

Table of Contents

Foreword	xi
Acknowledgements	xii
About the Hydraulic Institute	xiv
About Pump Systems Matter	xv

Chapter • One **Introduction, 1**

1.1 Purpose	1
1.2 Scope	1
1.3 Disclaimer	2

Chapter • Two **Overview, 3**

2.1 Objective of a Wastewater Treatment Plant	3
2.2 What Is Wastewater?	3
2.3 Why Treat Wastewater?	6
2.4 Biological Wastewater Treatment	7
2.5 Process Treatment Scheme	7

Chapter • Three **Pump Selection Considerations and Guide Instructions, 11**

3.1 Hydraulic Institute (HI) Standards and References	13
3.1.1 HI Standards	13
3.1.2 HI Pump References	15
3.2 Site Conditions	15
3.2.1 Installation Space	15
3.2.2 Piping Alignments	15
3.2.3 Wet-well Depth	19
3.2.4 Interior/Exterior Installations	19
3.2.5 Power	19
3.3 Pump Operational Requirements	19
3.3.1 Rate of Flow Requirements	20
3.3.2 Suction and Discharge Requirements	20

3.3.3	Efficiency	20
3.3.4	Type of Material Pumped	21
3.3.5	Additional Requirements	24
3.4	Asset Management, Life Cycle Cost, and Effective Procurement	34
3.4.1	Asset Management	34
3.4.2	Life Cycle Costs	35
3.4.3	Procurement	35
3.5	Reliability, Preventive Maintenance, and Repair	36

Chapter • Four

Treatment Plant Operations, 39

4.1	Collection System	39
4.2	Treatment Plant Influent Headworks	39
4.2.1	Pump Features and Considerations	40
4.3	Screens	42
4.3.1	Pump Features and Considerations	43
4.4	Grit Removal	44
4.4.1	Pump Features and Considerations	45
4.4.2	Pump Characteristics	46
4.5	Primary Treatment	47
4.5.1	Primary Clarifier or Primary Sedimentation Tanks/Basins	47
4.5.2	Primary Sludge	48
4.5.3	Primary Scum	50
4.6	Secondary Treatment	51
4.6.1	Aeration Basins	51
4.6.2	Anoxic Zone	53
4.6.3	Internal Recycle	55
4.7	Secondary Clarifier	56
4.7.1	Return Activated Sludge (RAS)	56
4.7.2	Waste Activated Sludge (WAS)	57
4.8	Secondary Scum	58
4.9	Tertiary Treatment	58
4.9.1	Filter Backwash	58
4.9.2	Backwash Wastewater	59
4.10	Membrane	60
4.10.1	Pump Features and Considerations	61
4.11	Disinfection	61
4.11.1	Chlorination	62

4.11.2 Ultraviolet Light	62
4.11.3 Ozone	63
4.12 Effluent Disposal.	64
4.12.1 Effluent Discharge	64
4.12.2 Plant Nonpotable Use	65
4.12.3 Water Reclamation	66
4.12.4 Groundwater Recharge Application.	66
4.13 Chemical Feed Systems.	67
4.13.1 Pump Features and Considerations	68
4.14 Other Pumping Applications	70
4.14.1 Sump	70
4.14.2 Sample	71
4.15 Sludge Handling and Disposal	72
4.15.1 Sludge Transfer	72
4.15.2 Sludge Thickener.	73
4.15.3 Digester and Digested Sludge.	73
4.16 Dewatering	74
4.16.1 Sludge Transfer Pumps.	75
4.16.2 Dewatering Feed Pumps.	76

Chapter • Five

Pump Drivers, 77

5.1 Motor Types	77
5.1.1 Open Drip-proof (ODP)	78
5.1.2 Totally Enclosed Fan Cooled (TEFC)	78
5.1.3 Totally Enclosed Nonventilated (TENV)	79
5.1.4 Weather Protected Types I and II (WPI, WPII)	79
5.1.5 Explosion-proof Motors (XP)	79
5.1.6 Immersible Motors	79
5.1.7 Submersible Motors.	80
5.2 Motor Starting Methods.	80
5.2.1 Across-the-Line or Direct-on-Line (DOL).	80
5.2.2 Reduced Voltage Soft Starters (RVSS).	81
5.2.3 Variable Frequency Drives (VFDs)	82
5.2.4 Application Considerations (Solid-state Starting Methods)	83
5.3 Pump Motor Controls	84
5.3.1 Timers	84
5.3.2 Level Controls	84
5.3.3 Flow Controls.	85
5.3.4 Pressure Controls	85
5.3.5 Process Controls	85

Appendix A
Pump Selection Summary Table, 87

Appendix B
Pump Materials of Construction, 95

Appendix C
**Mechanical Seals and Packing Used
with Wastewater Treatment Plant Pumps, 103**

C.1 Mechanical Seals	104
C.2 Packing	105
C.3 Single and Split Seals	106
C.4 Piping Plans and Bushings	109
C.4.1 Single Seals	109
C.4.2 Dual Seals	114
C.5 Pump Construction Exceptions	115

Appendix D
Couplings, 117

Appendix E
Image Credits, 119

Appendix F
Bibliography, 121

Appendix G
Glossary, 123

Appendix H
Index, 131

List of Figures

2.1 Conventional wastewater treatment plant flow diagram	8
2.2 Conventional wastewater treatment plant with clarifiers flow diagram	9

3.1	Pump selection guide chart	12
3.2	Rotodynamic pump types – overhung impeller	16
3.3	Rotodynamic pump types – between bearings	17
3.4	Rotodynamic pump types – vertically suspended	18
3.5	Recommended maximum operating speeds for single suction pumps (US customary units) with N_{ss} (S) = 8500	27
3.6	Recommended maximum operating speeds for single suction pumps (metric units) with S (N_{ss}) = 165	28
4.1	Influent pump station arrangement	40
4.2	Horizontal solids-handling pump	42
4.3	Vertical solids-handling pump	43
4.4	Grit removal system and pump	44
4.5	Grit removal and processing system	44
4.6	Multiple clarifier basin arrangement	47
4.7	Clarifier basin	48
4.8	Solids processing pumps	49
4.9	Aeration basin	52
4.10	Submersible pump	54
4.11	Submersible recycle pump	55
4.12	Typical UV lamps	63
4.13	Typical ozone generator unit	63
4.14	Chemical feed pump	68
4.15	Chemical feed pump assembly	68
4.16	Typical sump pump	70
4.17	Typical sample pump and container	71
4.18	Solids-handling pumps	72
5.1	Typical induction motors	78
C.1	Typical mechanical seal	104
C.2	Single cartridge pusher seal	107
C.3	Elastomer bellows seal	107
C.4	Split mechanical seal	108
C.5	Plan 02	109
C.6	Plan 03	110
C.7	Plan 11	111

C.8	Plan 13	112
C.9	Plan 32	113
C.10	Plan 54	114
C.11	Component dual seal for submersible solids-handling pump . . .	116