Appendix B

Sample Sump Pump Design
I. Calculation of Total Dynamic Head (T.D.H.)

A. Static Head:
(Maximum force main elevation - minimum wetwell elevation)

Elevation of force main discharge:
\[ \text{Elev}_{FM} := 100.24 \text{ft} \]

Elevation of floor of wet well:
\[ \text{Elev}_{WW} := 89.07 \text{ft} \]

Pump Off Level = 0.5 ft above floor:
Then Static Head:
\[ H_{ST} := \text{Elev}_{FM} - \text{Elev}_{WW} - 0.5 \text{ft} \]
\[ H_{ST} = 10.67 \text{ ft} \]

B. Friction Head:
Use Hazen-Williams Equation
\[ h := L \cdot f := \left( \frac{V}{1.318 \cdot C \cdot R^{0.63}} \right)^{1.852} \]

\[ V = \text{Velocity (fps)} = \frac{Q}{A} \]
\[ C = \text{Hazen-Williams Coefficient} \]
\[ R = \text{Hydraulic Radius} = \frac{\text{Area}}{\text{Wetted Perimeter}} = \frac{D}{4} \]

1. Force Main:

4" P.V.C., \( L = 70.36 \text{ft}, C = 150 \)
\[ D := 4 \text{in} \quad L := 70.36 \text{ft} \quad C := 150 \]
\[ Q := 283.33 \frac{\text{gal}}{\text{min}} \quad \text{or} \quad Q = 0.63126 \frac{\text{ft}^3}{\text{sec}} \]
\[ R := \frac{D}{4} \quad R = 0.083 \text{ft} \]
\[ V := \frac{Q}{\pi D^2} \quad V = 7.234 \frac{\text{ft}}{\text{sec}} \]
\[ f := \left( \frac{V}{1.318 \cdot C \cdot R^{0.63}} \right)^{1.852} \cdot \left( \frac{1}{\text{sec}^{0.685}} \right) \quad f = 0.0397 \text{ ft}^0 \]
\[ h := L \cdot f \]
\[ h = 2.79 \text{ ft}^1 \]
2. Spool on Force Main:

\[
4" \text{ D.I.P.}, L = 3.00\text{ft}, C = 120
\]

\[
D := 4\text{in} \quad L := 3\text{ft} \quad C := 120
\]

\[
R = 0.083 \text{ft}
\]

\[
V = \frac{7.234 \text{ ft}}{\text{sec}}
\]

\[
f = \left( \frac{V}{1.318 \cdot C \cdot R^{0.63}} \right)^{1.852} \cdot \left( \frac{1}{0.685} \right) 1.852
\]

\[
f = 0.06 \text{ ft}^0
\]

\[
h := L \cdot f
\]

\[
h = 0.18 \text{ ft}^1
\]

3. Fittings (Valves and Elbows using Equivalent Length Method):

Values for Equivalent Length taken from:

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>EQUIVALENT LENGTH OF STRAIGHT PIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC to DIP, fitting 4&quot; x 6&quot;</td>
<td>2 ea</td>
<td>1.00 ft</td>
</tr>
<tr>
<td>Vertical Swing Check Valve, 4&quot;</td>
<td>1 ea</td>
<td>31.00 ft</td>
</tr>
<tr>
<td>90 Elbow, 4&quot;</td>
<td>2 ea</td>
<td>22.00 ft</td>
</tr>
<tr>
<td>PVC, 4&quot;</td>
<td>1 ea</td>
<td>1.50 ft</td>
</tr>
<tr>
<td>Tee, 4&quot; x 4&quot; x 4&quot;</td>
<td>1 ea</td>
<td>17.00 ft</td>
</tr>
<tr>
<td>Reducer, 3&quot; x 4&quot;</td>
<td>1 ea</td>
<td>0.35 ft</td>
</tr>
</tbody>
</table>

Total \( L := 72.85\text{ft} \)

\[
h := L \cdot f
\]

\[
h = 4.37 \text{ ft}^1
\]

Total Dynamic Head = Static Head + Friction Head

= Static Head + Force Main + Spool + Fittings

= 7.34 ft + 2.79 ft + 0.18 ft + 4.37 ft

T.D.H. = 14.68 ft

Use T.D.H. = 14.7 ft
II. Calculation of Float Setting in Well to Satisfy Pumps:

Well Storage Dimensions (plan dimensions): L x W = 4’ x 4’

Storage per 1 foot rise within well given by:

\[
\text{Storage} = 4\text{ ft} \cdot 4\text{ ft} \cdot \left( \frac{7.48 \text{ gal}}{\text{ft}^3} \right)
\]

\[
\text{Storage} = 119.68 \frac{\text{gal}}{\text{ft}}
\]

Float Setting in Well:

\[
\text{Rise} = \frac{Q}{\text{Storage}}
\]

\[
Q = 283.33 \frac{\text{gal}}{\text{min}}
\]

Rise = 2.367 \frac{\text{ft}}{\text{min}}

Assuming that the pump cycle is 60 seconds:

Float := Rise \cdot 60 \text{sec}

Float = 2.37 \text{ ft}

Then, 2.37 feet is the float setting between lead pump on and off position in well to satisfy pump cycle.

Note, the recessed area of the well was not considered in figuring the float setting due to displacement of the pumps and fittings.