169–170
organization, 537, 556, 560, 564, 567, 568, 585
packing, 217–220
piston pumps, 205–206
pneumatic ejectors, 203–204
positive displacement pumps, 210–212
power, 154
pumps, 192–248
records, motors, 188, 190
report, 271
safety
electrical, 153, 154
motors, 178
screw pumps, 202
seals, mechanical, 221–222
shafts, 215–216
starters, 175–178
submersible pumps, 207
tagout, 153, 154
testers, 156
testing, pumps, 212
tools, 156
trash pumps, 208–211
troubleshooting, motors, 183–188
vibrations, motors, 179
volts, 154
watts, 156
Equipment repair/replacement fund, 612
Equipment-based CMMS, 488, 495
Excavate and replace, rehabilitation, 288–290
Excavations, 347
Exfiltration, 275, 607
Exiting, safety, 405
Explosions, 345
Extraordinary emergencies, 629
Eye protection, 367, 369

F

Facilities
landscaping, 460
offices, 459
operator facilities, 458
parking, 460
security, 457
shop, 457
storage of materials, 457
training area, 457
yard, 457
Failure consequences, rehabilitation, 284
Failure matrix, 286
Failures
motors, 170, 171
pump, 563
Falling objects, 342, 348
Falls, 345
Fayol, Henri, 427
Field data entry, 500–502
Financial management, 610
Financial stability, 610
Fire, 347, 403
First aid, 403
Fish kills, 605
Flammable materials, 413
Flac, 88
Flexibility, maintenance, 621
Flexible shafting, 246, 247
Float controllers, 47–49
Flotation of sewer, 607
Flow monitoring, 275, 625
Flushing crews, 548
Force main odors, 108
Force mains, 11, 623, 624
Forklifits, safety, 411
Frequency
cleaning, 583
maintenance, 578–581
visits, lift stations, 94–102
<table>
<thead>
<tr>
<th>Index 725</th>
</tr>
</thead>
</table>

| Fueling, safety | 417 |
| Functions, management | 608 |
| Fuse puller | 157 |
| Fused disconnect switch | 161 |
| Fuses | 162 |
| Fusion welds | 318 |
| G |
| GASB 34 (Governmental Accounting Standards Board Statement 34) | 613 |
| GFCl (ground-fault circuit interrupter) | 35 |
| GIS (geographic information system) | 269, 273, 490, 502–503, 655 |
| GPS (global positioning satellite) | 461 |
| Goals |
| administration, management | 609 |
| Governmental Accounting Standards Board Statement 34 (GASB 34) | 613 |
| Grease control, CMOM | 610, 622 |
| Grievances | 442 |
| Ground, electrical | 165 |
| Ground-fault circuit interrupter (GFCl) | 35 |
| Groundwater pollution | 607 |
| Grouting, chemicals | 290–296 |
| Guarding, machine | 408 |
| Gunite | 299 |
| H |
| HDPE (high density polyethylene) | 628 |
| Habitats for endangered species | 608 |
| Hard hat | 370 |
| Hazardous chemicals, safety | 414 |
| Hazardous energy control | 361–366 |
| Hazardous substances communication | 415 |
| Hazardous waste spills | 629 |
| Hazards | 342–348 |
| Head |
| dynamic, 25, 26 |
| static, 25, 26, 49, 70, 72, 73 |
| Head protection | 369 |
| Hepatitis | 344, 345 |
| Hertz, 155, 170 |
| High density polyethylene (HDPE) | 628 |
| High-velocity cleaners | 548 |
| Hoists, safety | 411 |
| Homeland defense |
| CMOM | 630 |
| Horsepower | 68 |
| Hydraulic and pneumatic systems | 621 |
| Hydraulic aspects, rehabilitation | 275–280 |
| Hydraulic cleaning, sewers | 621 |
| Hydraulic modeling | 617 |
| Hydraulic overload | 607 |
| Hydraulics, pump | 67 |
| Hydrogen sulfide | 346, 347 |
| Hydrogen sulfide monitoring and control | 622 |
| Hydrograph | 276 |
| Hygienic facilities | 458 |
| I |
| Identification number, lift stations | 112 |
| Identification of piping systems | 417 |
| Immunizations | 344 |
| Impellers, 31, 213–215 |
| Implementation, rehabilitation | 269 |
| Improvements, capital | 612, 625 |
| Induction, motors | 187–188 |
| Industrial waste |
| inspection | 567 |
| inspector, 346 |
| Infections | 342–345 |
| Infiltration/inflow (I/I) |
| CMOM program | 606 |
| evaluations | 275 |
| investigations | 566 |
| rehabilitation, sewers | 275 |
| removal deficiencies | 617 |
| Information management strategy | 632–636 |
| Infrastructure investment | 606, 613 |
| Injury frequency rate | 348 |
| In-line replacement | 301–302 |
| Inquiries, pre-employment | 437, 438 |
| Insitucutter | 306, 307 |
| Insitiform, 304–313 |
| Inspection |
| construction, 616 |
| lift stations, 82, 83–87, 624 |
| manholes, 625 |
| organization, 549, 564–568 |
| Inspectors, construction | 469 |
| Installation, pumps, 208, 209 |
| Insulation, motors | 44, 74, 170–175 |
| Insulators | 156 |
| Internal TV inspection, 626 |
| Inventory |
| maintenance program | 585, 588, 616 |
| parts, 585, 616 |
| system, 616, 627 |
| Inversion tube, 304, 305 |
| Investigations, infiltration/inflow | 566 |
| Issues, management | 608 |
Lift stations

Level 1 maintenance, Let’s Build a Pump!, 192
Legend, maps, 38
Leaks, sources, 38
Laptop computers, 38
Lantern ring, 62
Landscaping, 460
Ladders, safety, 62
Life-cycle costing, 635
Level of service, CMOM, 637
Level 2 maintenance, 610
Legal authority, 610
Lease equipment, 62
Leaking joints, 74
Lay-flat hose, 89
Laterals, service, 81
Lacerations, 82
Lift station O&M, organization, 93
LIS (lateral inspection system), 94
LIS (lateral inspection system), 626
(No listings)

J

Job related, personnel, 614
Jogging, 186

K

(No listings)

L

LIS (lateral inspection system), 626
Lacerations, 62
Ladders, safety, 406
Landscaping, 460
Lantern ring, 62
Laptop computers, 38, 474, 486
Lateral inspection system (LIS), 626
Laterals, service, 627
Lay-flat hose, 305
Leaking joints, 607
Leaks, sources, 277, 279–280
Laptop computers, 62
Legends, maps, 465, 469
Let’s Build a Pump!, 192–198
Level 1 maintenance, 576–577, 585
Level 2 maintenance, 577–578, 585
Level of service, CMOM, 635–637
Life-cycle costing, 287, 616
Lift station O&M, organization, 549, 561–564
Lift stations
air blowers, 53–56
air compressors, 129
alarms, 100, 101, 104–106
alignment, couplings, 133
auxiliary equipment, 79
bar racks, 31
blowers, 130
CMOM, 623–625
calibration, 83, 89–93
cast-in-place, 18–21
centrifugal pumps, 58–63, 136–138
chemicals, 12
chlorinators, 131–132
confined spaces, 79
corrugation, 81–93
couplings, 28–35, 46–57
costs, 112
coupling alignment, 133
cycle time, 28
dehumidifiers, 134
dry wells, 14, 32
electrical, 31, 32–35
electrode controllers, 53, 54
emergency conditions, 126
float controllers, 47–49
frequency of visits, 94–102
ground-fault circuit interrupter (GFCI), 35
hydraulics, pump, 67
identification number, 112
inspection, 82, 83–87, 624
insulation, motors, 44, 74
location, 11
maintenance, 109–112, 624
metering, 32
microprocessors, 57
motor control center (MCC), 33, 35, 42
motors, 40–46
operation, 94–108, 561–564, 623
pneumatic bubbler system, 53, 55, 56
pneumatic ejectors, 11, 14, 22
power transformers, 32
pressure-sensing controllers, 53, 55
preventive maintenance program, 121–141
prints, 81
problems, 106
pump capacity, 89–93
pump selection curve, 68–74
pumps, 58–75
purpose, 11
recordkeeping, 112–113, 624
reliability, 12, 103
reports, 113
SCADA, 96–101
safety, 31, 125
specifications, 82
station book, 103
submergence depth, 29, 30
submersible pumps, 12, 13, 14, 15, 61
sump pump, 74, 138
supervisory controls, 36–40, 46–57
system curve, pump, 70
types, 12
ultrasonic level detector, 49, 52
valves, 23–25, 75–79
variable-speed systems, 33, 35
ventilation equipment, 79, 130
wet wells, 14, 28–31
Line items, budget, 612
Line side/load side, 163
Locked-rotor current, 74
Lockout/tagout, 153, 154, 361–366, 408
Lubrication
compressors, 249
equipment, 250–253
motors, 180
Lubriflushing, 109

M

MSDS (material safety data sheet), 415
Magnetic starters, 175–178, 186
Main line inventory, 510, 512
Main line repairs, 627
Maintenance
  CMOM
    See Operation and maintenance, CMOM
corrective, 564, 621
equipment
  See Equipment maintenance
flexibility, 621
organization, 549, 561–564
predictive, 574, 624
preventive
  See Preventive maintenance
program, organization, 573–586
right-of-ways, 627
routine, 615, 624
scheduling, 109–112, 620, 621
timing, 621
Management, CMOM
  as-built plans (record drawings), 617
  asset management, 613
  assurance, capacity, 618
  authority, legal, 610
  budgeting, 612
  capacity assurance, 618
  capital improvements, 612
  certification, 614
  construction and inspection, 616
design, engineering, 616
employment policies and procedures, 614
equipment and tools, 615
equipment repair/replacement fund, 612
financial, 610
functions, 608
GASB 34, 613
goals, 609
  Governmental Accounting Standards Board Statement 34 (GASB 34), 613
  hydraulic modeling, 617
  improvements, capital, 612
  inspection, construction, 616
  inventory, parts, 616
  issues, 608
  legal authority, 610
  mission statement, 609
  modeling, hydraulic, 617
  objectives, 609
  organizational structure, 609, 611
  parts inventory, 616
  personnel, 613
  policies and procedures, employment, 614
  record drawings, 617
  rehabilitation, sewer, 617, 618
  repair fund, 612
  replacement fund, 612
  SSES, 617
  safety program, 614
  sewer system evaluation survey (SSES), 617
stability, financial, 610
staffing, 608, 614
system capacity assurance, 618
system mapping, 617
tasks/procedures, 609
tools, 615
training, 614
warehouse and parts inventory, 616
water quality monitoring, 619
Management, equipment, 455, 456
Management information systems, 471–488
Management, organization, 539
Mandrel, 206, 616
Manholes
  inspection
    CMOM, 625
  organization, 566
  rehabilitation, 320–329
  repairs, 627
Manual, safety, 393–396
Mapping, 269, 272, 273, 461–470
Maps, 617
Master map, 465, 466
Material handling, safety, 417
Material safety data sheet (MSDS), 415
Measurement, CMOM, 631
Mechanical cleaning, sewers, 621
Mechanical seals, 62, 65, 221–222
Mechanical systems, 621
Medical services, 403
Meetings, safety, 355
Megger, 159
Megohm, 159
Metering, lift stations, 32
Meters, equipment, 156
Methods, rehabilitation, 288–328
Microfiche copies, maps, 469
Microprocessors, 57
Minimizing costs, 635
Mission statement, 428, 609
Modeling, hydraulic, 617
Monitoring
  CMOM, 631
  flow, 625
  hydrogen sulfide, 622
  lift stations, 623
Motor control center (MCC), 33, 35, 42, 166
Motors
  alignment, 178, 242, 244
  belt drives, 244–246
  classifications, 40
electric motors, 184
failures, 170, 171
flexible shafting, 246, 247
induction, motors, 187–188
insulation, 44, 74, 170–175
lift stations, 40–46
Motors (continued)
lubrication, 180
magnetic starters, 175–178, 186
nameplate data, 167, 169–170
records, 188, 190
rotation direction, 180
safety, 178
starters, 44–46, 175–178
temperature limits, 171
troubleshooting, 183–188
types, 167
vibration, 179
Multimeter, 156

NPDES (National Pollutant Discharge Elimination System)
permit, 628, 629
NPDES permit violation, 575
NPSH (net positive suction head), 68
Nameplate, 42
Nameplate data, 154, 167, 169–170
National Electrical Code, 14, 31, 35, 44
National Pollutant Discharge Elimination System (NPDES)
permit, 628, 629
National Pretreatment Program, 610
Needs
administration, 427
collection systems, 606
organization, 537
rehabilitation, 284
Neglected collection systems, 606
Negligence, 607
Negotiations, 442
Net benefits, 635
Net positive suction head (NPSH), 68
New construction, organization, 560
Noise, 347, 416
Normal emergencies, 629
Notebook computers, 486
Notifications, CMOM, 628

O&M manuals, 616
OJT (on-the-job training), 614
OSHA
See Occupational Safety and Health Act (OSHA)
Objectives
administration, 428
management, 689
Occupational Safety and Health Act (OSHA)
approved state programs, 400–402
checklists, 403–418
definition, 153
standards, 398–400
violations, 349–353

Occupational titles, 540
Odors, force mains, 108
Offices, operator, 459
Ohmmeters, 159
On-site generators, 623
On-the-job training (OJT), 614
Openings, floor and wall, 405
Operating plan, administration, 428
Operating ratio, 610
Operation and maintenance, CMOM
air valves, 624
alarms and monitoring, lift stations, 623
chemical cleaning, 622
cleaning, sewers, 621
compliance, CMOM, 627
table and control of hydrogen sulfide, 622
corrigerative maintenance, 621
cross training, 621
dyed water flooding, 626
emergencies, lift stations, 623
flow monitoring, 625
force mains, 623, 624
hydrogen sulfide monitoring and control, 622
inspection
lift stations, 624
manholes, 625
internal TV inspection, 626
lateral, service, 627
lift stations, 623–625
main line repairs, 627
maintenance
lift stations, 624
right-of-ways, 627
scheduling, 620, 621
maintenance, lift stations, 624
manhole inspection, 625
manhole repairs, 627
monitoring
flow, 625
hydrogen sulfide, 622
lift stations, 623
operation, lift stations, 623
preventive maintenance, lift stations, 624
purpose, O&M, 620
recordkeeping, lift stations, 624
rehabilitation, main line and manhole, 627
repairs, main line and manhole, 627
right-of-way maintenance, 627
root removal, 622
routine maintenance, lift stations, 624
scheduling, maintenance, 620, 621
service laterals, 627
sewer cleaning, 621
sewer system evaluation, 625–627
smoke testing, 626
TV inspection, 620, 626
vacuum valves, 624
Operation, lift stations, 94–108, 549, 561–564, 623
Operator facilities, 458
Organization
accountability, 538
air testing, 549
authority, 537
balling crew, 548
bucket machines, 548
chemical crews, 548
closed-circuit television crew, 549, 564
computerized systems, 586
construction, 548, 560
controlling, management, 539
corrective maintenance, 564
crews, 537, 540, 547–549, 558
directing, management, 539
directed maintenance, 575
directed emergency service request crew, 547
development of equipment, 537, 556, 560, 564, 567, 568, 585
discharging crews, 548
frequency of maintenance, 578–581
high-speed cleaners, 548
industrial waste inspection, 567
inspection, 549, 564–568
inventory, maintenance program, 585
level 1 maintenance, 576–577, 585
level 2 maintenance, 577–578, 585
lifeguard O&M, 549, 561–564
maintenance
lifeguard stations, 549, 561–564
program, 573–586
scheduling, 575–584
management, 539
manhole inspections, 566
NPDES permit violation, 575
need, 537
new construction, 560
occupational titles, 540
operation, lift stations, 549, 561–564
organizing, management, 539
parts inventory, 585
performance indicators, 587–588
personnel, 537, 539–549
planning, management, 539
power rodders, 548
predictive maintenance, 574
pretreatment facility inspection, 567
preventive maintenance, 551–558, 574
principles, 427, 537–539
records, equipment, 558
rehabilitation crew, 549
reorganization, 573
repairs, 548, 559–561
replacement, 559–561
responsibility, 538
risk analysis, 585
safety, 573
scheduling maintenance, 575–584
service requests, 551–558
smoke testing crew, 549
span of control, 538
staff, 539–549, 568–571
staffing, management, 539
stoppages, 551
titles, occupational, 540
training crews, 555–556, 558
unitization, 537
warehouse, 585
work activities, 539–547
Organizational structure, 609, 611
Organizing, management, 539, 608
Orientation, operator, 439
Outreach program, 612
Overflow emergency response plan, CMOM, 630
Overflows, 621, 629
Overload, hydraulic, 607
Oxygen-deficient atmospheres, 346, 347
Performance indicators, 587–588, 621
Permit, confined space, 360
Personal protective equipment (PPE), 366–370, 615, 630
Personnel
accident investigations, 444
benefits, 439
certification, 440, 441, 614
compensation, 439
collective, 442
discrimination, 441
employment, 434–440
grievances, 442
management, CMOM, 613
negotiations, 442
organization, 537, 539–549
orientation, 439
probationary period, 439
requirements, 431
safety, 443
salaries, 439
training, 440–441, 614
Personnel, 431
Pipe insertion, 299, 301
PLC (programmable logic controller), 38–40
PPE (personal protective equipment), 366–370, 615, 630
Packaging, 62, 66, 69, 217–220
Parasites, 344
Park Road lift station, 121–141
Parking, 460
Parts inventory, 585, 616
Parts, pumps, 199
Pathogenic organisms, 342, 605
Performance, CMOM, 606, 630
Performance indicators, 587–588, 621
Permit, confined space, 360
Personal protective equipment (PPE), 366–370, 615, 630
Personnel
accident investigations, 444
benefits, 439
certification, 440, 441, 614
compensation, 439
contracts, 442
discrimination, 441
discrimination, 434–440
grievances, 442
management, CMOM, 613
negotiations, 442
organization, 537, 539–549
orientation, 439
probationary period, 439
requirements, 431
safety, 443
salaries, 439
training, 440–441, 614
Personnel, 431
Pipe insertion, 299, 301

Index 729
Pipeline-based CMMS, 488, 495–503
Piping identification, 417
Piston pumps, 205–206
Planning, management, 539, 608
Plug valves, 78
Pneumatic bubblers system, 53, 55, 56
Pneumatic ejectors, 11, 14, 22, 203–204, 623
Pneumatic systems, 621
Poisonous gases, 346
Pole shelter, 186
Policies and procedures, employment, 614
Policies, safety, 356, 359, 361, 367, 369, 378, 443, 614
Policy statement, safety, 443, 614
Pollution, groundwater, 607
Polyethylene pipe lining, 313–318
Polyurethane foam, 296
Portable electric generators, 623
Portable pumps, 208–210
Positive displacement pumps, 210–212
Power, 154
Power failures, 629
Power linemen, 548
Power transformers, 32
Precast concrete manholes, 320, 321
Predictive maintenance, 574, 624
Pre-employment, inquiries, 437, 438
Pressure-sensing controllers, 53, 55
Pretreatment facility inspection, 567
Pretreatment facility inspector, 346
Preventive costs, 612
Preventive maintenance
lift stations, 121–141, 624
organization, 551–558, 574
sample program for a lift station, 121–141
system, 621
Principles
administration, 427
organization, 427, 537–539
Priorities, rehabilitation, 286
Prioritization process, 508, 612, 619
Probationary period, 439
Professionalism, safety, 542
Program audit report, CMOM, 631
Program, CMOM, 605
Program formulation, rehabilitation, 267–275
Program modifications, CMOM, 631
Program, safety, 349
Programmable logic controller (PLC), 38–40
Promoted resin, 305, 308, 310
Propeller pumps, 201
Propulsive clothing, 453
Protective equipment, 366–370, 615, 630
Protocols, testing and acceptance, 616
Public education/outreach program, 612
Public health, CMOM, 606, 609
Public relations
administration, 519–522
CMOM, 628
Public’s infrastructure investment, 606
Pumps
bearings, 223–241
belt drives, 244–246
capacity, 89–95
cavitation, 25, 68, 198, 215
centrifugal, 58–63, 136–138, 199–201
classifications, 58
close-coupled, 206
couplings, 213–247
cycle time, 28
diaphragms, 210–212
diaphragms, 210–212
diaphragms, 210–212
diaphragms, 210–212
flexible shafting, 246, 247
impellers, 31, 213–215
installation, 208, 209
lif stations, 58–75
mechanical seals, 62, 65, 221–222
packing, 62, 64, 65, 217–220
parts, 199
piston, 205–206
pneumatic ejectors, 203–204
portable, 208–210
positive displacement, 210–212
propeller, 201
screw, 202
seals, mechanical, 62, 65, 221–222
seal curve, 68–74
shafts, 215–216
stuffing boxes, 62, 64, 196, 215, 216, 221
submersible, 12, 13, 14, 15, 61, 607
testing, 212
trash, 208–211
type, 199
Purchase equipment, 446
Purchase orders, 612
Purpose, O&M, 620
Q
(NO LISTINGS)
R
RILL (rainfall-induced infiltration), 618
Rainfall-induced infiltration (RII), 618
Record drawings (as-built plans), 269, 617
Recordkeeping
computers, 507–516
lif stations, 112–113, 624
Index  731

Records  
  equipment, 558  
  motors, 188, 190  
  safety, 371, 372, 403  
Reduced voltage starting, 45, 172  
Regulatory information, safety, 397–418  
Rehabilitation, sewers  
  acrylamide grouts, 296  
  capital costs, 286  
  chemical grouting, 290–296  
  cost analysis, 284  
  cost-effectiveness, 286, 287  
  crew, 549  
  cured-in-place, pipe, 296–297  
  data collection, 284, 285  
  deformed and reshaped, trenchless technology, 302  
  dyed water flooding, 280  
  evaluation of conditions, 275–283  
  excavate and replace, 288–290  
  exfiltration, 275  
  failure consequences, 284  
  flow monitoring, 275  
  gunite, 299  
  hydraulic aspects, 275–280  
  implementation, 269  
  inflow/infiltration, 275  
  in-line replacement, 301–302  
  Instiform, 304–313  
  leaks, sources, 277, 279–280  
  life-cycle costing, 287  
  main line, 627  
  management, CMOM, 617, 618  
  manholes, 320–329, 627  
  methods, 288–328  
  needs, 284  
  pipe insertion, 299, 301  
  polyethylene pipe lining, 313–318  
  polyurethane foam, 296  
  priorities, 286  
  problems, 275  
  program formulation, 267–275  
  service connections, 318, 319  
  shotcrete, 299  
  sliplining, 299, 300, 313–318  
  smoke testing, 280, 281  
  structural aspects, 282–283  
  system problems, 275  
  trenchless technology, 296–303  
  urethane gels, 296  
Reliability, lift stations, 12, 103  
Removal of infiltration and inflow (I/I), 617  
Reorganization, 573  
Repair fund, 612  
Repairs  
  main line and manhole, 627  
  organization, 548, 559–561  
Replacement fund, 612  
Replacement, organization, 559–561  
Report writing, 517–519  
Reports  
  accident, 371, 372, 444  
  annual, CMOM, 652  
  equipment maintenance, 271  
  lift stations, 613  
  program audit, 631  
Requisition system, 612  
Responsibilities, safety, 354, 443  
Revenue, 612  
Right-of-way maintenance, 627  
Risk analysis, 585  
Robots, 290–295  
Root intrusion, 607  
Root removal, 622  
Rotation direction, motors, 180  
Rotten egg odors, 622  
Routine maintenance  
  equipment and tools, 615  
  lift stations, 624  
  Ruptures, 347  
Sacramento County, California, 581  
Safety  
  AIDS, 344  
  accident prevention program, 381–391  
  accident reports, 371, 372, 444, 615  
  accidents, types, 548  
  administration, 443  
  atmospheres, 346  
  bites (insects, bugs), 347  
  CMOM, 614  
  Centers for Disease Control (CDC), 344  
  combustibles, 413  
  committee, 356, 615  
  communication, hazardous substances, 415  
  compressors, 410  
  confined spaces, 79, 347, 358–361, 412  
  contusions, 345  
  diseases, 342–345  
  drowning, 347  
  egress, 405  
  electric shock, 347  
  electrical, 153, 154, 415
Safety (continued)
employee transportation, 418
environmental controls, 413
excavations, 347
exiting, 405
explosions, 345
eye protection, 367, 369
fire, 347, 403
first aid, 403
flammables, 413
forklifts, 411
ground-fault circuit interrupter, 35
guarding, machine, 408
hard hat, 370
hazardous chemicals, 414
hazardous energy control, 361–366
hazardous substances communication, 415
head protection, 369
hepatitis, 344, 345
hoists, 411
homeland defense, 371–375
hydrogen sulfide, 346, 347
identification, piping, 417
immunizations, 344
infections, 342–345
injury frequency rate, 348
lacerations, 345
ladders, 406
lifef stations, 31, 125
lockout/tagout, 361–366, 408
MSDS, 415
manual, 393–396
material handling, 417
material safety data sheet, 415
medical services, 403
meetings, 355
motors, 178
noise, 347, 416
OSHA
approved state programs, 400–402
checklists, 403–418
standards, 398–400
violations, 349–353
openings, floor and wall, 405
organization, 573
oxygen-deficient atmospheres, 346, 347
parasites, 344
pathogenic organisms, 342
permit, confined space, 360
personal protective equipment, 366–370, 615, 630
piping identification, 417
poisonous gases, 346
policies, 356, 359, 361, 367, 369, 370, 443, 614
program, 349, 614
promotion, 443, 615
protective equipment, 366–370, 615, 630
records, 371, 372, 403
responsibilities, 354, 443
ruptures, 347
safety vest, 367
safety/survival programs, 333–348
sanitizing equipment and clothing, 418
seat belt, 367
shoring, 347
slips, 342
spraying, 412
stairs, 405
strains, 347, 348
threat levels, homeland defense, 373–375
tools, 407
toxic gases, 346
traffic mishaps, 347
training, 341, 357, 360, 365, 367, 443, 615
transmission of diseases, 343
transportation, employee, 418
trench shoring, 347
vest, 367
walkways, 404
welding, 409
work environment, 404
written program, elements, 356
Safety/survival programs, 333–348
Also see Safety
Salaries, 439
Sanitary sewer overflow (SSO), 605
Sanitizing equipment and clothing, safety, 418
Santa Clara County, California, 582–584
Saybolt Seconds Universal (SSU), 251
Scheduling maintenance
CMOM, 620, 621
organization, 575–584
Screw pumps, 202
Seal cage, 197
Seals, mechanical, 62, 65, 221–222
Seat belt, 367
Section map, 465, 467
Security, 457
Service connections, rehabilitation, 318, 319
Service laterals, 627
Service, level, CMOM, 635–637
Service request report, 484, 485
Service requests, organization, 551–558
Service sewer maintenance, policy, 521
Sewer cleaning, CMOM, 621
Sewer rehabilitation
  See Rehabilitation, sewers
Sewer rehabilitation crew, 549
Sewer system evaluation survey (SSES), 275, 284, 617, 625–627
Sewer-use ordinances, 625
Shafts, pumps, 215–216
Sheaves, 244
Shellfish harvesting quarantines, effects of SSOs and CSOs, 605
Shim, 242
Shop facilities, 457
Shop steward, 442
Shoring, 289, 347, 452–453
Also see Volume I, Chapter 7
Shotcrete, 299
Silicon-controlled rectifier (SCR), 35, 46
Shoes, sewer, 622
Sliplining, 299, 380, 313–318
Slips, 342
Smoke testing, 280, 281, 626
Smoke testing crew, 549
Span of control, organization, 538
Specifications, lift stations, 82
Spraying, safety, 412
Squirrel cage induction motor, 167, 168
Stability, financial, 610
Staff, organization, 539–549, 568–571
Staffing, management, 539, 608, 614
Stairs, safety, 405
Stakeholder groups, 608
Standard maintenance procedure (SMP), 614, 624
Standard operating procedure (SOP), 614, 624
Starters, motors, 44–46, 175–178
Static head, 25, 26, 49, 70, 72, 73
Station book, lift stations, 103
Stoppage trends, 509
Stoppages, 551, 621, 629
Storage of materials, 457
Strains, 347, 348
Strategy, information management, 632–636
Street subsidence, 686
Stretch, 277
Structural aspects, rehabilitation, 282–283
Staffing boxes, 62, 64, 196, 215, 216, 221
Submergence depth, 29, 30
Submersible pumps, 12, 13, 14, 15, 61, 207
Subsidence, 606
Sump pump, 74, 138
Supervisory Control And Data Acquisition (SCADA) systems, 40, 96–101, 503–507, 623
Supervisory controls, 36–40, 46–57
Surcharge, 267, 276, 631
Symbols, maps, 465, 469
System capacity assurance, 618, 631
System curve, pump, 70
System evaluation, CMOM, 631
System inventory, CMOM, 627
System mapping, 617
T
TDH (total dynamic head), 68
TV inspection, CMOM, 620, 626
Tagout, 153, 154, 361–366, 408
Telemetry alarm systems, 275
Television survey history, 623
Television survey technique, 513, 514
Temperature limits, AC motors, 171
Terrorism, 630
Testers
  atmospheric, 452
equipment, 156
Testing, pumps, 212
Thermostats, 165
Threat levels, homeland defense, 373–375
Timing, maintenance, 621
Tire inflation, safety, 418
Titles, occupational, 540
Tools
  CMOM, 615
equipment maintenance, 156
safety, 407
Total dynamic head (TDH), 68
Total failure index, 286
Toxic gases, 346
Toxic waste spills, 629
Traffic
control, 453
mishaps, 347
Training
  administration, 440–441, 457
area, 457
CMOM, 614, 615
crews, organization, 555–556, 558
personnel, 440–441, 614
safety, 341, 357, 360, 365, 367, 443, 615
Transmission of diseases, 343
Transportation, employee, safety, 418
Trash pumps, 208–211
Trench burning, safety, 347
Trenchless technology, 296–303
Trends, stoppages, 509
Troubleshooting
  motors, 183–188
  odors, 108
  portable pumps, 210
  positive displacement pumps, 210, 212
U
Ultrasonic level detector, 36, 49, 52
Unbalanced current, 158, 172–174
734 Collection Systems

Union contracts, 439, 442
Unitization, organization, 537
Universal joints, 246, 247
Urethane gels, 296
US Homeland Security Advisory System, 373
User rates/user charges, 612

V
Vacuum relief valve, 23–24
Vacuum valves, 624
Valves, 23–25, 75–79, 624
Vandalism, 607
Variable-speed pump systems, 53, 35
Ventilation equipment, 79, 130
Vest, safety, 367
Vibrations, motors, 179
Viscosity, 251
Voltage, reduced starting methods, 45, 172
Volts, 154
Volute, 67

W
Walkways, 404
Warehouse and parts inventory, 616
Warehouse, organization, 585
Warning tag, 153, 154, 364
Warning vests, 367
Warranty, 616
Water hammer, 22
Water quality monitoring, 619
Water wells, 140, 141
Watersew approach, 608
Watts, 154, 156
Wear rings, 62, 64
Welding, safety, 409
Wet wells, 13, 28–31
Why CMOM?, 605
Wire-to-water efficiency, 92
Work activities, organization, 539–547
Work directives, 484–488
Work environment, safety, 404
Work order, 485–488, 493
Work reports, 474–484
Working plans, 617
Wound rotor induction motor, 42, 167
Written safety program, elements, 356

X
(NO LISTINGS)

Y
Yard, facilities, 457

Z
(NO LISTINGS)