JACOBS

# Memorandum

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|---|---|
| **Subject** | **Activity 1: Monterey WWTP Influent Pump Station Diesel Pump Capacity Evaluation** |
| **Project Name** | JEA System Resiliency Program, Task Order No. 15, Monterey WWTP Assessment Services |
| **Attention** | JEA |
| **From** | Jacobs Engineering Group Inc. (Jacobs)[1] |
| **Date** | July 25, 2019 |
| **JEA Contract No.** | 174097 |

## 1. Purpose and Background

In September 2018, a power loss incident occurred at the Monterey Wastewater Treatment Plant (WWTP) during a storm event that resulted in a sanitary sewer overflow (SSO) of the influent manhole and wet well. JEA asked Jacobs to assess the capacity of the diesel-powered influent pump that is used during high-flow events and functions as the plant's emergency backup pump during periods of primary and backup power loss. Hydraulic modeling was conducted using a hydraulic modeling program (AFT Fathom) to assess the pump's capacity. Information used in the development of the hydraulic model included record drawings and pump curves and speed settings provided by JEA as well as site photos. This technical memorandum (TM) documents the results of the assessment and presents a discussion of the hydraulic model developed for the Monterey WWTP influent pump station.

## 2. Facility Description

The Monterey WWTP consists of an influent pump station, three parallel sequencing batch reactors (SBRs), an ultraviolet (UV) disinfection system, a transfer pump station, one equalization storage tank, gravity outfall, one aerobic digester (originally the fourth SBR tank), one sludge storage tank, and a centrifuge facility for sludge dewatering. The facility is permitted to discharge 3.6 million gallons per day (mgd) annual average daily flow (AADF) to the St. Johns River.

The influent pump station consists of a wetwell, mechanically cleaned bar screen, a backup manually cleaned bar screen, and an influent pump station. The influent pump station has three submersible pumps and one above grade diesel-powered pump. While the original design pump curves have been obtained for the submersible pumps and the diesel-powered pump, the design pumping capacities are not apparent from these curves, which justified the AFT Fathom model to determine the design capacity of the diesel-powered pump for this analysis. The pumps feed into a common force main that delivers influent flows to the three SBRs; one SBR unit is filled at a time. The original ductile iron force main was abandoned and replaced with a high-density polyethylene (HDPE) force main in 2018.

## 3. Peak Hour Influent Flow

Influent flow data are not available for the Monterey WWTP, and the effluent flowmeter is downstream of the SBRs and the equalization tank; thus, influent flow trends are difficult to determine based on the

[1] CH2M HILL Engineers, Inc. (CH2M) is now a wholly owned subsidiary of Jacobs Engineering Group Inc.

flowmeter data that are available. Per the *2018 Annual Water Resources Master Plan* (JEA, 2018), the historical AADF has been between 1.38 mgd and 2.04 mgd. The AADF has changed over time because flow transfer between Arlington East WRF and Monterey WWTP is possible and has been occurring when repairs are happening at either facility. JEA has predicted a relatively flat growth in the service area for Monterey WWTP, as the basin is mostly built-out (JEA, 2018), with the projected AADF increasing from 1.70 mgd in 2019 to 1.84 mgd in 2040. Jacobs is developing a future AADF and peak hour flow (PHF) projection that accounts for the impacts of increased sea level rise and increased rainfall due to climate change that will be submitted to JEA in a separate TM. The projected 2040 AADF increases from the JEA projection of 1.84 mgd to 2.01 mgd.

The 2040 projected PHF is 6.45 mgd (4,500 gallons per minute [gpm]). The 2019 projected PHF was calculated by applying a PHF:AADF peaking factor of 3.5 to the 2019 projected 1.70 mgd AADF (4,130 gpm). The 2040 projected PHF was then determined by increasing the flow over time and accounting for increased rainfall over time. Note that the peaking factor in 2040 is roughly 3.2 (6.45 mgd/2.01 mgd = 3.2) because the rate of AADF increase due to climate change is more than the rate of PHF increase.

Per JEA's request, an alternate influent PHF methodology using the Ten State Standards was used. JEA provided an influent peaking factor of 2.65 which equates to a 2040 projected PHF of 3,700 gpm (2.01 mgd x 2.65 = 5.3 mgd or 3,700 gpm).

# 4. Model Assumptions, Development, and Results

## 4.1 Assumptions

Pipe lengths, valves, fittings, materials, and elevation data were input into the hydraulic model based on the best available information from record drawings and site photos. The water level elevations in the influent pump station and SBRs were based on information provided in the 1997 record drawings by CH2M, which were in the National Geodetic Vertical Datum of 1929 (NGVD29). Fittings losses were provided within pipe segments and not individually shown, with the exception of key junction points as shown in the model workspace included in Attachment 1 to this TM. A Hazen-Williams friction loss model was used with C-factor assumptions based on the material and age of the pipes. A C-factor of 140 was used for HDPE pipes and a C-factor of 100 was used for stainless steel and older ductile iron pipes.

## 4.2 Model Development and Results

The hydraulic model begins at the influent pump station and terminates at the SBRs. Attachment 1 presents a view of the model workspace. The pump curves provided by JEA for the influent pumps and entered in the model are presented in Attachment 2. The diesel pump was assumed to operate at 1,500 rotations per minute (rpm) and the submersible pumps were assumed to each have a 10.5-inch impeller diameter based on information provided by JEA. Multiple model scenarios were developed to represent different potential pump operating conditions. In each scenario, only the diesel pump was operating to assess its capacity during a period of primary and backup power loss when the submersible pumps are inoperable.

**High Head Scenario:** A high head scenario was developed that represents a "worst-case" scenario for the pump that will result in the lowest flow output. Under the high head scenario, the water elevation in the influent pump station was at a minimum (11.0), the water elevation in the SBR was at a maximum (45.5), and the flow was directed to the farthest SBR to maximize head loss.

**Low Head Scenario:** A low head scenario was developed that represents operating conditions that will result in the maximum pump output. Under the low head scenario, the water elevation in the influent pump station was at a maximum (14.0), the water elevation in the SBR was at a minimum (39.5), and the flow was directed to the closest SBR.

**Average Head Scenario:** An average scenario was also developed to represent typical pump operating conditions between the high head and low head scenarios.

AFT Fathom was used to develop system curves for the three model scenarios (high head, low head, average head). System curves show the total pump discharge head required for a given flow output. Figure 1 presents a plot of the system curves for the three model scenarios as well as the existing diesel pump curve at 1,500-rpm operating speed. The intersections of the pump curve and the system curves represent the predicted pump operating point for each scenario and is provided in Table 1.

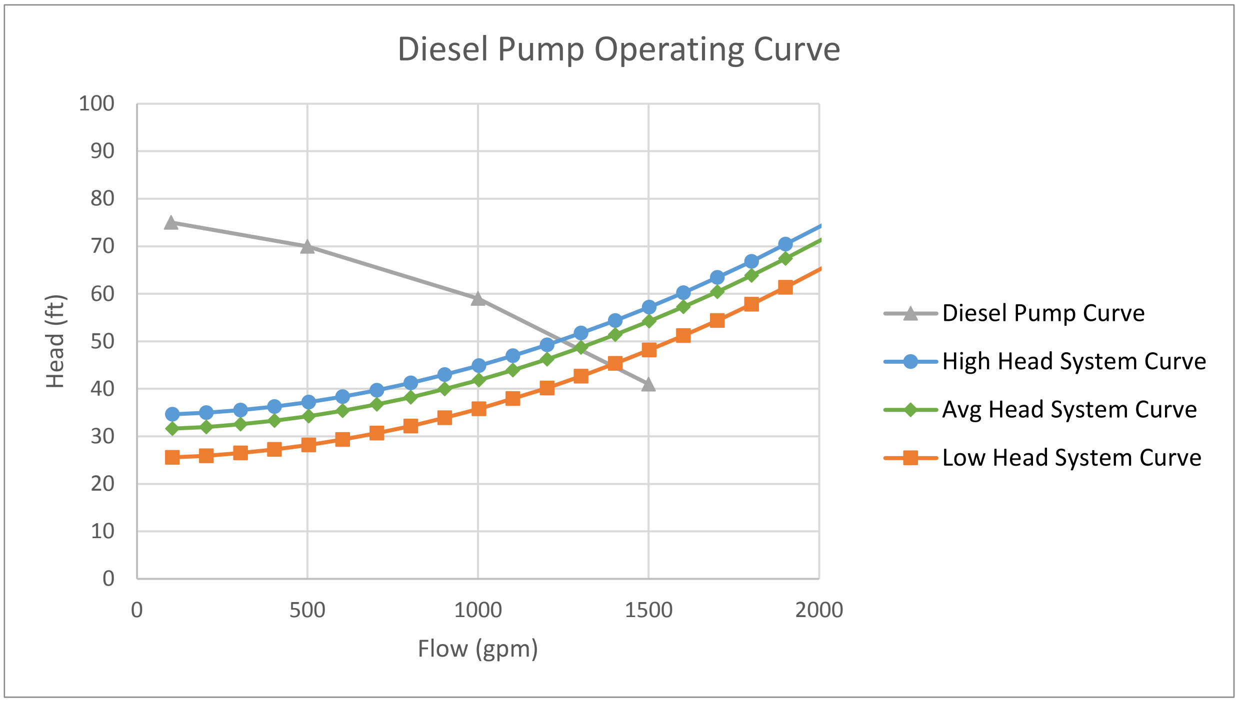



**Figure 1. Diesel Pump Curve vs. System Curves**

**Table 1. Diesel Pump Operating Conditions**

| Scenario | Flow (gpm) | Flow (mgd) | Head (feet) |
|---|---|---|---|
| High Head | 1,255 | 1.8 | 51 |
| Average Head | 1,304 | 1.9 | 49 |
| Low Head | 1,398 | 2.0 | 45 |

Note: Scenarios are defined above.

The model results estimate that the diesel pump can provide approximately 1,250 to 1,400 gpm, or approximately 1.8 to 2.0 mgd, at 1,500-rpm operating speed, depending on operating conditions. Attachment 3 presents a visual view of the model workspace with select output shown for the high head scenario.

This evaluation also considered the Net Positive Suction Head (NPSH) available for each operating condition. The NPSH required was provided by the pump manufacturer. Comparison of the NPSH available to the NPSH required indicated that NPSH is a limiting factor for the pump. Increasing the pump operating speed likely would cause cavitation and potentially damage the pump.

## 5. Conclusions and Recommendations

Based on input from JEA, the influent pump station diesel pump is intended to provide full capacity for current and future influent PHFs during periods of primary and backup power loss when the other submersible influent pumps are inoperable. Based on JEA's provided peaking factor of 2.65, the 2019 influent PHF will be 3,130 gpm and the 2040 influent PHF will be 3,700 gpm. Attachment 4 presents a visual view of the model workspace with select output shown for the future 3,700-gpm scenario. Therefore, the modeled existing diesel pumping capacity of 1,250 to 1,400 gpm is not enough to transfer the projected current and future influent PHFs.

Because the existing influent pump station was constructed with four pump locations and three are occupied by the existing submersible pumps, there is only one location currently available for a backup diesel pump. Therefore, it is recommended to remove the existing diesel pump and replace it with a similar but larger diesel pump that meets the projected future peak hour influent flow. JEA may choose to relocate the existing diesel pump to a new location that currently does not have a backup system. The change to a larger pump will also require upsizing the current pump suction and discharge piping. Because the existing welded stainless-steel discharge piping is 12 inches, it is recommended to upsize the discharge piping and check valve to 12 inches. It should be noted that the 12-inch discharge piping will result in a short run of high flow velocity (v=10 feet per second), which should be accounted for in the final pump sizing.

If this recommendation is approved for implementation by JEA, it is recommended that the AFT Fathom model be validated with field measurements to verify model results prior to final pump selection. The model developed may also be used in future analyses of the Monterey WWTP influent pump station and assessments of the influent submersible pumps.

## 6. Preliminary Cost Estimate

A conceptual cost estimate for replacing the existing diesel pump is provided in Table 2. The total cost is approximately $329,000. The cost estimate prepared is a facility planning level estimate and is considered a Class 5 estimate in the Association for the Advancement of Cost Engineering (AACE) International classification system. Based on AACE guidelines, Class 5 estimates range in accuracy is -20 to -50 percent on the low side and +30 to +100 percent on the high side. A 15-percent contingency was added to the sub-totaled estimated cost of each item.

**Table 2. Conceptual Cost Estimate**

| Cost Item | Estimated Cost |
|---|---|
| Remove Existing Diesel Pump and Piping | $2,000 |
| Furnish and Install New 3,700-gpm Diesel Pump | $250,000 |
| Furnish and Install New Pump Pad | $5,000 |
| Furnish and Install New Diesel Pump Control Panel and Rack | $4,000 |
| Furnish and Install New 12" 316 SST Piping, Fittings, and Check Valve | $25,000 |
| **Sub-Total** | $286,000 |
| 15% Contingency | $43,000 |
| **Total Estimated Construction Cost** | **$329,000** |

Note: Cost estimate is based on JEA O&M performing the construction work.

# 7. References

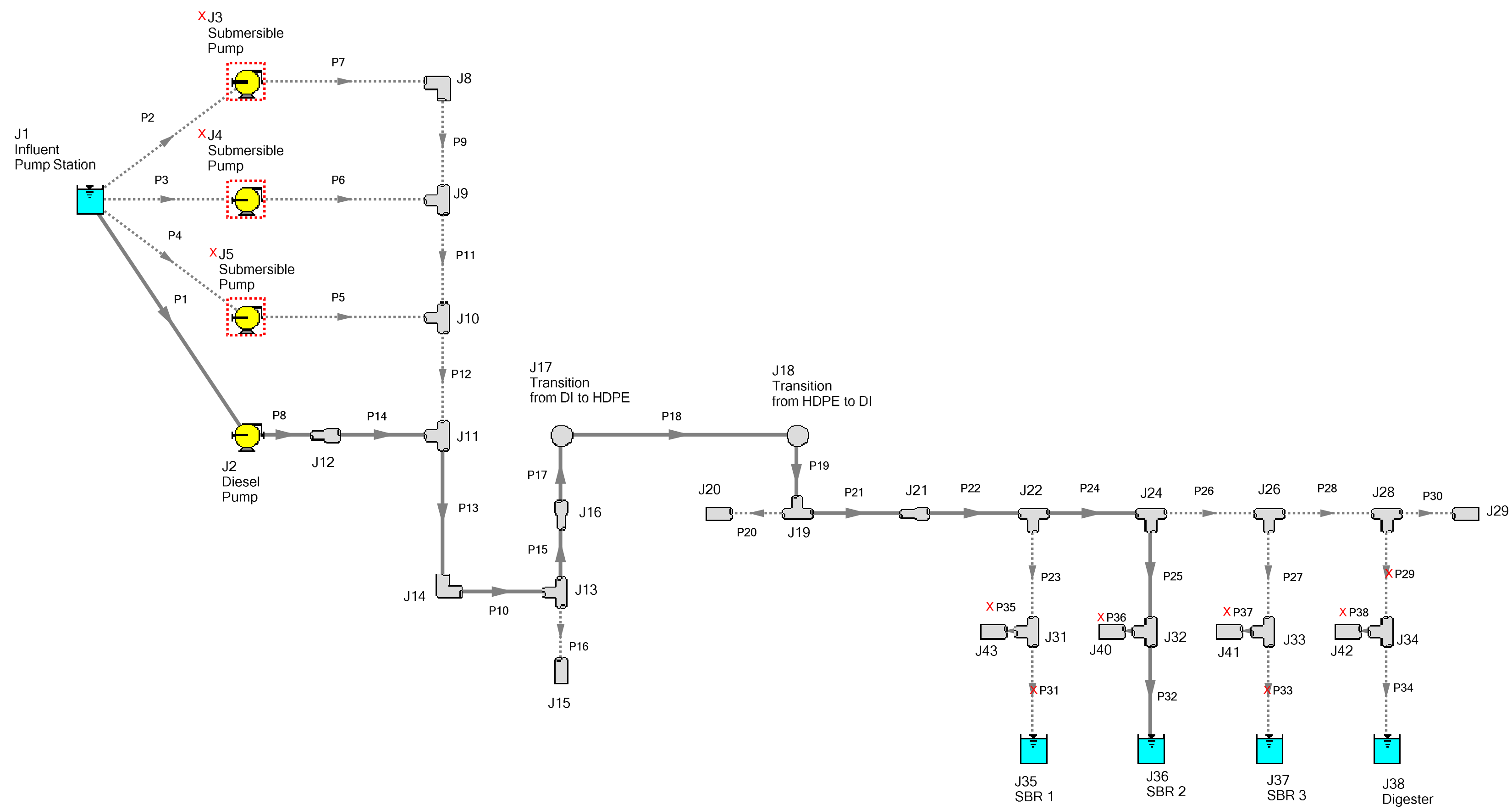
Crane Company. 1988. *Flow of Fluids Through Valves, Fittings, and Pipe*. Technical Paper No. 410. Joliet, Illinois.

Idelchik, I.E. 1994. *Handbook of Hydraulic Resistance, 3rd Edition*. CRC Press. Boca Raton, Florida.

Miller, D.S. 1990. *Internal Flow Systems, 2nd Edition*. Gulf Publishing Company. Houston, Texas.

JEA. 2018. *Annual Water Resource Plan*. September.

# Attachment 1
# Model Workspace

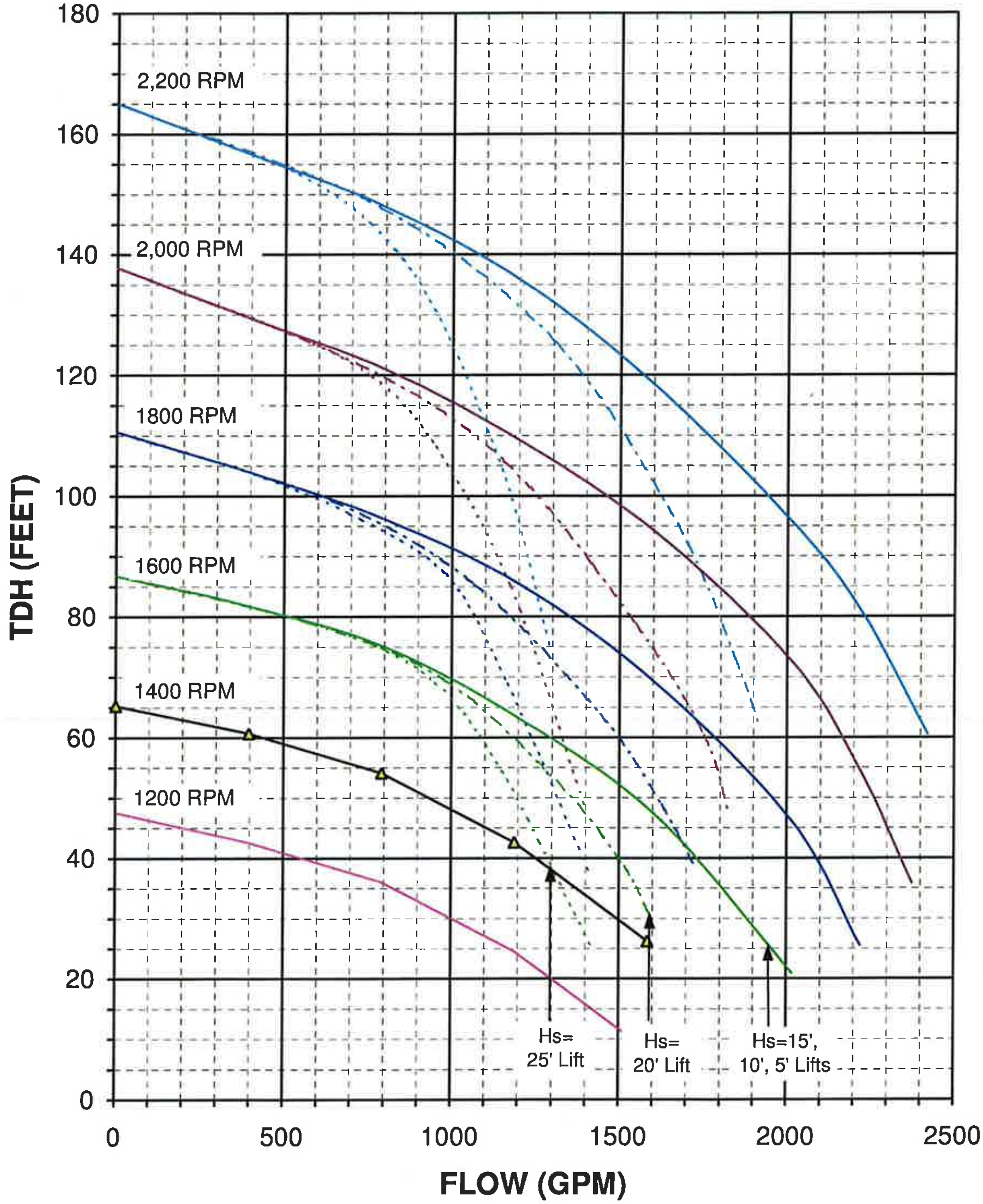


J1
Influent
Pump Station
J3
Submersible
Pump
J4
Submersible
Pump
J5
Submersible
Pump
J2
Diesel
Pump
P1
P2
P3
P4
P5
P6
P7
P8
P9
P11
P12
P13
P14
P10
P15
P16
P17
P18
P19
P20
P21
P22
P23
P24
P25
P26
P27
P28
P29
P30
P31
P32
P33
P34
P35
P36
P37
P38
J8
J9
J10
J11
J12
J13
J14
J15
J16
J17
Transition
from DI to HDPE
J18
Transition
from HDPE to DI
J19
J20
J21
J22
J24
J26
J28
J29
J31
J32
J33
J34
J40
J41
J42
J43
J35
SBR 1
J36
SBR 2
J37
SBR 3
J38
Digester

# Attachment 2
# Pump Curves

## GODWIN DRI-PRIME® CD150M ONE (1) PUMPSET DYNAMIC SUCTION LIFT PERFORMANCE CURVES

(6" x 6")



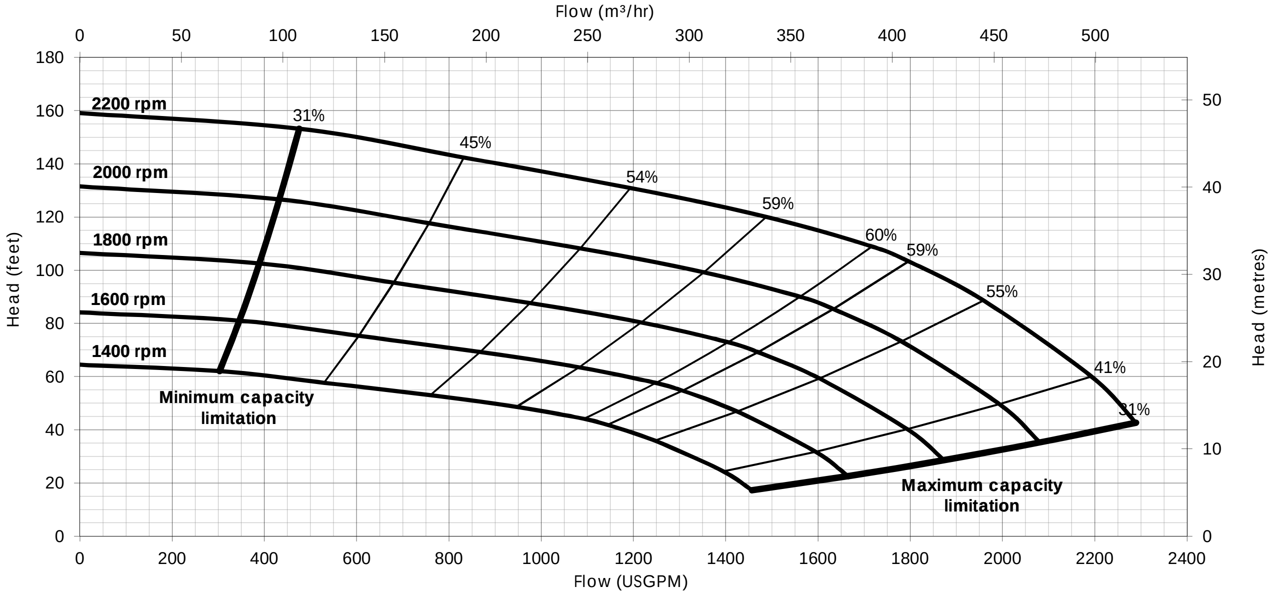
# CD150M Dri-Prime® Pump

| | | | |
|---|---|---|---|
| Pump Type | CD150M | Branch Sizes | 150 x 150 mm |
| Curve No | 95-1011-3098 | Speed | Variable |
| Revision | 8 | Max Solids Handling | 3.0 " (75.0 mm) |
| Date | 26 September 2014 | Max Impeller Diameter | 11.0 " (280.0 mm) |
| | | Min Impeller Diameter | 9.4 " (240.0 mm) |

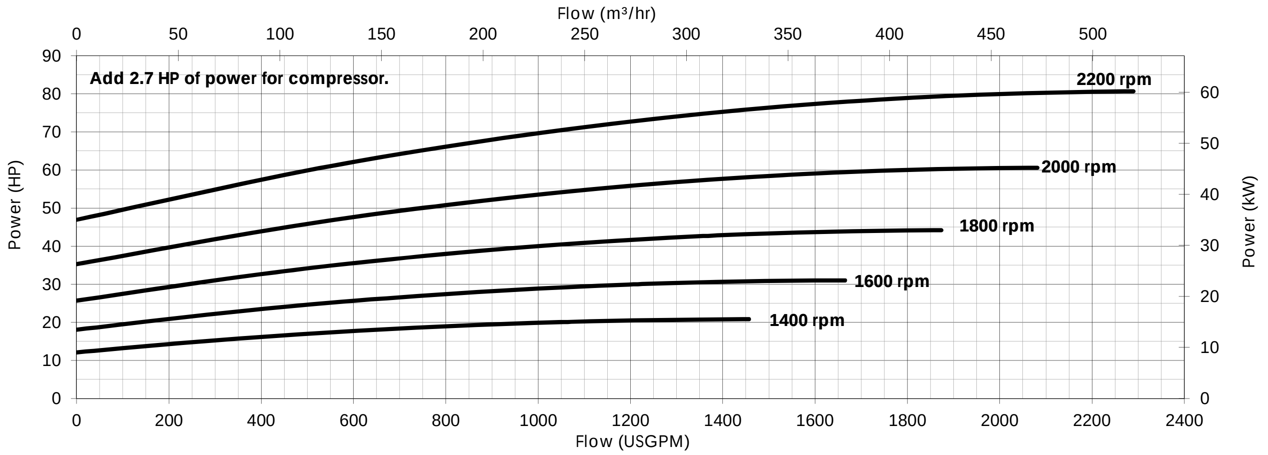
godwin
a xylem brand

CD150M

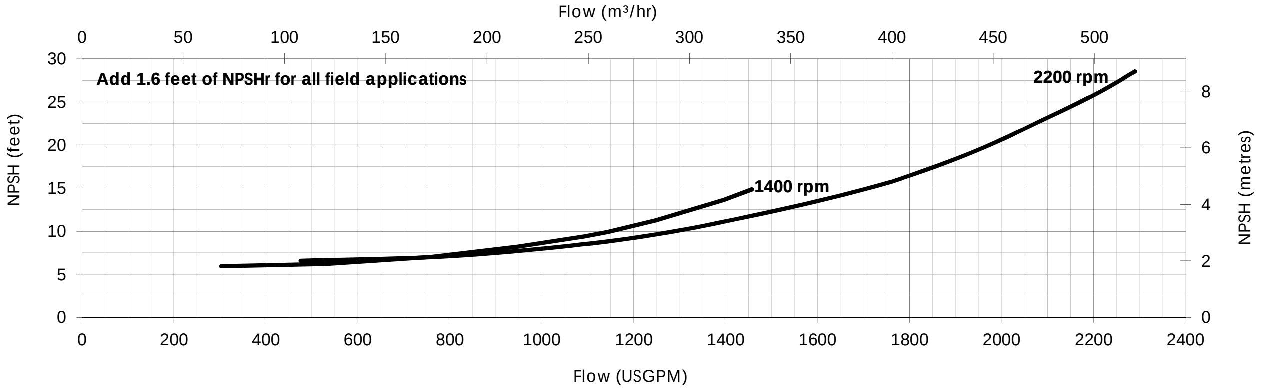
## Performance




## Power



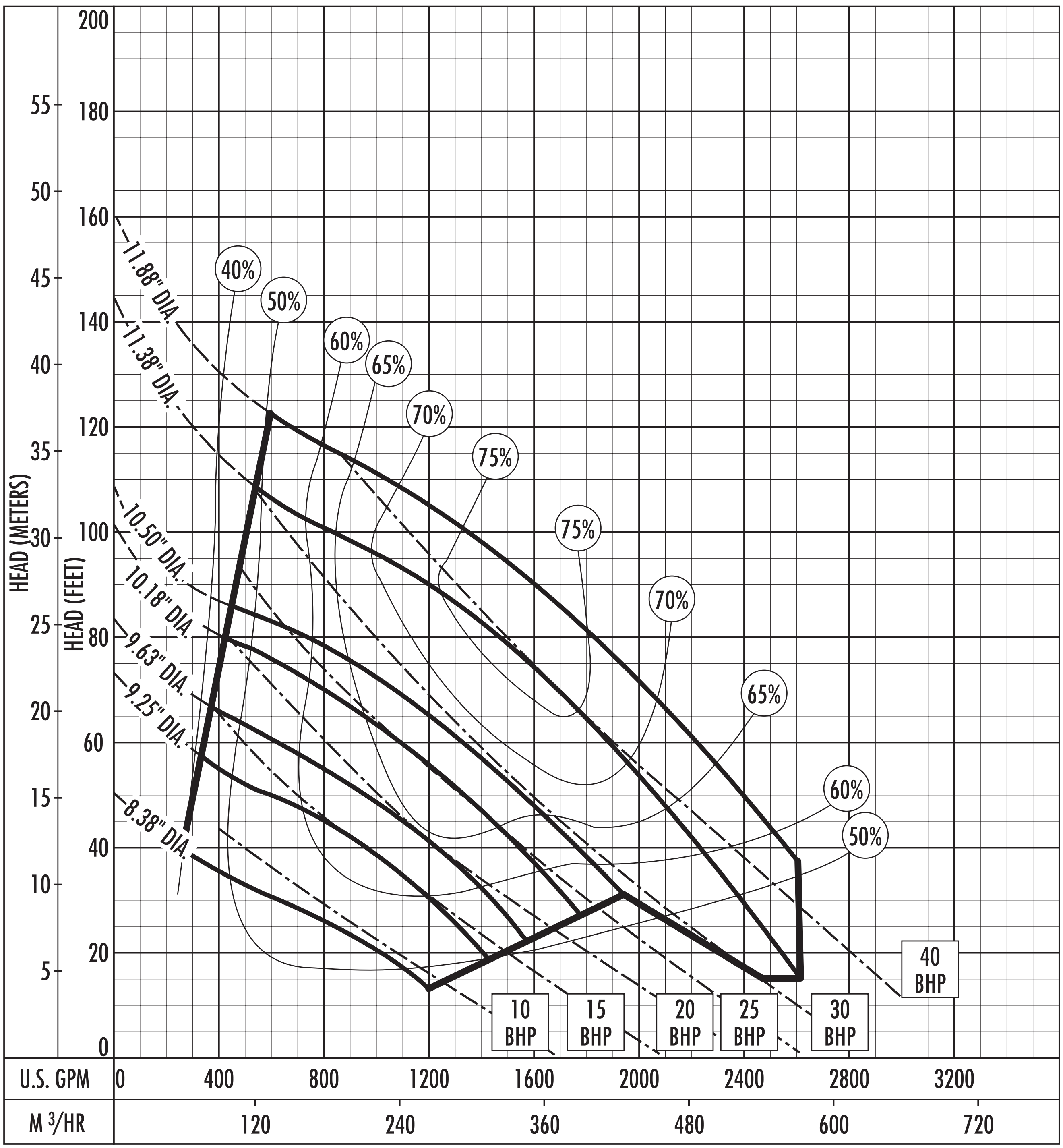

## NPSHr




84 Floodgate Road, Bridgeport, NJ 08014 USA, (856) 467-3636 . Fax (856) 467-4841
Email: sales@godwinpumps.com, godwinpumps.com

# Performance Curve – S8F/S8FX

RPM: **1750** DISCHARGE: **8"** SOLIDS: **3-1/4"**




The curves reflect maximum performance characteristics without exceeding full load (Nameplate) horsepower. All pumps have a service factor of 1.2. Operation is recommended in the bounded area with operational point within the curve limit. Performance curves are based on actual tests with clear water at 70° F. and 1280 feet site elevation.

Conditions of Service:

GPM: __________ TDH: _______

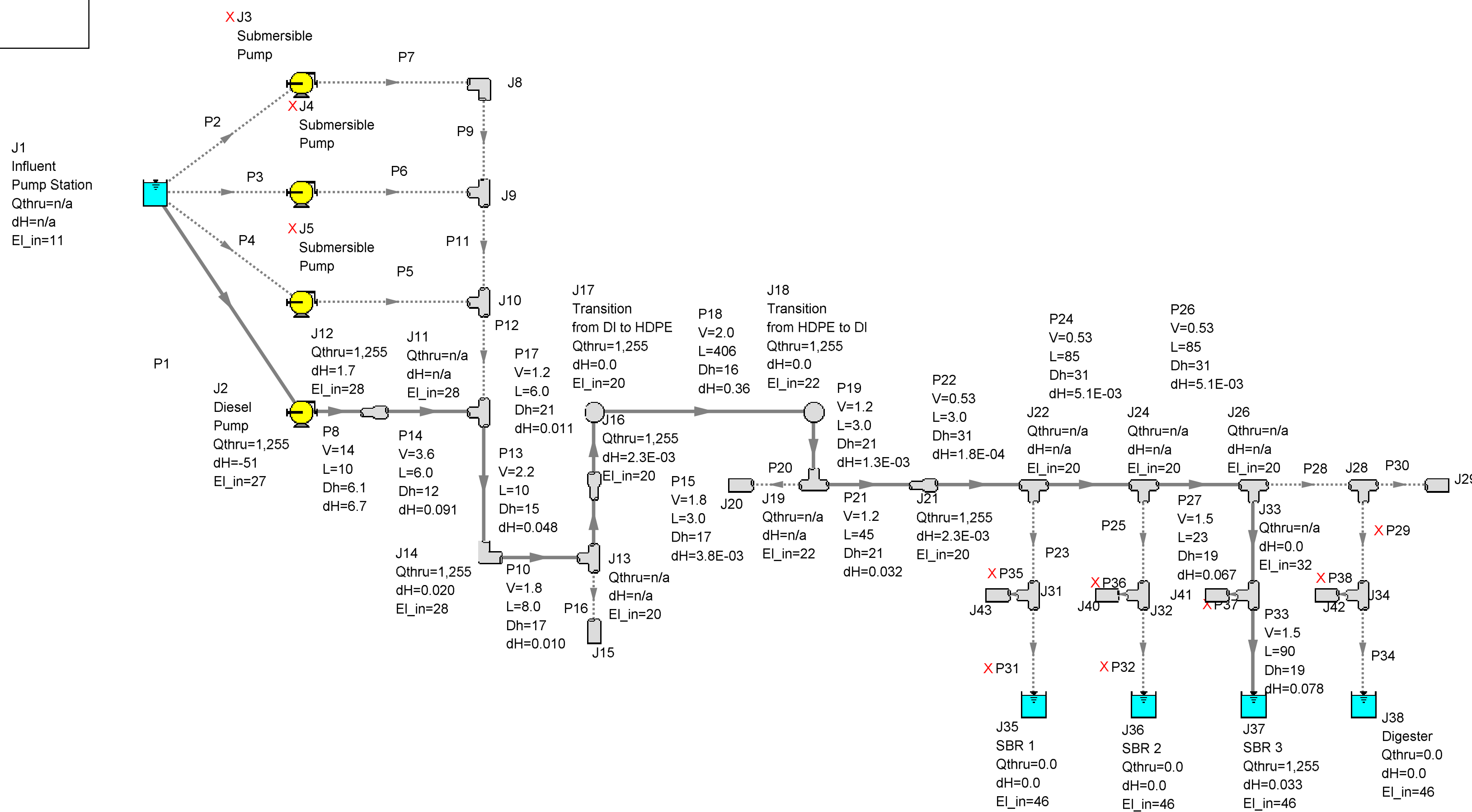
# Attachment 3
# Model Visual Report—Existing High Head Scenario

AFT Fathom Model

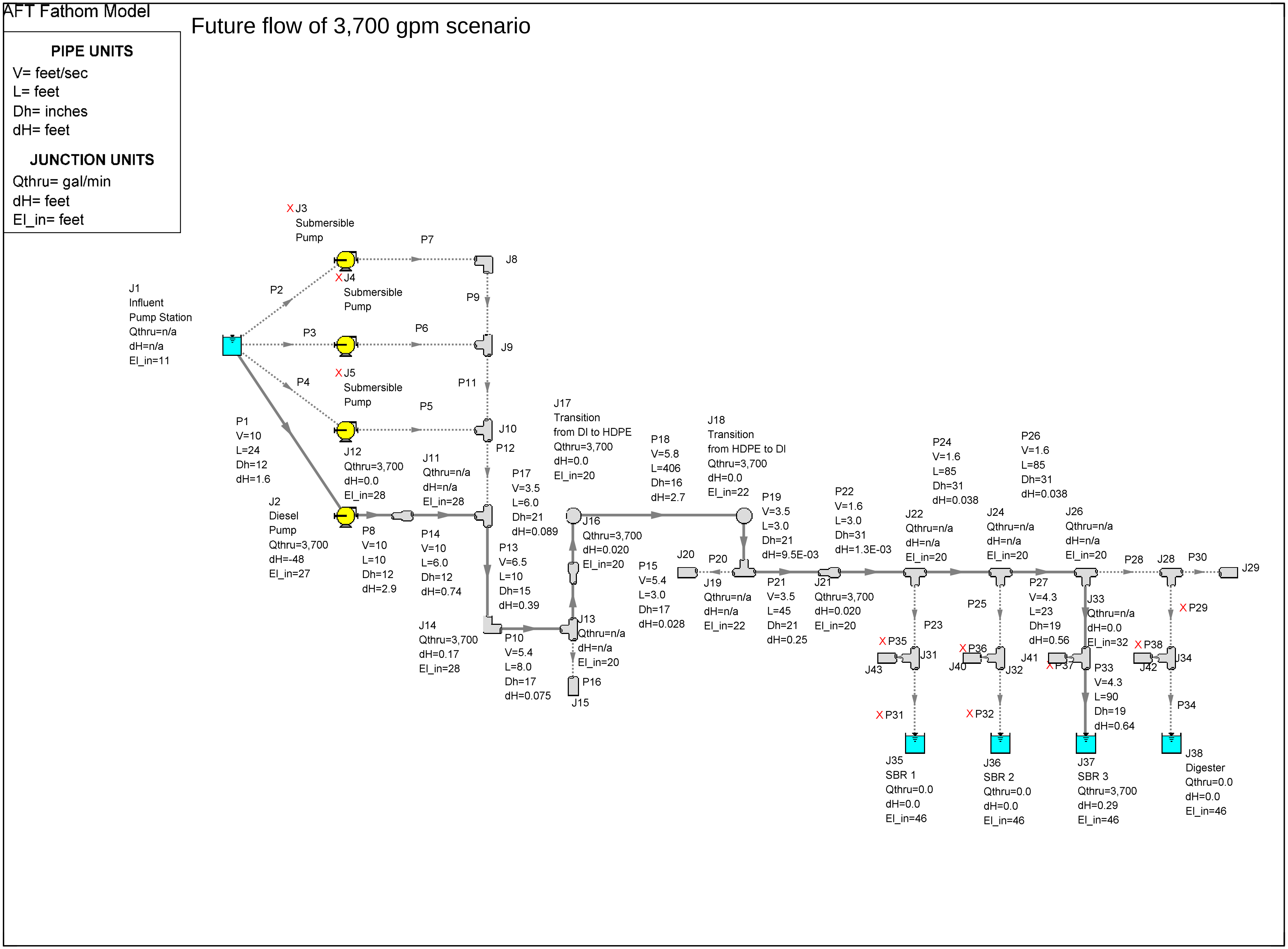
# Current diesel pump high head scenario

**PIPE UNITS**
V= feet/sec
L= feet
Dh= inches
dH= feet

**JUNCTION UNITS**
Qthru= gal/min
dH= feet
El_in= feet



# Attachment 4
# Model Visual Report—Future Flow Scenario


AFT Fathom Model
Future flow of 3,700 gpm scenario
PIPE UNITS
V= feet/sec
L= feet
Dh= inches
dH= feet
JUNCTION UNITS
Qthru= gal/min
dH= feet
El_in= feet
J3 Submersible Pump
P7
J8
J4 Submersible Pump
P2
P9
J1 Influent Pump Station Qthru=n/a dH=n/a El_in=11
P3
P6
J9
J5 Submersible Pump
P4
P11
P5
J10
P12
P1 V=10 L=24 Dh=12 dH=1.6
J12 Qthru=3,700 dH=0.0 El_in=28
J11 Qthru=n/a dH=n/a El_in=28
P17 V=3.5 L=6.0 Dh=21 dH=0.089
J17 Transition from DI to HDPE Qthru=3,700 dH=0.0 El_in=20
P18 V=5.8 L=406 Dh=16 dH=2.7
J18 Transition from HDPE to DI Qthru=3,700 dH=0.0 El_in=22
P24 V=1.6 L=85 Dh=31 dH=0.038
P26 V=1.6 L=85 Dh=31 dH=0.038
J2 Diesel Pump Qthru=3,700 dH=-48 El_in=27
P8 V=10 L=10 Dh=12 dH=2.9
P14 V=10 L=6.0 Dh=12 dH=0.74
P13 V=6.5 L=10 Dh=15 dH=0.39
J16 Qthru=3,700 dH=0.020 El_in=20
P19 V=3.5 L=3.0 Dh=21 dH=9.5E-03
P22 V=1.6 L=3.0 Dh=31 dH=1.3E-03
J22 Qthru=n/a dH=n/a El_in=20
J24 Qthru=n/a dH=n/a El_in=20
J26 Qthru=n/a dH=n/a El_in=20
P28
J28
P30
J29
P15 V=5.4 L=3.0 Dh=17 dH=0.028
J20
P20
J19 Qthru=n/a dH=n/a El_in=22
P21 V=3.5 L=45 Dh=21 dH=0.25
J21 Qthru=3,700 dH=0.020 El_in=20
P27 V=4.3 L=23 Dh=19 dH=0.56
J33 Qthru=n/a dH=0.0 El_in=32
P29
P25
P23
J14 Qthru=3,700 dH=0.17 El_in=28
P10 V=5.4 L=8.0 Dh=17 dH=0.075
J13 Qthru=n/a dH=n/a El_in=20
P16
J15
P35
J31
J43
P36
J40
J32
J41
P37
P33 V=4.3 L=90 Dh=19 dH=0.64
P38
J42
J34
P31
P32
P34
J35 SBR 1 Qthru=0.0 dH=0.0 El_in=46
J36 SBR 2 Qthru=0.0 dH=0.0 El_in=46
J37 SBR 3 Qthru=3,700 dH=0.29 El_in=46
J38 Digester Qthru=0.0 dH=0.0 El_in=46