The Systems Approach to Lift Station Design, Operation, Installation and Maintenance
Xylem is a world leader in water handling and treatment. With global direct sales and service capabilities, we work closely with our customers to deliver energy-efficient and reliable solutions in more than 150 countries.

- Intelligent pumps and controls to transport water and wastewater
- Advanced treatment systems to clean and disinfect water
- Full-service dewatering capabilities – including pump sales, rental and onsite services – to remove unwanted water
- Advanced TotalCare service capabilities

Integrated solutions combining world-class products and systems design expertise

Flygt invented the world’s first submersible sewage pump and continues to innovate with self-cleaning Flygt N technology ensuring efficient non-clogging performance.
Speakers

**Barry Jongsma**  
Manager of Product Engineering  
Pentair

**Ernest C. Sturtz, P.E., BCEE**  
Associate  
CDM Smith

**Jim Vukich**  
Application Engineer  
Xylem – Flygt Products
Station Classifications

Packaged  Pre-Engineered  Custom

Complexity
What is the Systems Approach?

Charlotte, N.C.
200 MGD
Sugar Creek WRF
Influent PS (2009)

Images Used with Permission of CMU
Available Data for Creation of a Computer Model (Existing Systems)

- GIS
  - Pipes
  - Nodes
  - Elevation
  - Parcels
  - Land use

- Pump Station DB
  - Pumps
  - Wet Wells
  - Controls

- Customer Billing Database
  - Water Demands
  - Customer Type
Design of a Single Pump Station

Gravity Collection System Boundary

Population - 1,000
ADF - 60 gpm

Peak factor - ?
Design flow - ?
Examples of ADF and Population Based Peak Factors
Design of a Single Pump Station

Gravity Collection System Boundary

Population - 1,000
ADF - 60 gpm

Peak factor - 3.80
Design flow - 230 gpm
Small Systems Are “Easy” to Design

Capacity of pump station #2 must be equal to capacity of pump station #1
Large Manifolded Systems Are Another Matter
What is the Appropriate Size of the Re-Pump Station?
Modeling Practice –
Limit Pumps in Operation
Modeling Practice – Discount Flows

Re-pump Station
Preliminary Evaluation of Manifolded Systems

Relative Size of Pump Station
- Small
- Medium
- Large

Re-pump Station
- Less than MAF
- Flow exceeds MAF
- Flow exceeds design flow rate
Over Sizing Facilities can Cause as Much Trouble as Under Sizing

![Chart showing pump flow (gpm) vs TDH (feet) with an overlay indicating a pump performance curve. The chart highlights a flow rate of approximately 800 gpm and a TDH of 18 feet.](chart.png)
Step by Step Design of a Typical Pump Station
Municipal Design Code
Requirements

How many pumps are needed?

A typical design should include permanently-installed redundant pumping capacity equaling the largest single pump in a station.

Firm capacity = with one largest pump out of service
Understand Your Project

New, upgrade or retrofit?

New or existing force main?

Present and future conditions?
First

Understand Your Project

- Owner expectations?
- Present and future conditions?
  - Demographics?
  - Zoning?
  - Land usage?
First

What do We do First?

Establish relevant design information

- Location of station
  - Go visit the site!
- Location of discharge point
- Electrical requirements
  - Find out actual line voltages
  - Back-up power needs
  - Utility supply limitations
What do We do First?

Establish relevant design information, cont.

- Condition of existing installation and equipment
- Verify static head
- Find flow duration data
  - Daily peak flows
  - Daily min. flows
  - 10, 25, 50 or 100 year flows
- Research existing force main data
Quick and rough design take-off

System head loss calcs

- Use 6fps (based on daily peak flow) to rough out a force main size
  - Calculate FM head loss
  - Add ~5ft for station piping losses
  - Don’t add unnecessary safety factors!
Quick and rough design take-off

Establish station design flow based on one of the year daily peak flows

- Duplex station
  - 2 equal pumps, each sized for daily peak flow
  - Standard concept
- Triplex station
  - 3 equal pumps, each sized for ½ daily peak flow
  - May yield better energy efficiency, more redundancy, and a lower LCC
Quick and rough design take-off

- Select pumps for both the duplex and triplex scenarios
- Establish the minimum station inside diameter based on:
  - HI 9.8 intake design formula (section 9.8.2.3)
  - I.D. based on the required minimum active wet pit volume
  - Pump manufacturer’s recommendations
- Decide on preliminary start-stop levels
HI 9.8 intake design formula for minimum station ID

Warning: This formula may give a sump diameter that is too small – verify pump start/hour and active sump volume

\[ D_{S_{\text{min}}} = 2 \cdot D_b + 2 \cdot C_w + C_b \]

\[ D_{S_{\text{min}}} = 2.5 \cdot D_b + 2 \cdot C_w + C_b \]
Station Diameter & Minimum Active Volume

- Active volume is the volume between pump “on” and pump “off” (in a duplex station)

- Min. volume is dictated by allowed motor starts/hour
How To Determine Minimum Active Volume

\[ V_{\text{min.}} = \left( T_{\text{min.}} \times Q \right) \div 4 \]

Where:
- \( V_{\text{min.}} \) = minimum active sump volume
- \( T_{\text{min.}} \) = minimum cycle time for fill-up and draw-down
- \( Q \) = pump flow rate

To keep the size of the sump at a reasonable minimum, the pump capacity should be two times the inflow at critical or peak flow times.
Quick and rough design take-off

Make a decision

- Analyze the two station designs based on:
  - Excavation volume ($/c.y.)
  - Pump, valve, piping, accessory, and control cost ($)
  - Energy usage (kW-hr)
  - Redundancy (subjective value?)
  - Complexity and general attractiveness (subjective value?)
  - Calculate station LCC (total $ for life of station)
Final Design Process

- Use the “Quick & Rough” design as a basis to lay out final station and FM piping
  - Make adjustments based on findings during the preliminary pump selections
    - Be flexible with head loss and flow rates so that you can select pumps that operate close to BEP
  - Use station piping that gives an average liquid velocity of 3-6 fps through fittings
  - Use a FM diameter that satisfies your LCC analysis (often 4-7 fps)
Pump Selection – Full Sump

Full Sump
Min Static Head
New Pipe
Minimum Friction
Pump Selection – Head loss increase

Full Sump
Min Static Head
Old Pipe
Maximum Friction

Operating range
Pump Selection – Empty Sump

Operating range

Empty Sump
Min Static Head
New Pipe
Old Pipe
Pump Selection – All Together

Operating range

5’ draw-down

Empty sump

Full sump
Pump Operating Range

CONDITIONS OF SERVICE

<table>
<thead>
<tr>
<th>FLOW</th>
<th>HEAD</th>
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<tbody>
<tr>
<td>550</td>
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<tr>
<td>500</td>
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EFFICIENCY

HEAD

TOTAL PUMP HEAD (FEET)

FLOWRATE (GPM)

POWER

NPSHR

Driver:
5 HP
Submersible

Model:
4" PUMP

Impeller:
4-SSH-10

Vanes:
TWO

Speed:
1185 RPM

Dia. (in):
8.7

Sphere:
3.00"

Date:
2/27/2014

Plotted By:
BGJ

Reference:
SWPA
Summary

Dry Well Pumping Station

Wet Well Pumping Station
Don’t miss SWPA’s two-day Pumping Systems and Controls Training Seminar – all based on the systems approach.

April 9-10 – Baltimore, MD

Register by calling 847.681.1868 or visiting swpa.org.

Today’s webinar attendees may receive ½ off their registration.
Q & A

To contact today’s presenters, email:

Barry Jongsma - Barry.Jongsma@pentair.com
Ernest C. Sturtz - sturtzec@cdmsmith.com
Jim Vukich – jim.vukich@xyleminc.com

Visit pump-zone.com to:

- view the answers to all of the questions asked during the Q&A session
- access the recording of the webinar or download the presentation

The next webinar in the SWPA series will be on June 19, 2014. More details coming soon.