Pumping System Design Seminar

Hydraulic Variations for Both PC and Centrifugal Grinder Pumps Utilized in Pressure Sewer Systems

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Pressure Sewer Systems
5-13-10
COLUMBUS, OHIO

Engineered for life

Water & Wastewater

A Pressure Sewer is . . .

- **A sanitary sewer system that utilizes a network of grinder pumps to transport wastewater through small diameter pipes to a collection and treatment system.**
- **A grinder pump is a submersible pump designed to reduce wastewater particulate to a slurry through the use of a grinding mechanism.**

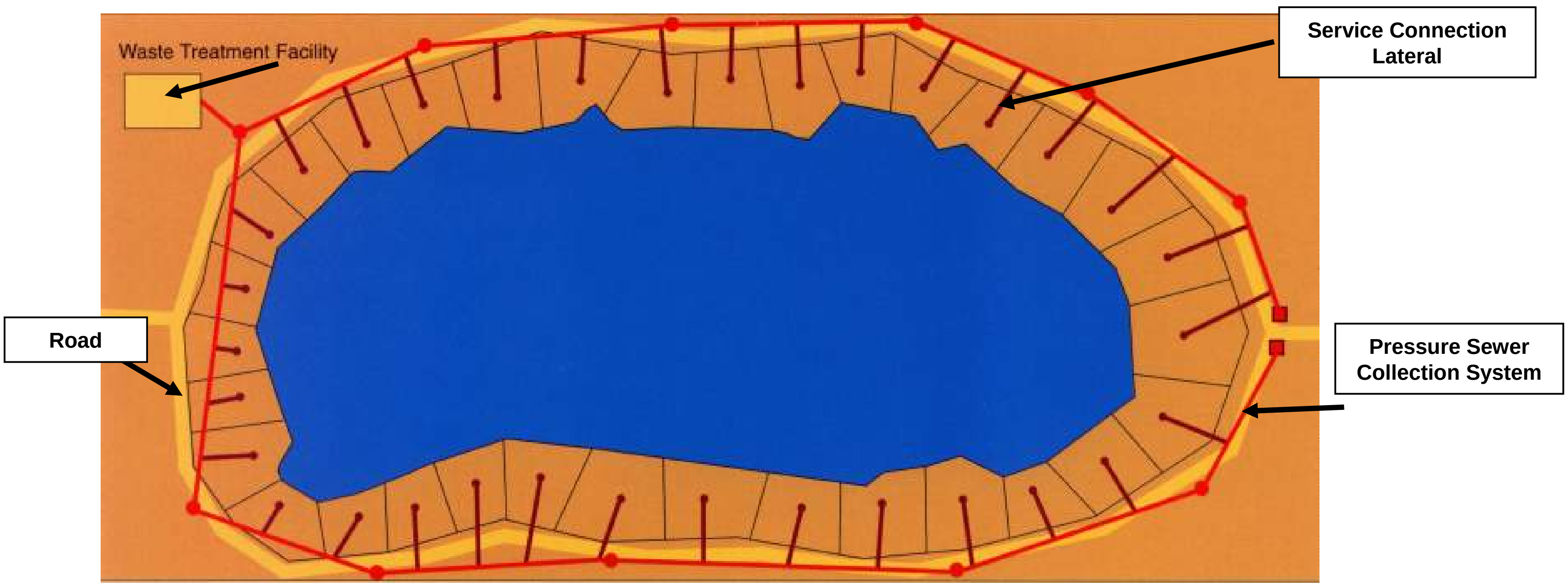
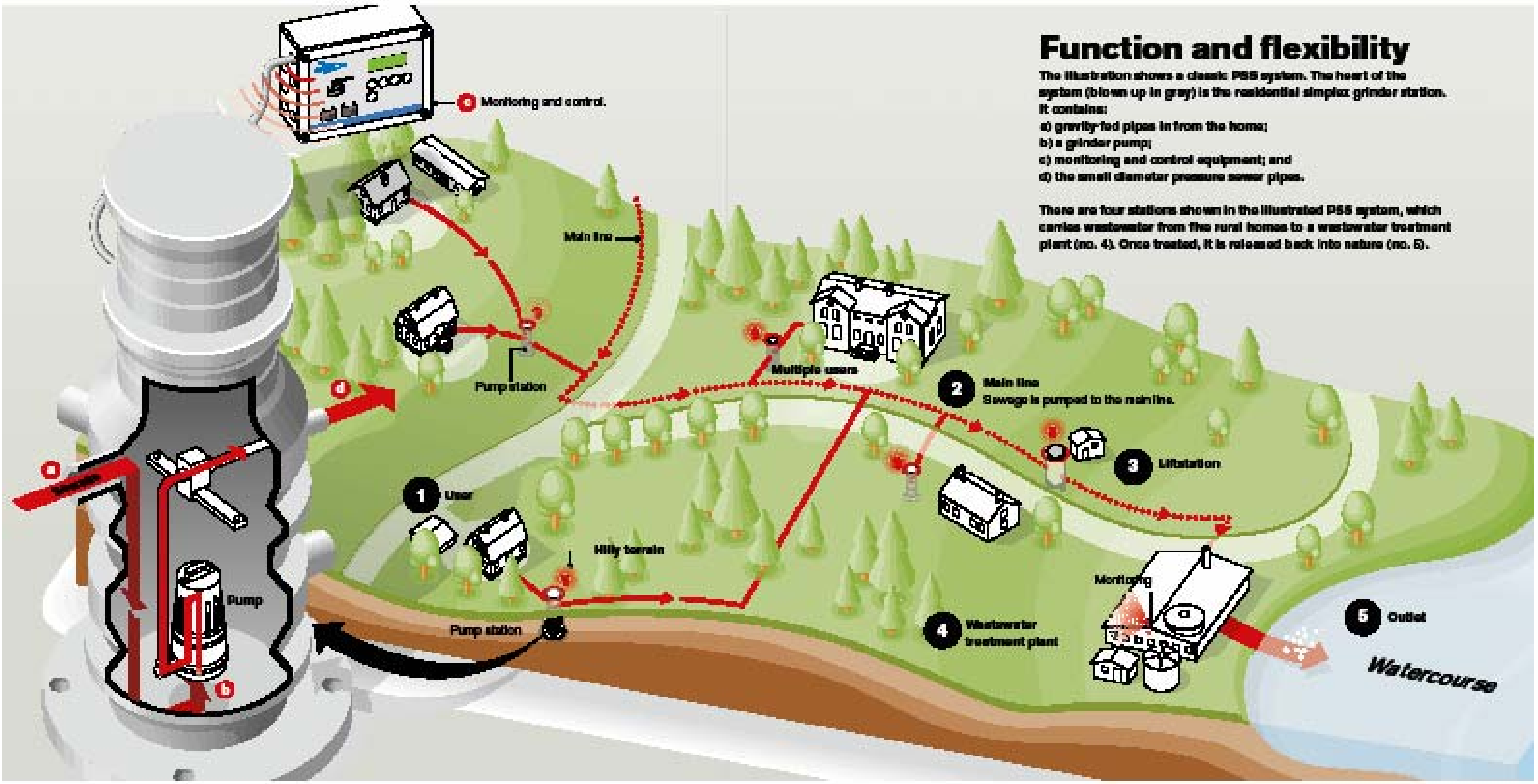


Figure 1.1 -- Typical lakefront pressure sewer system

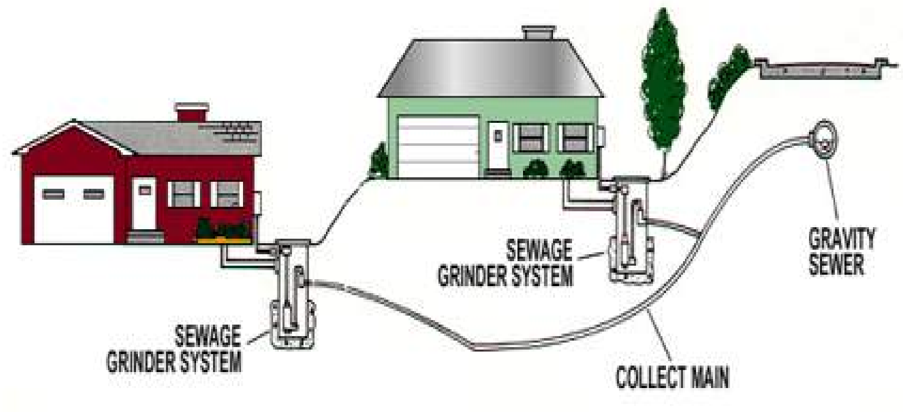
Pressure Sewer System



How big is it?

- Systems can be as small as a single station pumping into an existing gravity sewer line

- Systems can be as large as thousands of stations tied together with a piping network stretching for miles before discharging to a collection point



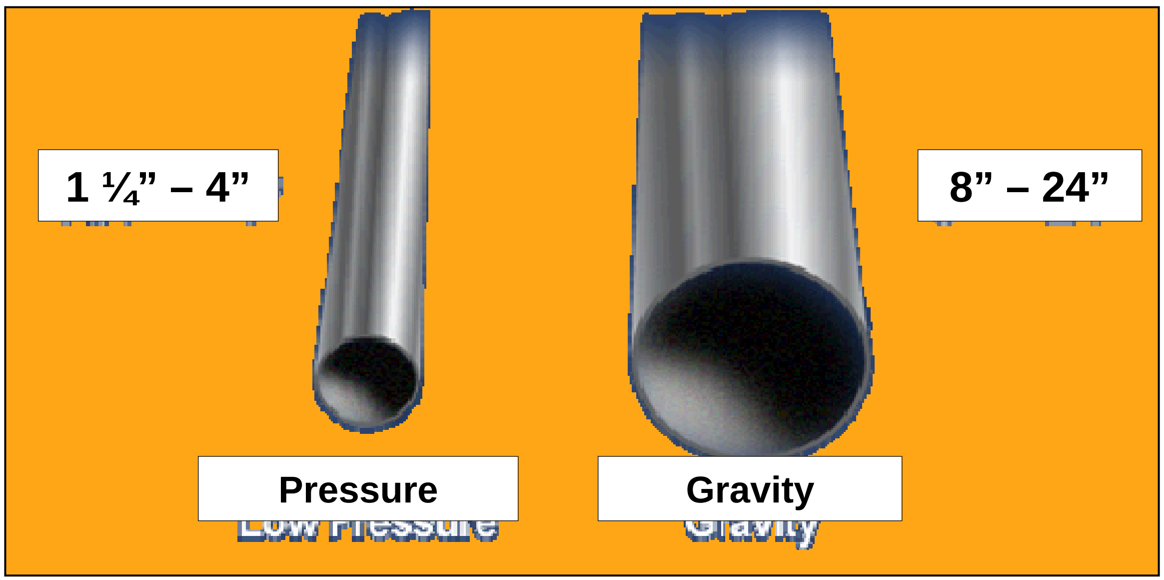
Gravity sewers require big equipment, major excavation

Pressure Sewers do not rely on limitations of gravity

- **Wastewater is pumped through small diameter pipes following the contour of the land, set in shallow trenches just below the frost line**
- **Lift stations are minimized or eliminated in virtually every installation**
- **Wastewater treatment plants for these systems are less costly to build since the system is closed to infiltration and solid sizes are minimized.**

Infrastructure development costs are lower

- Major excavation is eliminated
- Labor and material costs can be dramatically reduced
- Environmental disruption and restoration are minimized
- Time to complete construction is reduced



Overcoming obstacles

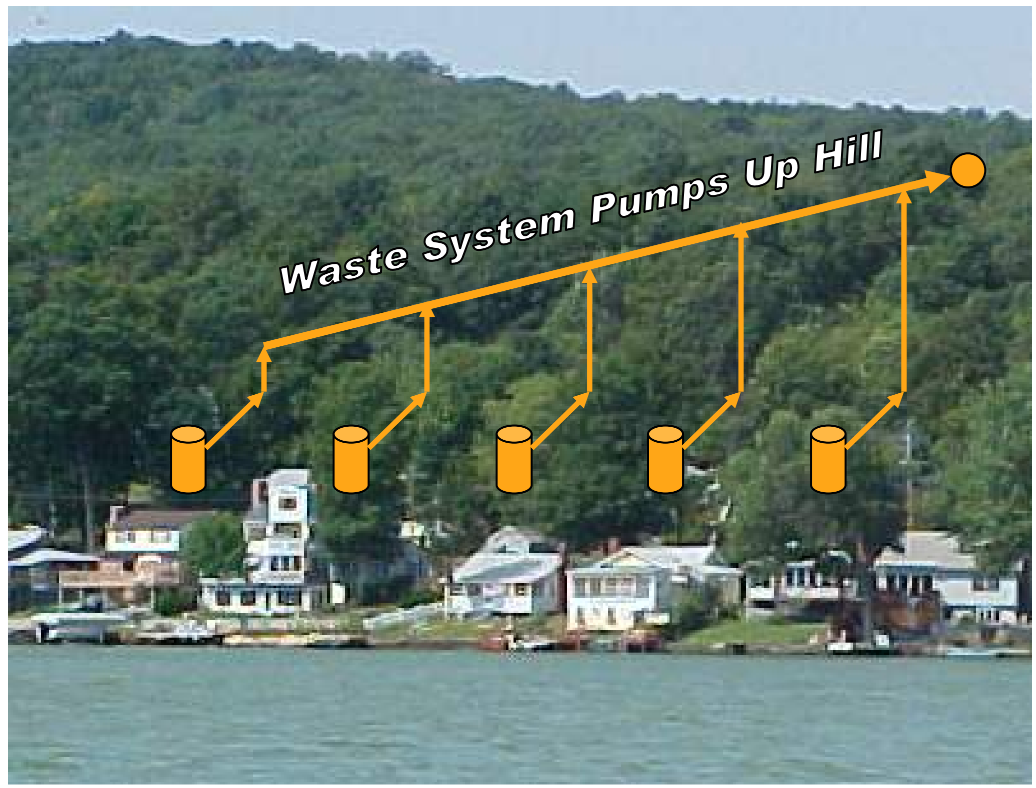
- Directional boring can eliminate the need for trenches and install pipe under rivers and roadways

- Site restoration costs are minimized

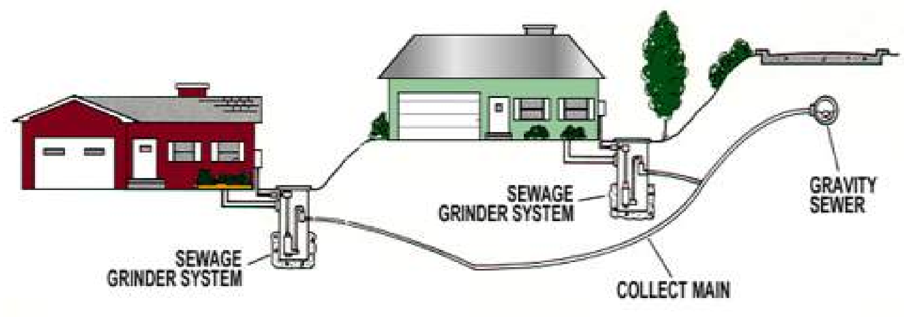
Pressure Sewers provide…

- **An economical solution to geo-technically challenging environmental conditions where gravity sewers may be impractical if not impossible.**

- ***Examples include*:**
  - **- Rocky soil**
  - **- Hilly terrain**
  - **- Shallow bedrock**
  - **- High water tables**
  - **- Long flat terrain**
  - **- Slow growth areas**
  - **- Existing structures and roads**
  - **- Shallow bedrock**



Pressure Sewers are economical



- Prepackaged systems lower up front costs by allowing developers to add grinder pump stations as new homes are built
- Allows developers to build in areas that are inaccessible to gravity sewers
- Minimizes the need for manholes and lift stations, making more lots marketable for sale
- Lower cost per lot in low density development areas

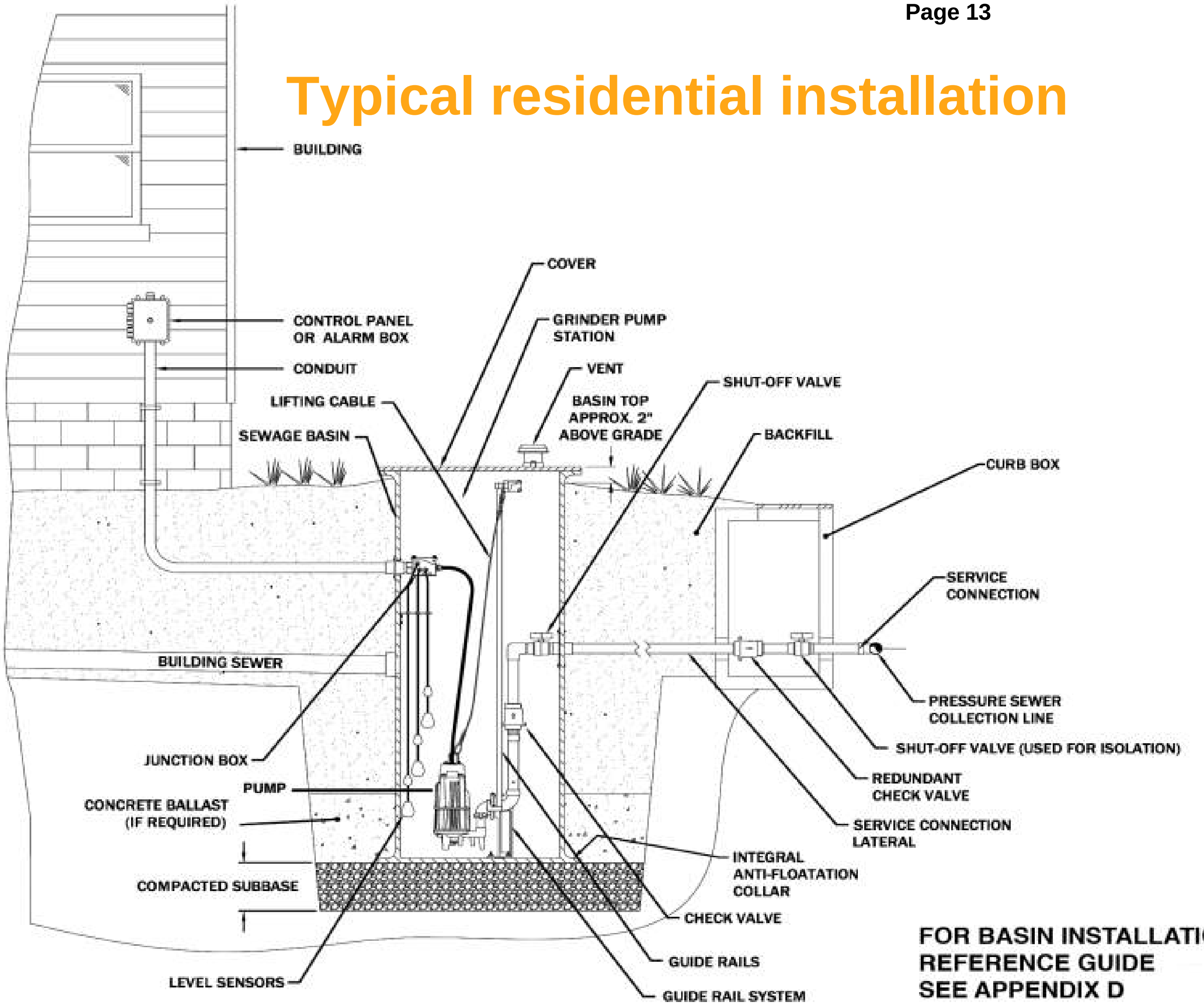
Pressure Sewers:
A Proven Technology

- **First used in the early 1970's**
- **Provide daily service to millions of users worldwide**
- **Have demonstrated excellent performance, high reliability and low Operating and Maintenance costs**

A compatible solution

- Pressure sewer systems are compatible with other types of collection systems
- Pressure sewer systems can be integrated into existing collection systems
- Multiple systems can be blended into site specific designs to provide a complete solution to wastewater challenges

Typical residential installation



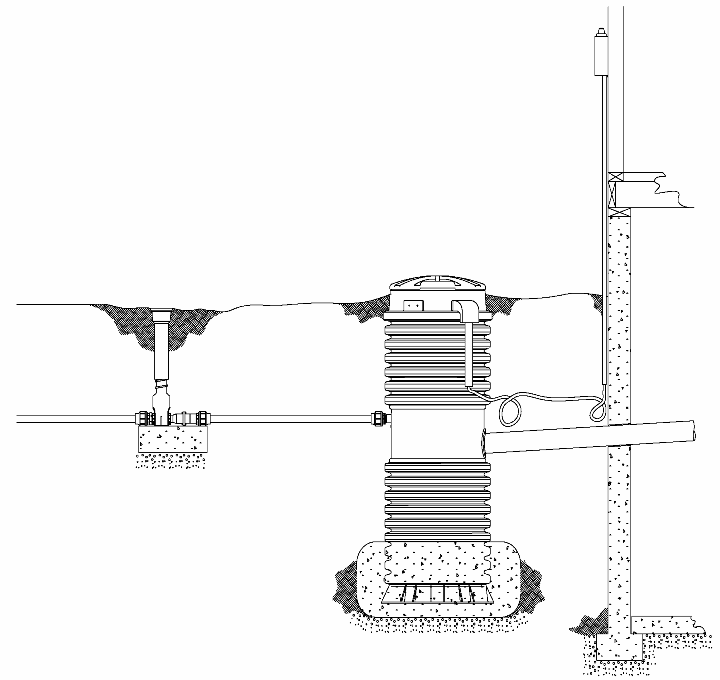
FOR BASIN INSTALLATION REFERENCE GUIDE SEE APPENDIX D

Typical residential Grinder Pump site components

•A pressure sewer collection line is laid along the edge of the roadway, following the contour of the land

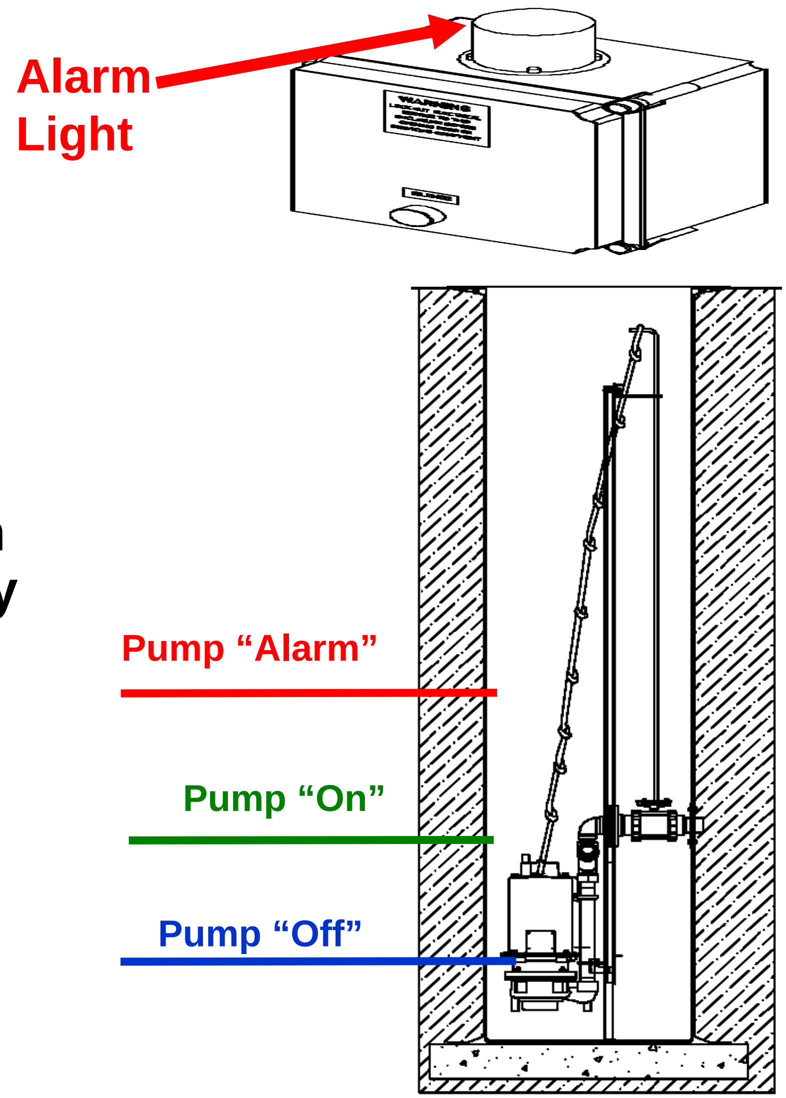
•The pressure sewer collection line delivers the wastewater to a central treatment system, manhole, or force main

•Wastewater may be transported several thousand feet to a discharge point at a higher elevation

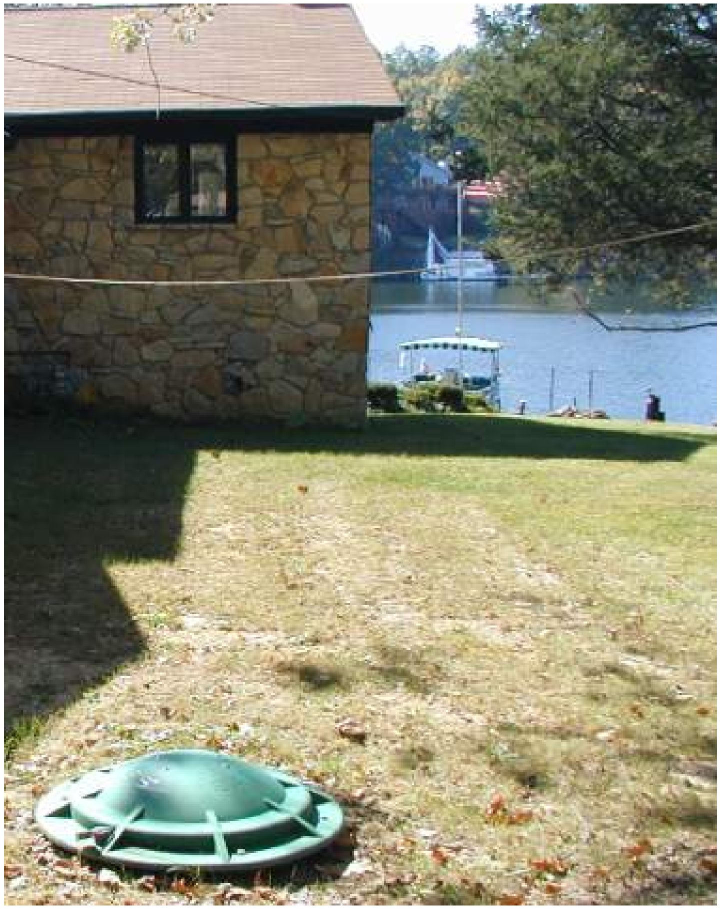


Station operating sequence

- **If the pump does not operate when signaled by the level sensor the sewage level continues to rise, activating a high water alarm**
- **The high water alarm is normally an audible and/or visual alarm and may be a remotely monitored signal**



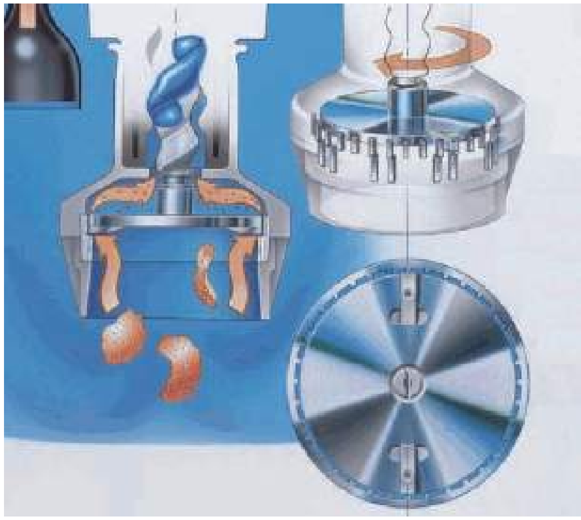
Typical residential installation



- A grinder pump station is located in the yard or basement of each home
- Wastewater flows into the station from the building's sewer line (typically 4")
- The basin contains a grinder pump, level sensors, valves and discharge piping

Centrifugal & PC Grinder Pump Cutters

- **A submersible pump designed to reduce wastewater particulate to a slurry through the use of a grinding mechanism**
- **Typical Types**
  - **Progressing Cavity (1 - 2 HP)**
  - **Centrifugal (2 - 15 HP)**
- **Discharge Size - 1-1/4” to 3”**

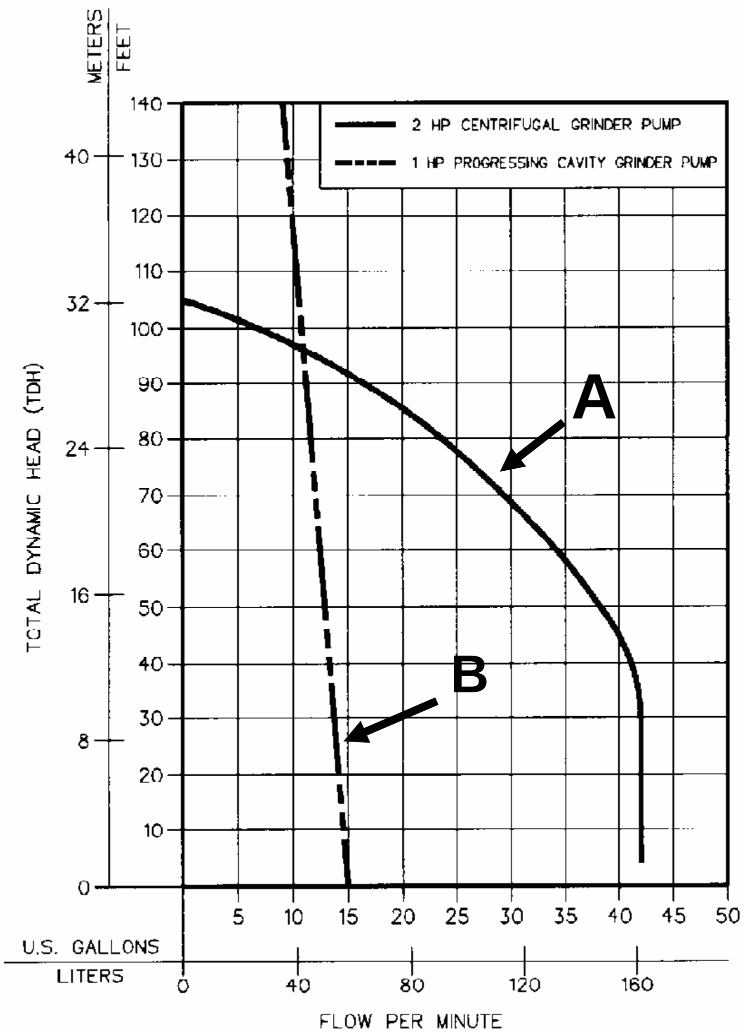


Pump Hydraulics

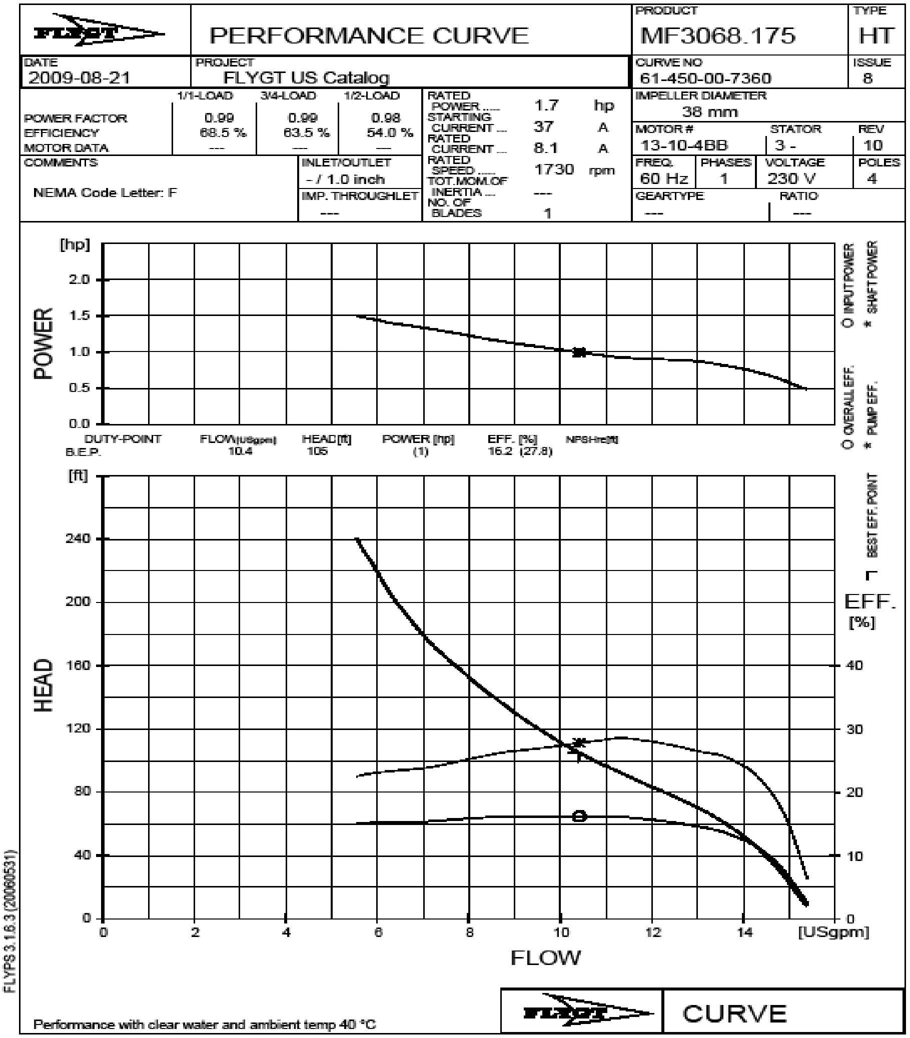
- **Typical residential performance curves**

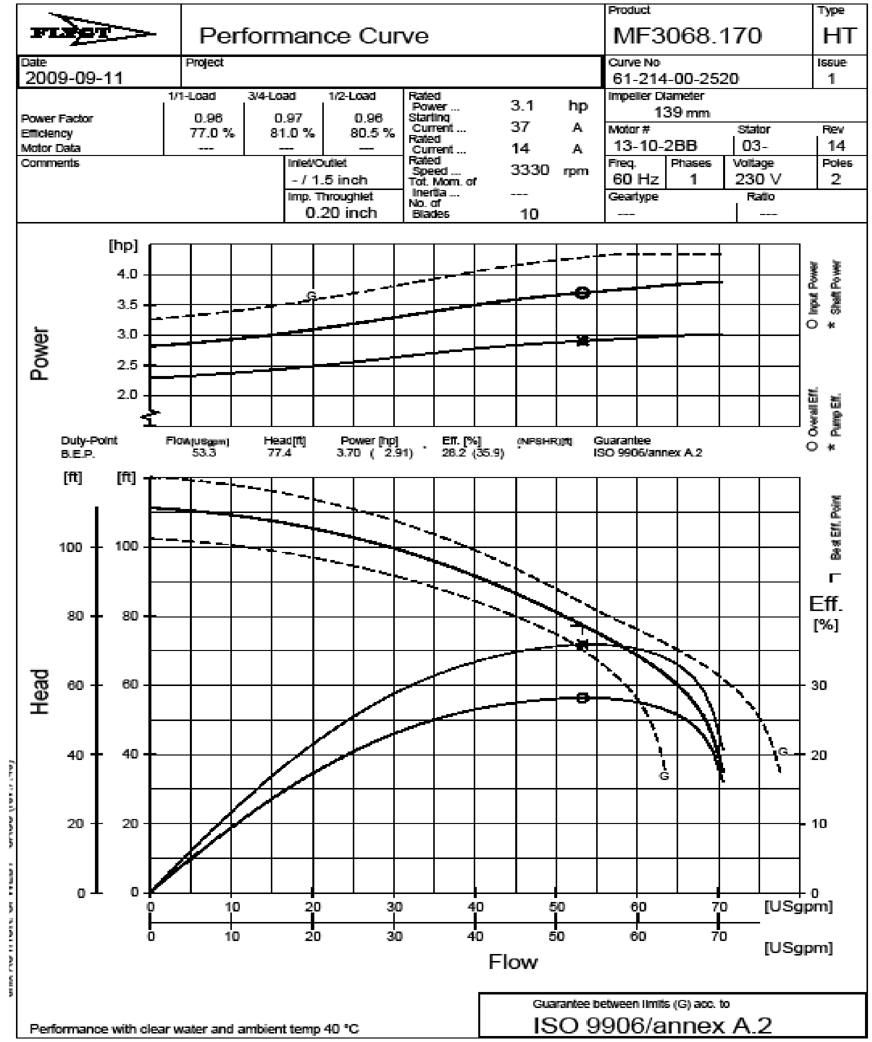
  A – Centrifugal

  B – Progressing Cavity

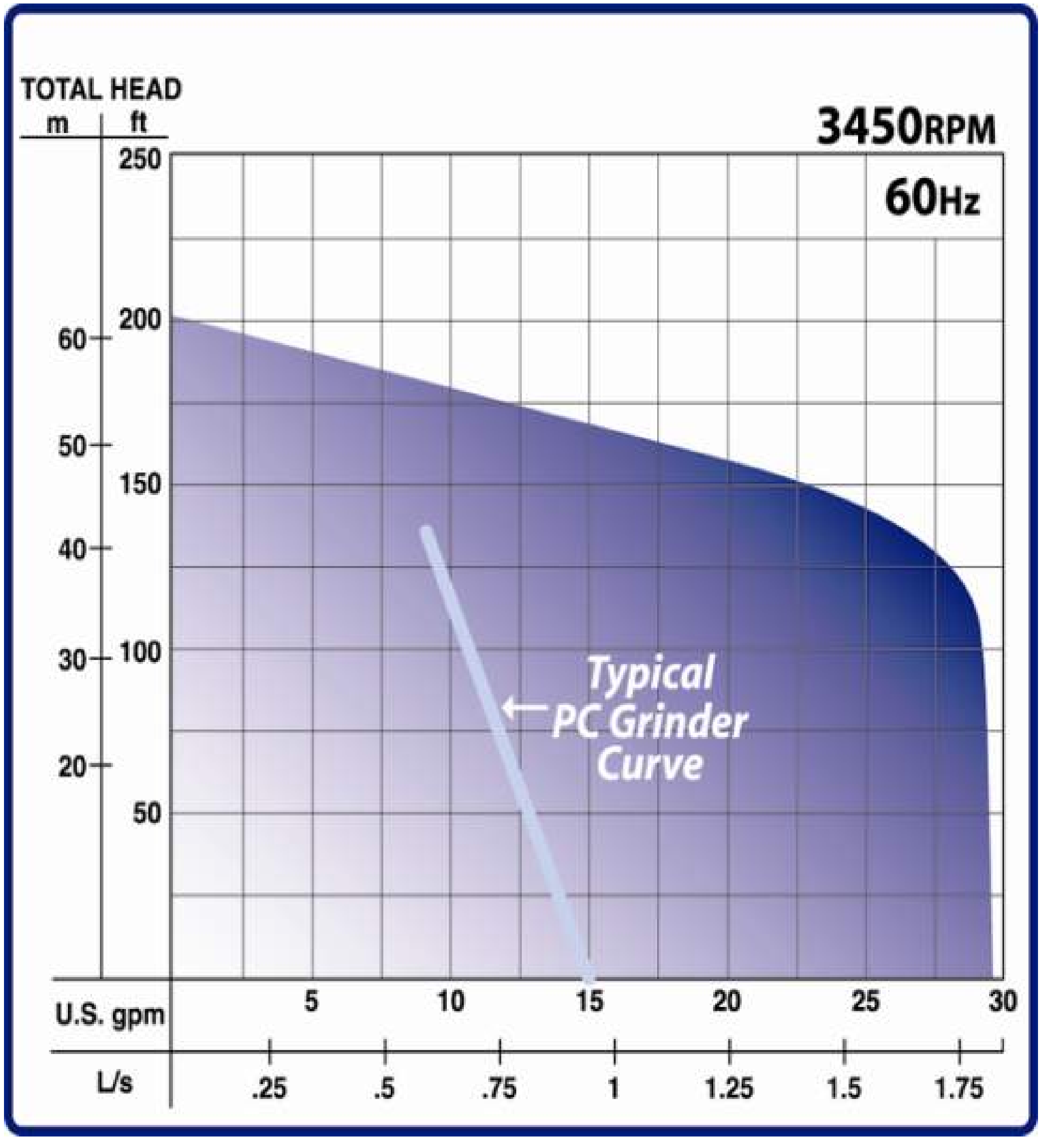


Hydraulic Variations for Both PC & Centrifugal





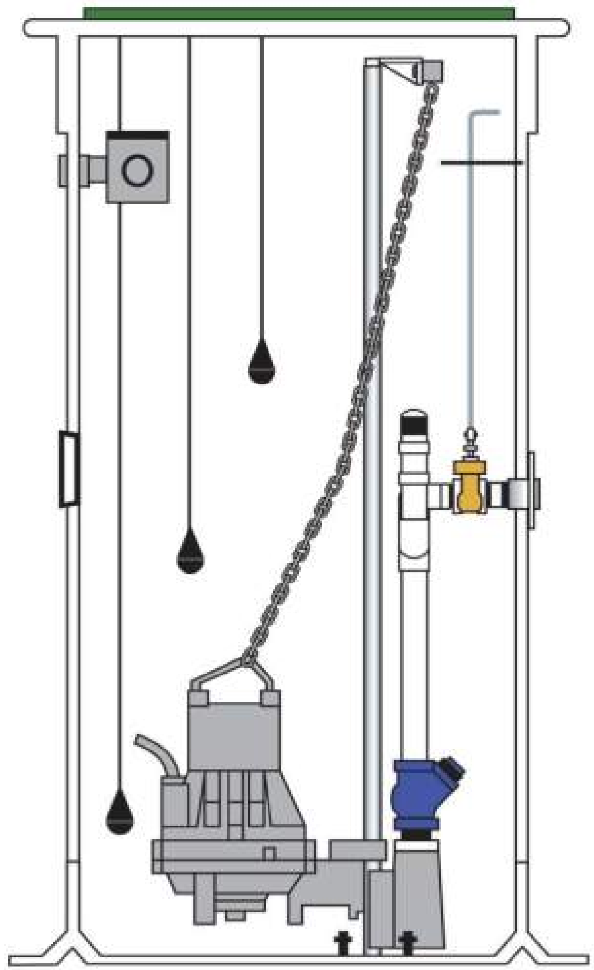
2-STAGE HIGH HEAD CENTRIFUGAL



RESIDENTIAL & LIGHT COMMERICAL GRINDER PUMP PACKAGE STATION

24" Diameter

30" Diameter



PRESSURE BELL OR FLOAT TREE

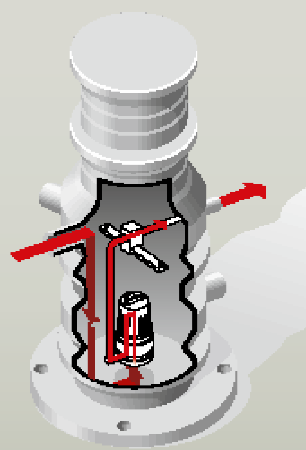
Basin Design Considerations




The PSS solution

In hilly terrain of West Virginia, the town of Leon has been designated a brand new pressure sewer system (PSS) with Flygt grinders, a pioneering move in the United States. ITT Water & Wastewater's technology, although firmly established in Europe, is breaking into America's fast-growing PSS market.

Text Mark Cardwell
Illustration Svenska grafikbyrån/TT



WEST VIRGINIA'S MOTTO – Mountaineers are always free – is a pretty good indication of the rugged topography that makes up much of the picturesque American state. It offers clues too about the many things that wastewater specialists must consider when they plan, design and develop modern collection and treatment processes for the hundreds of small communities that dot the hills and valleys of West Virginia. "Our terrain is steep and rocky," said Fred Hypes, vice president of Dunn Engineers, a state leader in the field of potable water and wastewater treatment since 1975. "It adds to the challenge of doing what we do."

A case in point is the new collection system that Fred Hype helped to design for the town of Leon. Founded in 1872 on the banks of the state's longest river, the Kanawha, which empties into the Ohio, it has never had a sanitary sewer system for its 160 homes. "Unfortunately, that's not uncommon in West Virginia," said Fred Hypes. Also typical, he added, is the fact that most town residents are connected to decades-old septic tanks, many of which have failed or are failing. "But a lot of houses have straight pipes that go right in the river," Fred Hypes said from his office in Charleston, a regional hub located a half-hour's drive southeast of Leon. "It's not a pretty sight and it's not good for the people or the environment."

Last year municipal authorities secured federal and state funding (through the American Recovery and Reinvestment Act – or ARRA) for the construction of a new wastewater collection and treatment system for their town. Working with Dunn Engineers and Precision Pump and Valve Service, an ITT Water & Wastewater distributor that is also located in Charleston, they designed a pressure sewer system – or PSS – to overcome the geological realities that made an on-site system impractical.

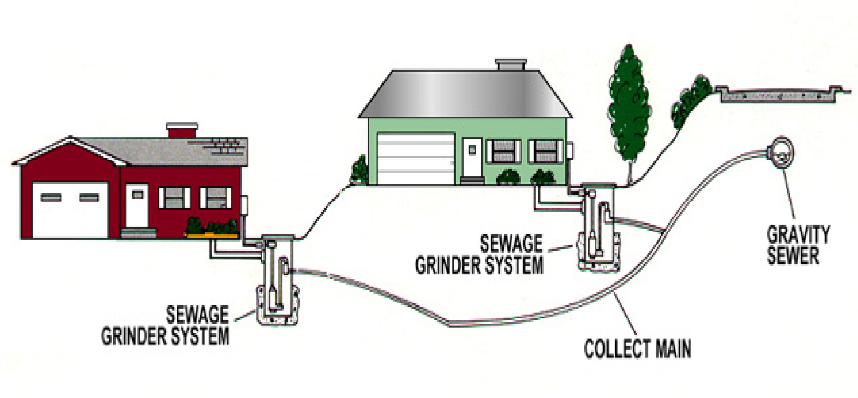
At the heart of the $3.7-million system, which is now under construction and should be operational by the end of the year, are several Flygt progressive cavity grinder pumping stations, and three duplex stations that will also use centrifugal Flygt pumps. It is the first time the small but heavy-duty Flygt 3068 progressive cavity grinder with cast iron pump and motor casing – ideal for rugged operating environments like Leon – will be used on American soil. "We chose the Flygt 3068 because of the challenging terrain and the need to closely control peak flows," said Fred Hypes. "And the Flygt pump's proven performance history played a big role. Because of its rural location, long-term reliability of the pumping systems is critical to Leon's customers."

SUCH COMMENTS ARE music to the ears of Dana Mullen. As the person responsible for developing PSS-related marketing and business initiatives for ITT in the United States, he has spent the past year spearheading the company's efforts to break into one of the world's fastest growing and competitive PSS markets. "We've got our work cut out for us," says Dana Mullen. "PSS has been around for more than 40 years in the U.S. but it is not yet as popular or widespread as it is in some

PRESSURE SEWER DESIGN IDEOLOGY

- PROBABILITY METHOD

- RATIONAL METHOD



PROBABILITY / CONSTANT FLOW

- **PROBABILITY (PM) Method**

3 KEY DETERMINATES:

- **"Maximum number of pumps theoretically expected to be running at any time."**
- **Constant Flow Rate of each Pump Running**
- **A Consistent Inflow Pattern, (i.e., 200 gpd/edu)**

EPA Manual 625/1-91/024

PROBABILITY (PM) METHOD

Quick Design Reference

EDU'S	Pumps running	Pipe Size	GPM	FPS	Friction Loss/100ft.
1	1	1 1/4	11	2	1.77
2-3	2	1 1/2	22	3.04	3.25
4-9	3	2	33	2.92	2.33
10-18	4	2 1/2	44	2.66	1.57
19-30	5	3	55	2.24	0.91
31-50	6	3	66	2.69	1.28
51-80	7	3	77	3.14	1.7
81-113	8	4	88	2.17	0.64
114-146	9	4	99	2.44	0.8
147-179	10	4	110	2.71	0.97
180-212	11	4	121	2.98	1.15
213-245	12	5	132	2.13	0.48
246-278	13	5	143	2.31	0.56
279-311	14	5	154	2.48	0.64
312-344	15	5	165	2.66	0.73

RATIONAL METHOD

- **"A design flow corresponding to the number of homes served by the pressure sewer"**
  (EPA Manual 625/1-91/024)
- **"The rational method can be logically applied when either centrifugal pumps or progressive cavity pumps are used"**

Rational Method Baseline Formula
Q = AN+B

- **Q = Predicted flow derived from input data below**
- **A = Coefficient that adjusts based on ave. daily flow {EPA national average is 67 GPCD or 200 GPD / EDU} { Assigned value is typically <u>0.5</u> }**
- **N = Number of Equivalent Domestic Units or Lots**
- **B = Minimum flow one pump will produce with maximum static head and no friction loss**
- **Alternative** $\dfrac{\text{EDU'S x GPD x 2.5\{pf\}}}{1440} = \text{GPM}$

Total EDU'S x gal/day/house x peak factor

Hour's flow/day x 60 min.

92 x 400 x 2.5

24 x 60

Q = **64 GPM** **LPS Design flow**

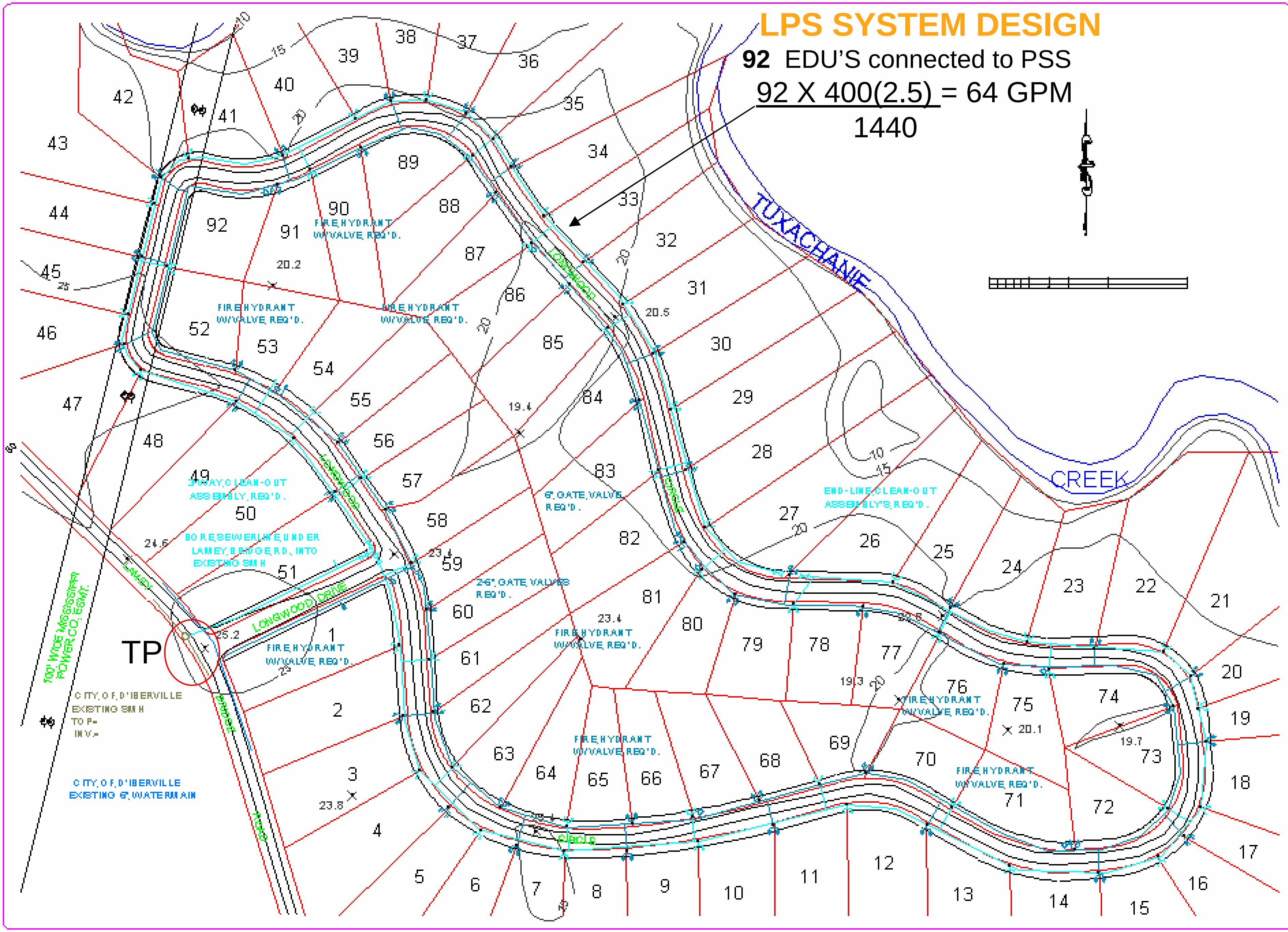
20

4 GRINDER PUMPS running simultaneously to satisfy design flow requirements

DESIGNING AN LPS SYSTEM
WHAT ARE WE TRYING TO ACHIEVE?

- **Assure that each beginning mainline will be flushed at least once daily**
- **Assure that all hydraulic grade conditions are met with the correct pump type- Centrifugal or PC**
- **Assure that minimum velocity requirements set by EPA are achieved**
- **Size the LPS system with the appropriate pipe size and type.**
- **Achieve design flow requirements**

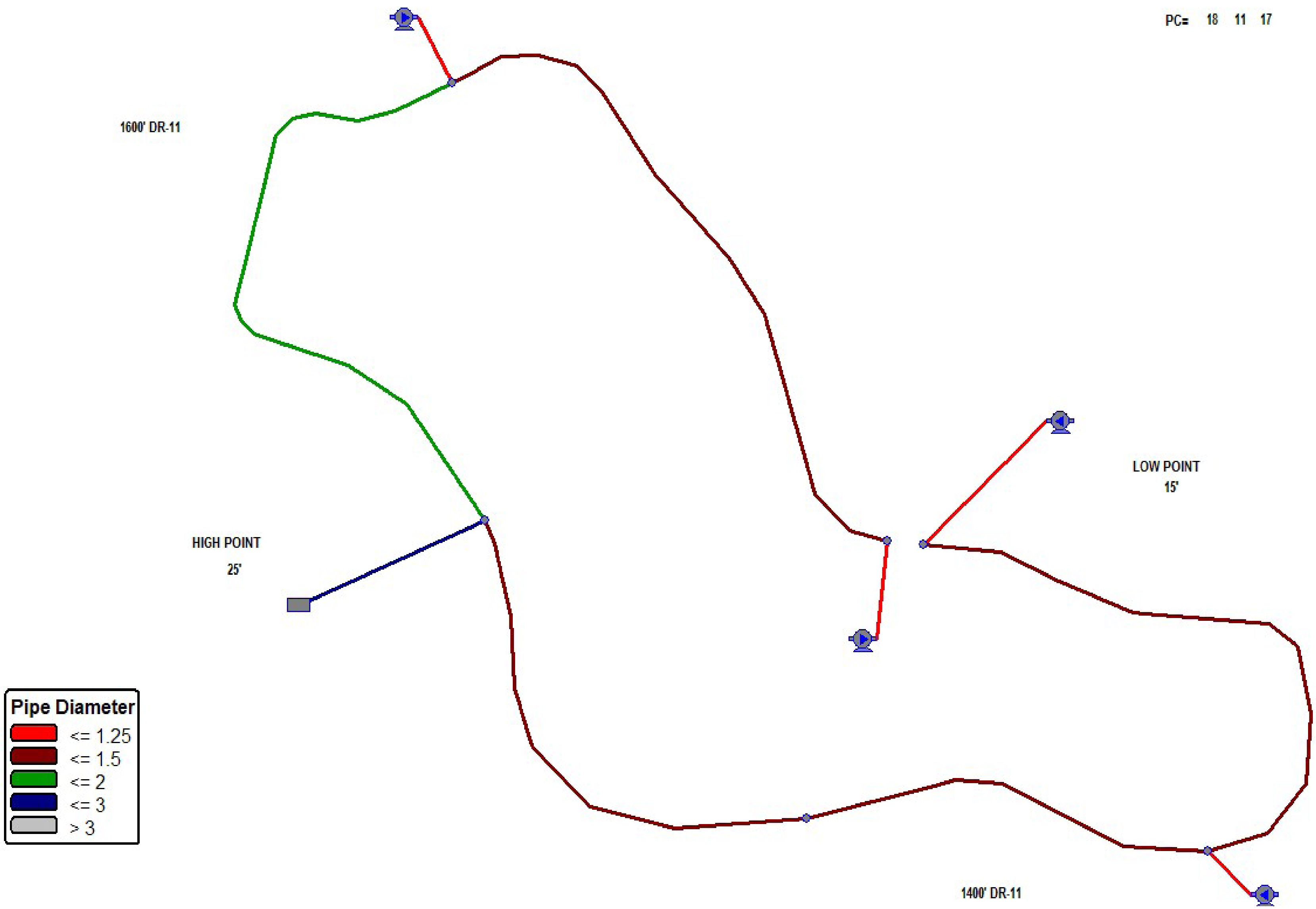
PIPE DIAMETER	PIPE TYPE	GPM REQ. 2-FPS
1.25 ”	DR-11	9
1.5 ”	DR-11	11.50
2 ”	DR-11	18
3 ”	DR-11	40
4 ”	DR-11	65
6 ”	DR-11	140


LPS SYSTEM DESIGN
92 EDU'S connected to PSS
92 X 400(2.5) = 64 GPM
1440
TUXACHANIE
CREEK
TP
FIRE HYDRANT W/VALVE REQ'D.
3-WAY CLEAN-OUT ASSEMBLY REQ'D.
BORE SEWERLINE UNDER LAMEY BRIDGE RD. INTO EXISTING SMH
6" GATE VALVE REQ'D.
2-6" GATE VALVES REQ'D.
END-LINE CLEAN-OUT ASSEMBLY'S REQ'D.
LONGWOOD DRIVE
CITY OF D'IBERVILLE EXISTING SMH
TO P=
INV.=
CITY OF D'IBERVILLE EXISTING 6" WATERMAIN
100' WIDE MISSISSIPPI POWER CO. ESMT.

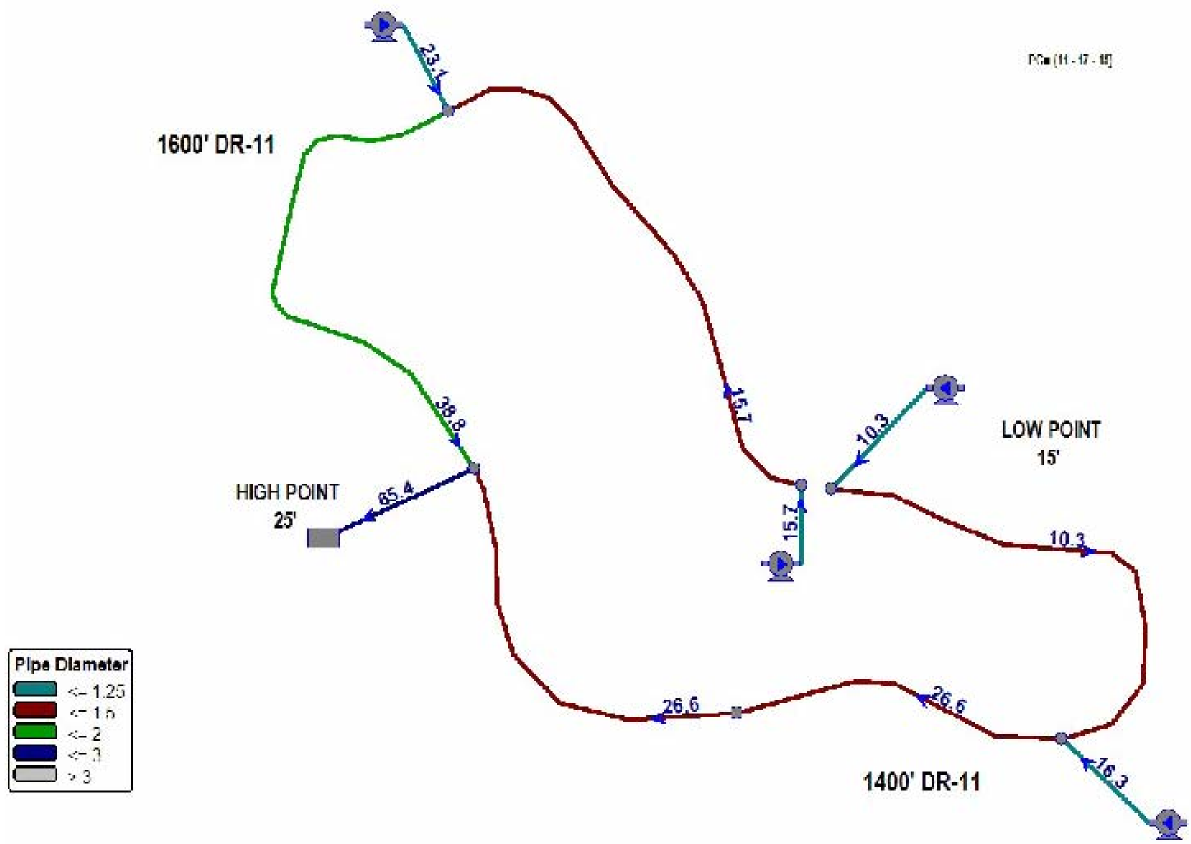
LPS Design Steps

1. IDENTIFY TOTAL HOMES CONNECTED TO THE LPS SYSTEM = 92
2. ESTABLISH DESIGN FLOW =
3. $\frac{\text{92 EDU'S * 400 GPD * PF\{2.5\}}}{1440}$ = 64 GPM
4. Q = AN + B
   66 = .5 *92 + 20
5. IDENTIFY THE LOWEST ELEVATION IN THE SYSTEM VS. THE HIGHEST STATIC ELEVATION INCLUDING THE TE Static = 15 FEET
6. IDENTIFY LONGEST PUMPING DISTANCE FROM TE IS LOTS # 79 & 26
7. 4 PUMPS WILL OPERATE SIMULANTEOUSLY LOTS # 40, 79, 15, 26

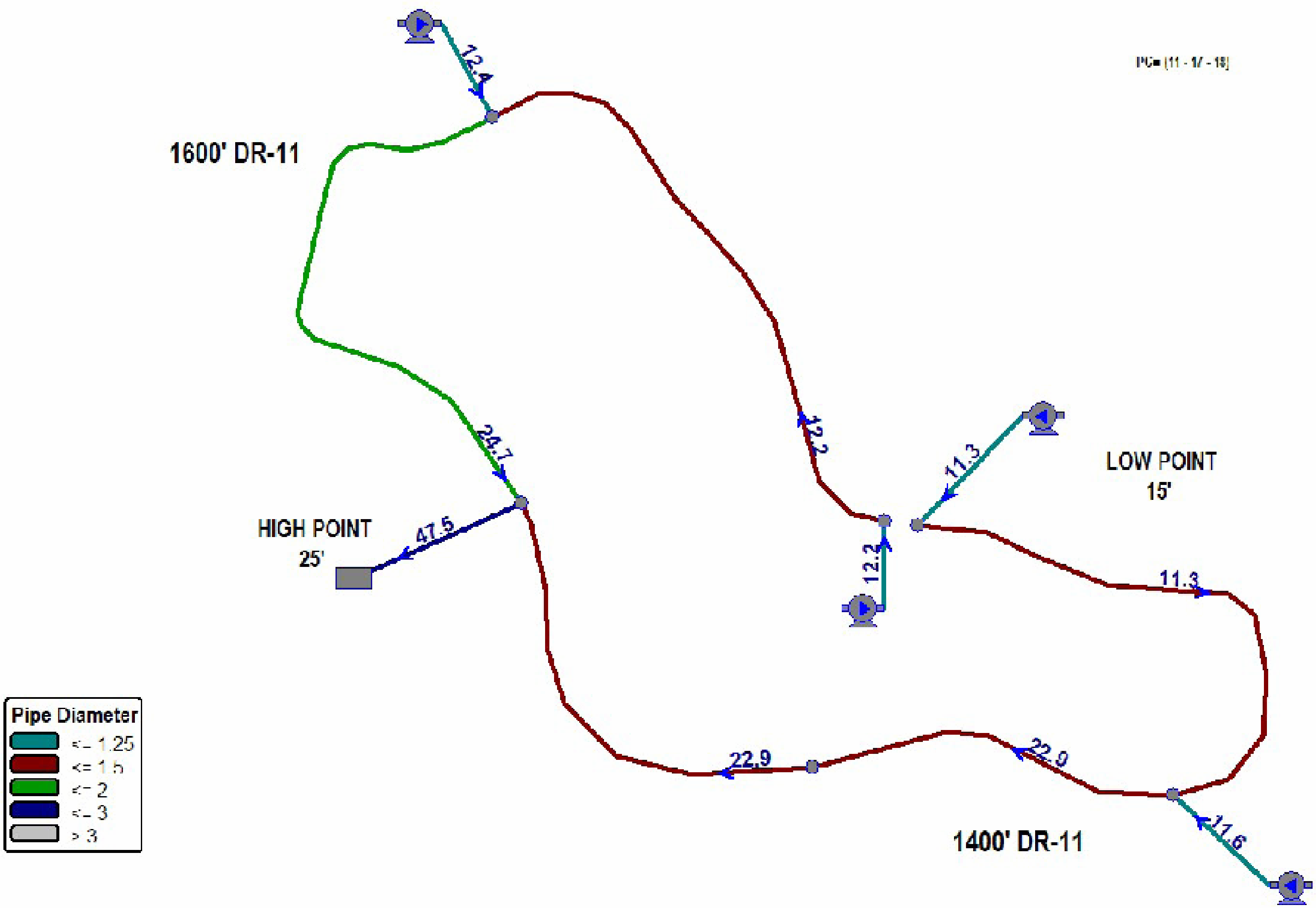
HYDRAULIC VARIATIONS PC & CENTRIFUGAL



CENTRIFUGAL HYDRAULIC ANALYSIS



PC HYDRAULIC ANALYSIS



CENTRIFUGAL PUMPS –
VERTICAL OR HORIZONTAL DISCHARGE

PC GRINDER PUMPS
E-1

BARNES

MYERS-HYDROMATIC & DELTA ENVIRONMENTAL

ZOELLER

FLYGT

PSS APPLICATIONS UTILIZE BOTH

CENTRIFUGAL

&

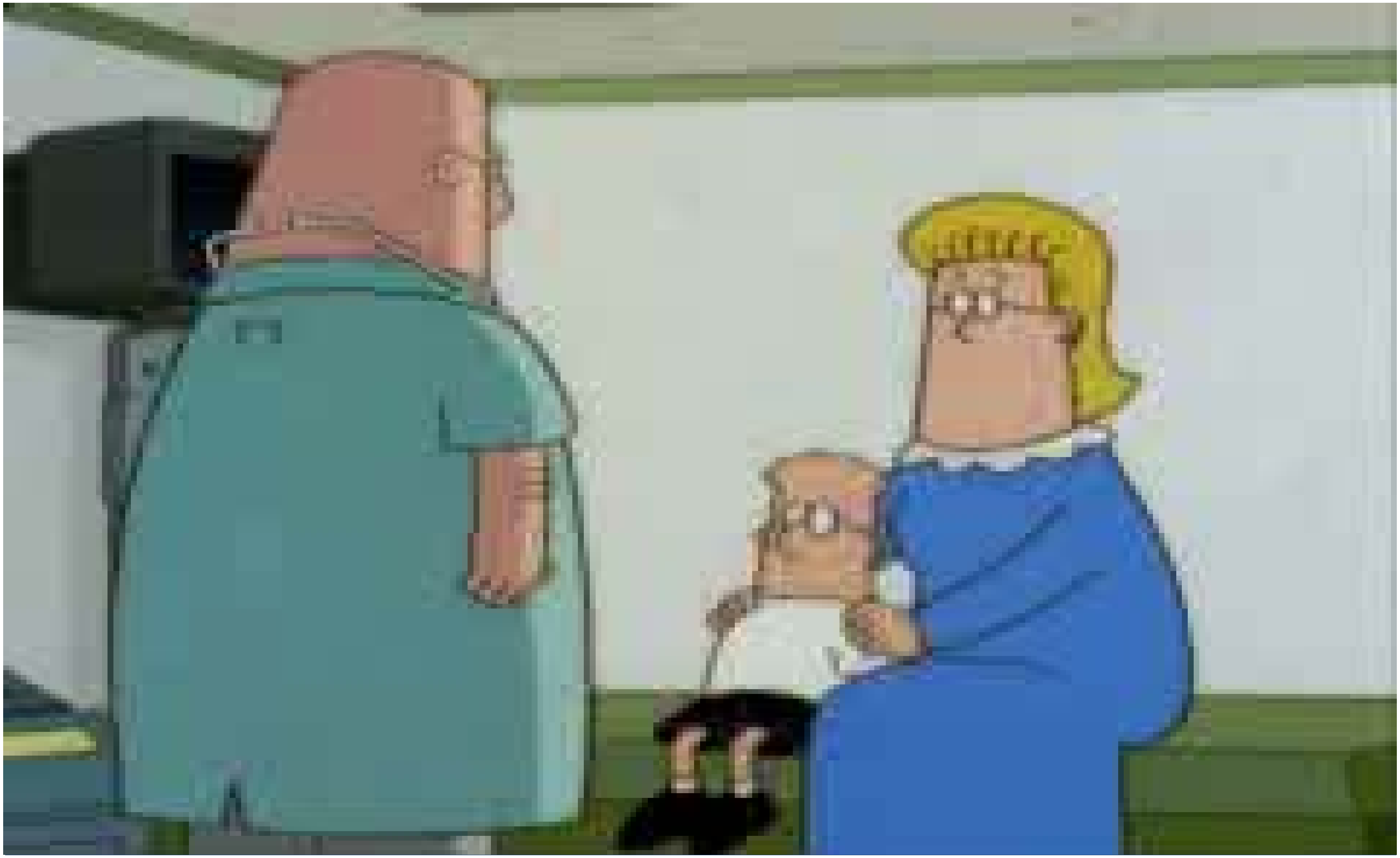
PROGRESSIVE CAVITY

WHAT DO YOU CHOOSE AND WHY?

QUESTIONS / COMMENTS / SUGGESTIONS

?

In conclusion…



THANK YOU TODAY

Dana Mullen, Market Manager
PSS Pre-engineered Package
Pump stations