Index

A
AACEi (Association for the Advancement of Cost Engineering) 19, 21, 24
Accuracy, expected 2, 20–1
Actual costs 3, 4, 21–2
Administrative Cost 34, 79
Advanced Water Treatment ix, 100–1, 103
plants xii, 2, 13, 86–7, 89, 91, 93, 96
processes v, 12–3, 15, 108
Agencies, regulatory 9, 10, 27, 107
Air Scour Wash 59, 60, 78
Allowances xii, 21–2, 25
Alternatives, process treatment 24
Alum/Ferric 11–3, 15
Ammonia, anhydrous 46
Anhydrous Ammonia Feed vii, 33, 46, 77
Anionic Polymer 12, 15, 74
Annual Operating and Maintenance Cost viii
Applicable Range 76, 78
Aqua Ammonia Feed vii, 33, 46–7, 77

B
Basic Conventional Water Treatment Processes v, 8, 9, 11–2
Basic Plant Design Philosophy v, 5
Belt Filter Press vii, 34, 69, 79

C
Capital cost, total 75, 95
Capital Improvement Costs vi, 20, 26–7
Capital improvement programs 20, 26
Cast-in-place 39, 50, 53, 55
Cationic Polymer 11–3, 15, 74
CCI, see Construction Cost Index
CD (compact disk) xii
Centrifuge Facility vii, 34, 71–2
Chlorination 6, 10, 105
Chlorine 8, 10, 35–6, 46, 74
application of 6
feed cap 33, 76
storage 33, 36, 76
Circular clarifiers vii, 30–3, 52–3, 66, 77
Clarifiers, rectangular 31–2, 54
Clear Water Storage 34, 62, 78
Clearwell 10–5, 62–3, 74
Coagulant 9, 88
Coarse media flocculation/roughing filter process 9
Commandments 5
Compact disk (CD) xii
Comparison of Alternative Process Construction Costs 25
Construction administration costs 31
budget 19, 22
cost curve 38
estimates xi, 20–1, 25–6
Construction Cost Estimating vi, 19
Construction cost index xii, 24
Construction Cost Index (CCI) xii, 23–4, 95
Construction Cost Trending 22
Consumer Price Index (CPI) 23
Contact Filtration process 9
Contactors 38–9
Containment, secondary 43–4, 46
Contingencies 22, 25
Contingency analysis of cost estimates 22
Conventional Treatment viii, 29, 84–5, 97, 100
Conventional Treatment Process x, 12, 15, 74
Conventional Water Treatment Plant viii, 3, 8, 75, 81, 83, 85
Corrosion Control 11–2, 14–5, 74
Corrosion Inhibitor 13–4
Cost curves vi, xii, 1, 3, 15, 24, 29, 31–2, 38–9, 41, 50, 56–7, 60, 62, 65, 95–6
data 3, 24
equations 31
estimates vi, 1, 2, 5, 19–23, 26, 73
developing 2
finished 25
predesign 21, 31
project construction 22
trended 22
Cost of Advanced Water Treatment Plants 87, 89, 91, 93
Cost Equation Minimum Maximum 76, 78
Cost Estimating Parameters vi, 30–1
Cost indexes 3, 22–3
Costs average xii, 24, 72
civil engineering capital construction 23
cost 30
dissolved air flotation tank construction 18
estimating construction 29
facilities construction 19
fixed 95
historic xi, 3, 31
indexes effecting construction 22
nonprocess 26, 30
operating 18, 27
predesign 1
preliminary construction 15
total direct xii, 21
total plant xii, 1, 30
updated construction 31
variable 95
CPI (Consumer Price Index) 23
Curves cost capacity 24, 30
process cost 36
DAF (Dissolved Air Flotation) x, 13, 29, 98
Data, primary xii, 3
DBM (design build-maintain) 8
DBO (design-build-operate) 8
Definition of Terms vi, 21, 23
### Department of Health Services (DHS)
- Design criteria xi, 31, 36, 75
- Development 5, 19
- Flow rates 29, 30
- Parameters 2, 74
- Philosophy 2, 35

<table>
<thead>
<tr>
<th>Basic Water Treatment Plant</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Flow</td>
<td>15</td>
</tr>
<tr>
<td>Scheme</td>
<td>107–8</td>
</tr>
<tr>
<td>Team</td>
<td>8, 19, 20</td>
</tr>
</tbody>
</table>

- Design build-maintain (DBM) 8
- Design-build-operate (DBO) 8
- Direct Chlorine Feed 37
- Direct Filtration viii, x, 9, 29, 80, 84–5, 97, 100
- Direct Filtration Process ix, 11, 15

<table>
<thead>
<tr>
<th>Discharge</th>
<th>14, 17, 108</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disinfection Process</td>
<td>62</td>
</tr>
<tr>
<td>Byproducts</td>
<td>7</td>
</tr>
<tr>
<td>Ozone</td>
<td>38</td>
</tr>
</tbody>
</table>

- Distillation, multiple-effect viii, 87, 89
- Distribution systems 63, 106

<table>
<thead>
<tr>
<th>Drinking Water</th>
<th>Quality Standards</th>
<th>7, 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe</td>
<td>87, 106</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dry Alum Feed</th>
<th>vi, 33, 40–1, 76</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Alum Process</td>
<td>41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drying</th>
<th>v, 18, 66</th>
</tr>
</thead>
</table>

### E
- Engineering News Record (ENR) xii, 24
- Engineering News-Record Construction Cost Index 23
- ENR-CCI xii, 23, 95

<table>
<thead>
<tr>
<th>ENR-Construction Cost Index</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA (Environmental Protection Agency)</td>
<td>7, 12, 24–5, 30</td>
</tr>
<tr>
<td>Equation function</td>
<td>1, 32, 56</td>
</tr>
<tr>
<td>Equations xii, 25, 31–2, 52, 73</td>
<td></td>
</tr>
<tr>
<td>Escalation</td>
<td>23, 25</td>
</tr>
<tr>
<td>Escaping Chlorine Gas</td>
<td>36–7</td>
</tr>
</tbody>
</table>

### F
- Ferric Chloride Feed vi, 33, 45, 77
- Filter cells 56, 59
- Media vii, 55, 57–9
- FILTER AREA 55–6, 59
- Filter area-SF 33–4, 78
- Filter backwash 66, 74–5
- Filter Backwash Pumping vii, 33, 58, 78
- Filter Belt Press 70–1
- Filter Media Area-SF 33, 77–8
- Filter Media Dual Media 57
- Filter to Waste 11–5, 74
- Filter Waste Wash Water Storage Tank 61
- Filters 10, 18, 38, 56, 59, 60, 88, 92, 100
- Vacuum 18
- Filtrate 18

<table>
<thead>
<tr>
<th>Filtration</th>
<th>6, 13–4, 88</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant</td>
<td>direct vii, 80</td>
</tr>
<tr>
<td>Dissolved Air Flotation</td>
<td>viii, 81</td>
</tr>
<tr>
<td>Micro Membrane</td>
<td>viii, 83–4</td>
</tr>
<tr>
<td>Pre-Ozone</td>
<td>84</td>
</tr>
<tr>
<td>Two-Stage</td>
<td>viii, 75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process</th>
<th>advanced membrane 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granular</td>
<td>10</td>
</tr>
<tr>
<td>Granular Media</td>
<td>10</td>
</tr>
<tr>
<td>Slow Sand</td>
<td>6</td>
</tr>
</tbody>
</table>
INDEX

Finished Water Pumping vii, 34, 64, 78
Flash chambers 90
Flash Mix 11–3, 15, 74
Flocculation 8, 10–3, 15, 74
Flocculator vii, 33, 50–2, 77
Function of Size and Treatment Plant Efficiency 25, 30

G
GAC Bed 15
Granular Bed Filtration 11–2, 74
Gravity Filter Structure vii, 33, 55, 77
Gravity Sludge Thickener vii, 34, 65–6, 78
Growth, economic 106, 108
Guidelines 19–21
cost-estimating 24

H
Handy-Whitman Index of Water Utility Construction Costs 23
Headworks 70, 72
High-speed micro-sand settling process 13
Historical process costs 30
Holding Tank 11–5, 34, 60, 74–5, 78

I
Individual Treatment Process Cost Curves vi
Integrated Design and Operation of Water Treatment Facilities xi, 91

K
KMnO 12, 14, 74

L
Laboratory vii, 34, 72–3, 79
Lagoons 18, 67, 69
Leach field 70, 72
Lime 13–4, 98
Lime Feed vi, 33, 42, 76
Lime and Soda Ash Water Softening Process x, 13
Limitations 20, 27, 106

M
Maintenance xii, 2, 8, 26, 72, 75
Maintenance Building vii, 34, 72–3, 79
Maintenance Cost Impacts 95–6, 98, 100, 102
Maintenance costs viii, xii, 2, 6, 19, 24, 27, 30–1, 72, 90–1, 95
Maximum Contaminant Levels (MCL) 12
MCL (Maximum Contaminant Levels) 12
MDG (Millennium Development Goals) 105–6
Mechanical processes, expensive 69
Mechanical Vapor Compression, see MVC
MED (Multiple-Effect Distillation) viii, ix, 87, 89, 102
MED Construction Cost 89
Membranes 88, 91
Micro Filter 12, 14–5, 74
Micro-Filtration Plant Designed 83
Micro Membrane Filtration Process x, 14
Microorganisms 9, 10
Index

Millennium Development Goals (MDG) 105–6
Monitoring instruments 40, 43
MSF (Multi-Stage Flash) viii, 87, 90
Multi-Stage Flash, see MSF
Multiple-Effect Distillation, see MED
MVC (Mechanical Vapor Compression) viii, ix, 87, 89, 102

N
NF (nano-filtration) 13, 91, 93, 101, 103
Nonconstruction costs 75, 80–2, 84
Nonprocess cost multipliers 31

O
O&M cost curves 27, 96
O&M Cost Curves viii, 97, 99
O&M Costs
  for Conventional Treatment viii, ix, 97
  for Direct Filtration viii, ix, 97
  for Dissolved Air Flotation ix, 98
  for Iron Manganese Removal ix, 99
  for Lime and Soda Ash 98
  for Mechanical Vapor Compression 102
  for Micro Membrane Filtration ix
  for Multi-Stage Flash ix, 101
  Flash Treatment 101
  for Multiple Effect Distillation ix, 102
  for Reverse Osmosis 101
  for Two-Stage Filtration viii, 96
  for Ultra-Filtration and Nano-Filtration ix, 103
One-Ton Chlorine Cylinders and Chlorine Feeder 35
Operation and Maintenance Cost viii
Cost Impacts 95
Overhead View of Water Treatment Plant 9
Oxidation process 10
Ozonation 13, 15, 29, 100
  and GAC Filters ix, x, 15, 85, 100
Ozone contactors 39
  generation process 38

P
PAC (Powdered activated carbon) vii, 11, 15, 33, 47, 56, 77
Plant O&M curves range, common 96
Plate press 69, 72
Polymer 11–5, 74
Polymer Feed vi, 33, 41, 76
Potassium Permanganate Feed vi, 33, 42, 76
Powdered Activated Carbon vii, 33, 47, 77
PPI (Producer Price Index) 23
PPPs (public-private-partnerships) 8
Pre-Ozonation ix, x, 15, 100
Pretreatment 88
Pretreatment Process x, 13
Pretreatment processes 105
Price-level changes 23
Privatization 8
Process
- parameters xii, 1, 21, 24, 30
- pipeline sizes 30
- pumping facilities 74
- schematics 1
- train, advanced treatment 107
- treatment trains 25
- vessels 2
- water 50, 54
- supply 36
- Producer Price Index (PPI) 23
- Product water 62, 88
- Public-private-partnerships (PPPs) 8
- Pump Capacity 34, 78
- Pumps, metering 39, 41, 44, 46

R
- Rapid Mix vii, 33, 48–9, 74, 77
- Raw water 9, 12, 14, 27, 32, 65
- quality 9
- Rectangular Clarifier vii, 33, 53–4, 77
- Recycle 12, 14–5, 74
- Regions 14, 106–7
- Regulatory requirements 8, 107–8
- Reverse osmosis viii, 87–8, 101, 108
- RO (Reverse Osmosis) viii, ix, 13, 87–8, 91, 93, 101, 108
- RO process, expensive 91
- Rotary sludge dryers 18

S
- Sand drying beds vii, 18, 34, 68–9, 78
- Sanitation 106
- Seawater 87, 89, 90
- Seawater Desalination ix, 88, 101, 103
- Seawater Desalination Cost data 100
- Seawater desalination plants 29, 106
- Sedimentation 8, 12, 74
- process 9
- Sewer 14, 17–8, 69, 70, 72
- Sludge 10–5, 17, 66, 69, 70, 72, 74
- collected 17
- Sludge Dewatering Lagoons vii, 66–8
- Sludge removal process 17
- Soda ash filtration plant viii, 81
- Standards
  - basic regulatory 107
  - stringent drinking water quality 7
- Storage tanks 39, 44, 46
- Stratified Sand vii, 57, 77
- Sulfuric acid 33, 43–4, 76, 88
- Sulfuric Acid Feed vi, 33, 43, 76
- Surface
  - wash system vii, 10, 59, 78
  - water treatment 8, 74

T
- Tanks
  - decant 70, 72
  - elevated 58, 60
  - mixing 40, 43
- Thickening 17
- process 18
- TOC (total organic carbon) 9, 12
- Total organic carbon (TOC) 9, 12
- Total Project Construction Cost
  - Comparison 87
- Transfer pumps 39, 41, 44, 46
- Treatment process
  - technologies 12
  - train 8, 107
Two-Stage Filtration Process ix, 11
Two-step process 88
Typical Iron and Manganese Removal Process 14

U
UF (ultra-filtration) 13, 29, 87, 91, 93, 103
UV disinfection process 13

V
Valves xi, 39–44, 46, 56, 59
Variable frequency drive (VFD) 50
VFD (variable frequency drive) 50

W
Wash Waste 11, 14–5
Wash Waste Optional 13, 15
Wash Water Holding Tank 61
Wash Water Storage Tank 34, 78
Wash Water Surge Basin vii, 34, 60, 78
Waste Wash Water 61
Wastewater treatment xiii, 108
design 5, 14
plants 23, 108

Water
demands 106–7
distribution systems 7, 107
finished 105, 107
fresh 86
improvements 105–6
potable 7, 106, 108
processed 53
quality 10, 27
drinking 105, 107–8
required finished 5, 73
reuse 14, 27, 108
source 10, 91, 107
supply ix, 105–8
surface 9, 95
treatment 6, 7, 25, 30, 105
designs 27, 29
modern 7
facilities xi, 29, 91, 108
plant
design 30–1
advanced 14
types 95
plants xi, xii, 1, 6, 8–10, 17–8, 29, 31–2, 106–7
prepackaged advanced 87

Water treatment
processes v, xi, xii, 5, 6, 8, 10, 12, 14, 24, 31–3
technologies, advanced 7, 87

Water Treatment Predesign vi