Sewer Lift Station Design and Pump Application

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Delta Process Equipment


DELTA
PROCESS
EQUIPMENT
INC

Sizing Wastewater Pumping and Treatment Systems

- Using State of Louisiana Administrative Code & Associated DHH Information

RECOMMENDED STANDARDS for WASTEWATER FACILITIES

POLICIES FOR THE DESIGN, REVIEW, AND APPROVAL OF PLANS AND SPECIFICATIONS

FOR WASTEWATER COLLECTION AND TREATMENT FACILITIES

1997 EDITION

A REPORT OF THE WASTEWATER COMMITTEE

OF THE

GREAT LAKES -- UPPER MISSISSIPPI RIVER

BOARD OF STATE AND PROVINCIAL PUBLIC HEALTH AND ENVIRONMENTAL MANAGERS

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Ten State Standards

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Recommended Standards

- Written by the 9 member states, plus one Canadian Province, as recommended standards.
- Codified in Louisiana in the Administrative Code and now the **LAW**.
- Regional DHH offices in LA responsible for design review and compliance

Chapter 15. Sewage Loading Criteria [formerly Chapter 13 Appendix B]

§1501. General Requirements

A. See Note (a)

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Apartments		250	0.425	one bedroom
		300	0.52	two bedroom
		400	0.68	three bedroom
Assembly	Note (b)	2	0.0034	per seat
Bowling Alleys (no food service)	Note (b)	75	0.13	per lane
Churches	Note (b)	5	0.0088	per sanctuary seat
Churches (with permitted kitchens)	Note (c)	10	0.017	per sanctuary seat
Country Clubs		50	0.085	per member
Dance Halls	Note (b)	2	0.0034	per person
Drive-In Theaters		5	0.0085	per car space
Factories (no showers)		20	0.051	per employee
Factories (with showers)		35	0.06	per employee

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Mobile Home Parks				
up to 5 trailer spaces		400	0.68	per mobile home space
6 trailer spaces or more		300	0.51	per mobile home space
Motels	Note (b)	100	0.12	per unit
Nursing and Rest Homes	Note (c)	100	0.25	per patient
		100	0.17	per resident employee
Office Buildings		20	0.051	per employee
Recreational Vehicle Dumping Stations				Consult OPH
Recreational Vehicle Parks and Camps		125	0.21	per trailer or tent space
Retail Store		20	0.034	per employee
Schools□ Elementary	Note (c)	15	0.038	per pupil
Schools□High and Junior High	Note (c)	20	0.051	per pupil

Sewer Lift Station - Example

- 200 home subdivision
- Central collection pump station
- Pumping 3,000’ to receiving manhole
- Natural ground = 35.00’
- Lowest gravity line into station = 25.00’
- Submersible pump station desired
- Three-phase power available

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Hotel/Motel Food Service		45	0.17	per room
Homes/ Mobile Homes in Subdivisions		400	0.68	per dwelling
Individual Homes/Mobile Homes (where individual sewage technology is utilized. For each additional bedroom add 100 gpd)		250	0.425	one bedroom
		300	0.51	two bedrooms
		400	0.68	three bedrooms

Calculations

- 400 GPD x 200 homes = 80,000 DAF
- 80,000 / 1440 min. per day = 55.56 GPM DAF

Calcs continued …

- 55.56 GPM x 4.0 peak factor = 222.24 GPM Peak Flow (*minimum pumping capacity*)
- 55.56 GPM x 30 minute max detention time = 1,666.8 gallons
- Minimum pump run time = 2.0 minutes
- 1,666.8 gallons / 2 minutes = 833.4 GPM (*maximum pumping capacity*)

Calcs continued …

- Selected detention time = 15 minutes (30 minute max) = 55.56 GPM x 15 = 833.4 gallons
- Selected pump capacity = 300 GPM
- Pump cycle = 833.4 gal / 300 GPM = 2.78 minutes (min. 2 minutes)
- Storage capacity in 6’ diameter wet well = 212 gallons per foot depth
- 833.4 gallons / 212 = 3.93’ depth required

Wet Well Data

- Natural ground = 35.00’
- Top of wet well = 35.50’
- Lowest gravity invert = 25.00’
- High water alarm = 24.50’
- Lag pump on = 24.00’
- Lead pump on = 23.50’
- Pumps off = 19.57’
- Wet well bottom = 17.50’
- Total wet well depth = 35.50’ – 17.50’ = 18’

Force Main Data

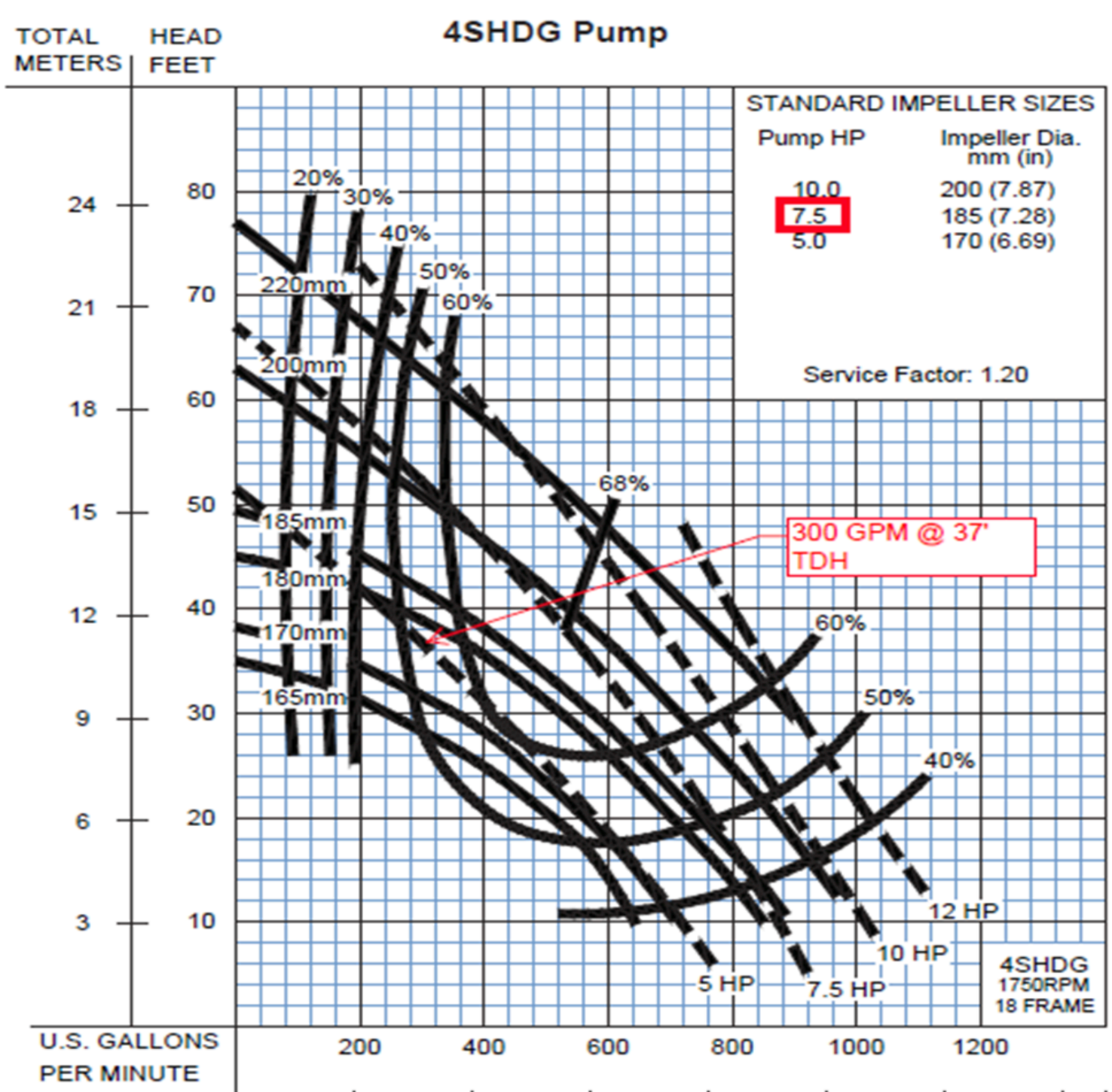
- 2.0’/sec min. velocity required for scouring
- Velocity in 4” FM = 7.66’/sec
- Velocity in 6” FM = 3.40’/sec – this one
- Friction loss in 6” = 1.32’/100 line length, C=100
- 1.32 x 30 = 39.6’ x .54 (K factor) for C=140 (PVC) = 21.38’ friction loss
  - Hazen & Williams Formula

TDH Data

- 300 GPM selected pumping capacity
- Friction loss in line = 22’
- Max. static = 32.00’ FM – 19.57 OFF level in wet well = 12.43’ or 13’
- Losses through pump station valves & fittings = 150’ equivalent length = 1.98’ or 2’
- Total dynamic head = 22’ + 13’ + 2’ = 37’

Pump Station Summary

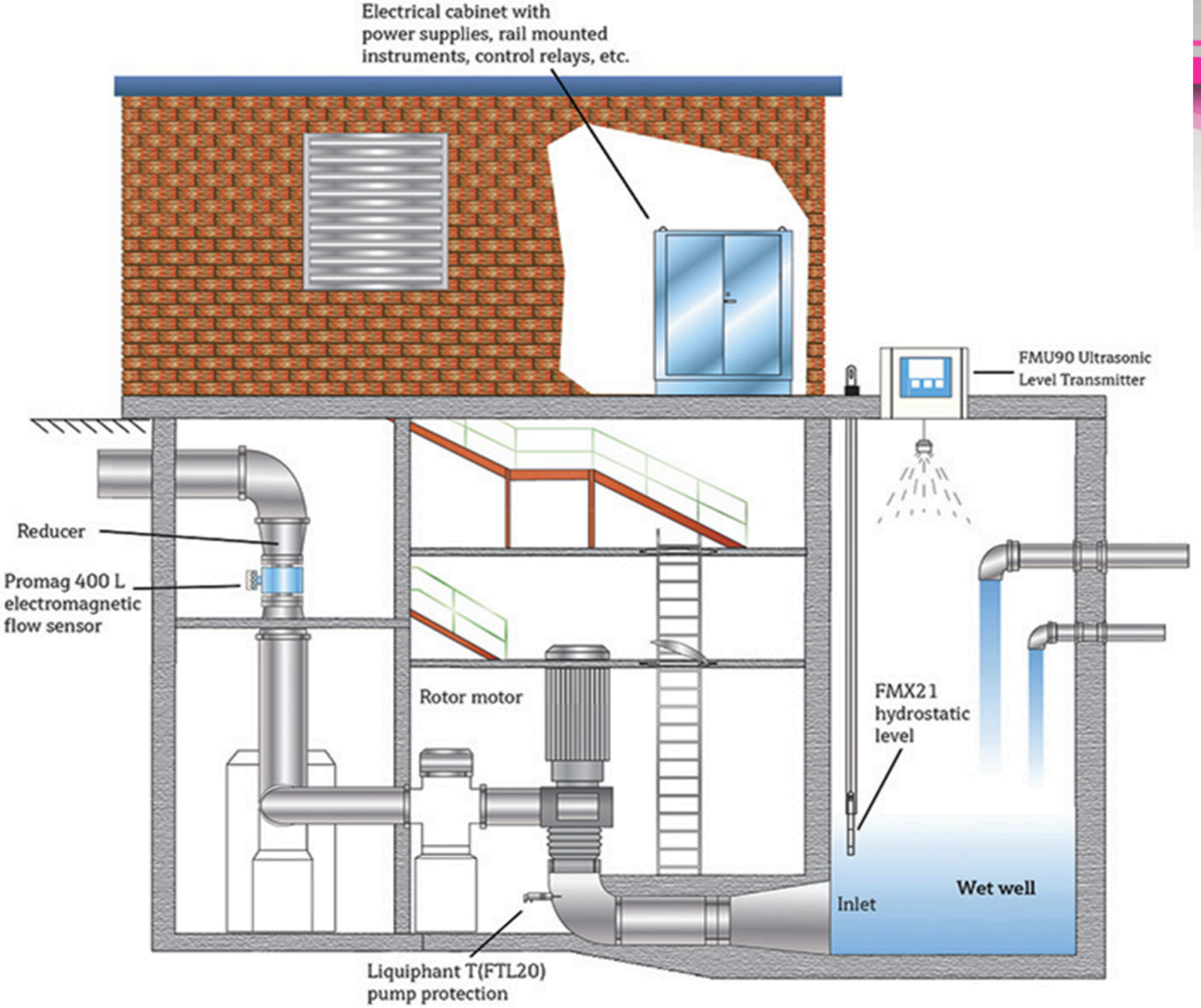
- 6’ diameter x 18’ deep wet well
- 6” force main
- Pump selection: 300 GPM @ 37’ TDH
- Three-phase power (why?!)



Pump Selection

Early Lift Stations

- Involved a sump (wet well) to collect wastewater and some method of pumping
- Pumps had to be able to handle solids
- Submersible and self-priming pumps had not yet been used for wastewater
- Many dry-pit stations with solids-handling pumps; expensive to construct and maintain



Conventional Dry Pit Lift Station

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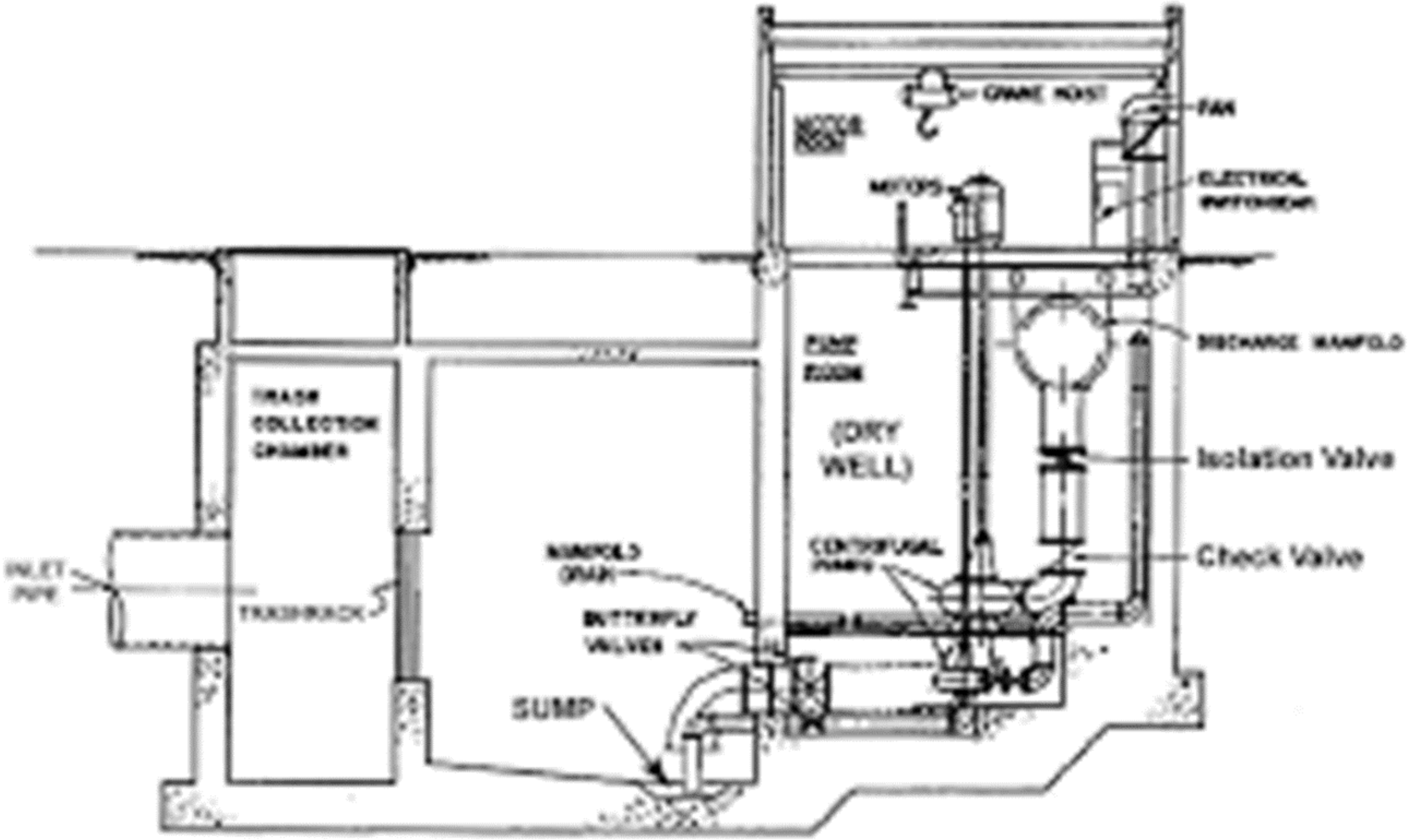

Vertical-Shaft Dry Pit Lift Station

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Problems Remain

- Operators tired of dealing with vertical shaft bearing and coupling issues
- Injuries and confined space deaths occurred in some dry-pit stations
- Owners asked for a way to get the pump directly into the wastewater
- Vertical shaft submersible pumps were developed
- Similar issues as vertical dry-pit pumps

Modern Pumping Stations

- Various choices of submersible, self-priming and vertical shafts available to do the job
- Similar hydraulic coverage amongst all styles
- No wet well required?!?!

Submersible Pump & Slide Rail Removal System

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Types of Submersible Pumps

- Grinders: small flows 1-1/4” and 2” discharge
- Shredders: medium flows 2” – 4” discharge
- Non-clogs: 3” discharge and up
- Vortex: 3” discharge and up
- Recessed Impeller: 3” discharge and up
- Chopper: 3” discharge and up

Submersible Grinder Pump - Two Stage

Submersible Non-Clog & Chopper Pumps

Submersible Advantages

- Typically lower profile and out of sight when in aesthetically-sensitive areas
- Can be quieter
- No priming required
- Not much owner can do to maintain (this is a double-edged sword)
- Wet well depth doesn’t matter
- Wide range of flow and pressure capabilities
- Most can operate on VFD’s

Submersible Challenges

- Submersible replacement pumps typically take a minimum of 4-6 weeks to get
- There are so many submersible models and sizes, the manufacturers don’t keep on hand
- In the event of a motor or seal failure, pump must go to a rewind shop for repair
- Larger submersible pumps are very heavy, requiring cranes for removal and are more expensive than self-primers
- Below water level and not easily maintained
- Typical life expectancy of 7-10 years

Above Ground Pumps

- Submersible pump failures in the 1950's and 1960's led operators in Florida to experiment with Gorman-Rupp self-priming pumps
- Self-primers used in the industrial and commercial markets since the 1930's
- Not designed to operate in the municipal wastewater environment
- Worked well on wastewater, but operating and priming issues persisted

Gorman-Rupp Sewage Self-Primers

- T-Series pump designed to solve sewage pump station specific problems in the early 1960's
- Super-T Series improvement in the early 1990's
- Ultra-V Series expanded flow and pressure capabilities in the mid-2000's
- Flows from 50 – 5000 GPM, heads to 325'
- Self-priming to approximately 23'

Gorman-Rupp Super-T Series Self-Primer

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Gorman-Rupp Ultra-V Series Self Prime

Gorman-Rupp Ultra-VS Series 2-Stage Self-Primer

Self-Priming Advantages

- Pump is “high and dry” for easy maintenance
- Standard motor – readily available from any motor supplier
- Wide range of flows and pressure with only six 3” – 12” models (takes 125 submersible models to cover that same performance)
- Typical life expectancy of 20-30 years
- No confined space entry required in the wet well to maintain the pumps and accessories
- Easy to unclog if a clog develops

Self-Priming Challenges

- Wet well depth can’t exceed a max of 23’
- Max flow capability of 5000 GPM
- Minimum flow capability 50-75 GPM
- Must prime and re-prime
- Noise – can be noisier than submersible pumps, though not always so
- Larger footprint in aesthetically-sensitive areas
- Subject to freezing if not provided with casing heaters or installed in an enclosure

What's the Best Choice?

- Owner, engineer and pump supplier should evaluate all requirements to determine which pumping solution best fits the needs of each specific job
- No one pumping technology will be the right choice for every lift station
- The capabilities of local suppliers and service personnel should be considered. If no one within 100 miles can work on or pull a 100HP submersible pump, another technology may be best.