CWMAG 2023

Paper 9 – Pump Design and Optimisation

By Ashley Upton and Andy Aung - HydroCo

Paper Overview

1
2
3
4
5

STEP 1
Measuring the Existing System

STEP 2
Reducing System Losses

STEP 3
Design Optimum Pumps

STEP 4
Collect Manufacturers 'Best Offering'

STEP 5
Pump Selection for Optimum Efficiency

CASE STUDY
Transfer Pump Optimisation

HydroCo water systems engineering

UK Water Industry Challenges

Water companies to be net zero by 2030

4th most energy intensive sector in the UK

Water industry uses 3% of UK's energy

Industry only generates 8.5% from renewable sources.

Largest consumption from distribution of water in networks

Sources: UK Government

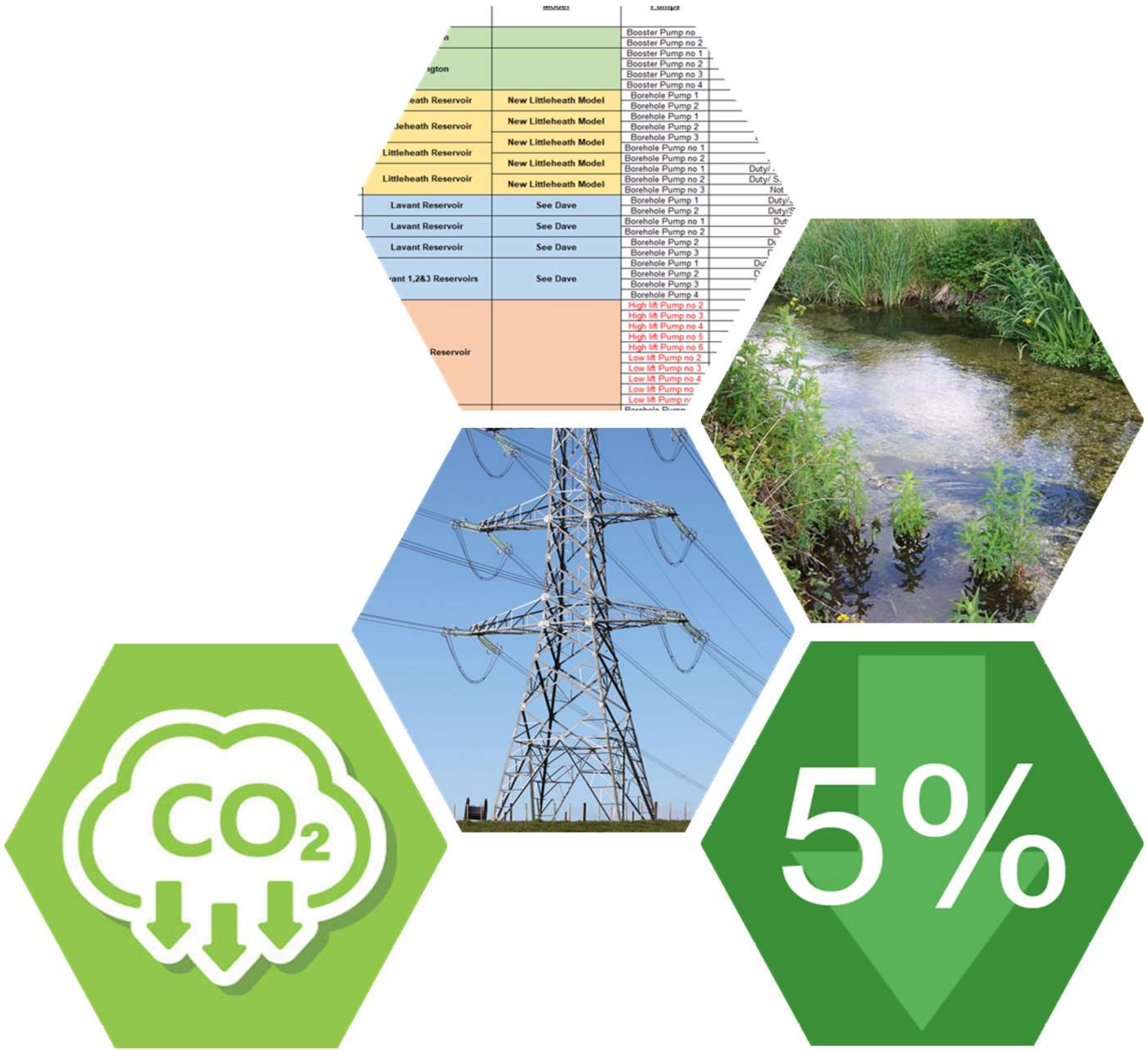
Borehole Optimisation Study

Scope:

- Review the client's borehole sites
- Rank on power consumption
- Select 6 highest consuming sites

Target:

- Reduce overall site operational costs by 5%



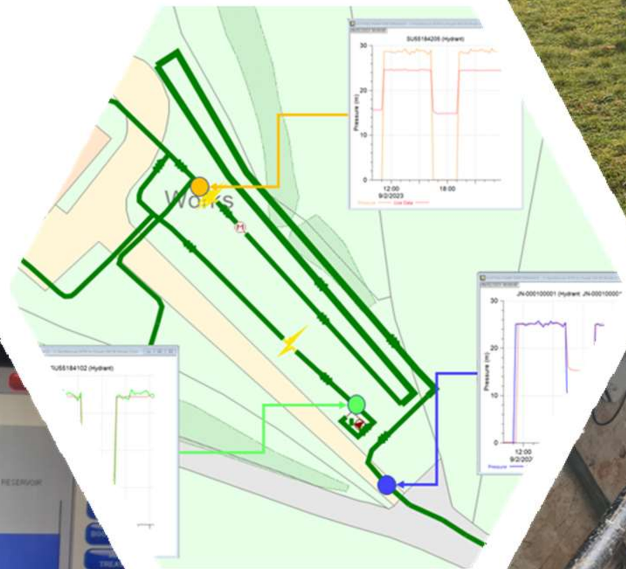
HydroCo water systems engineering

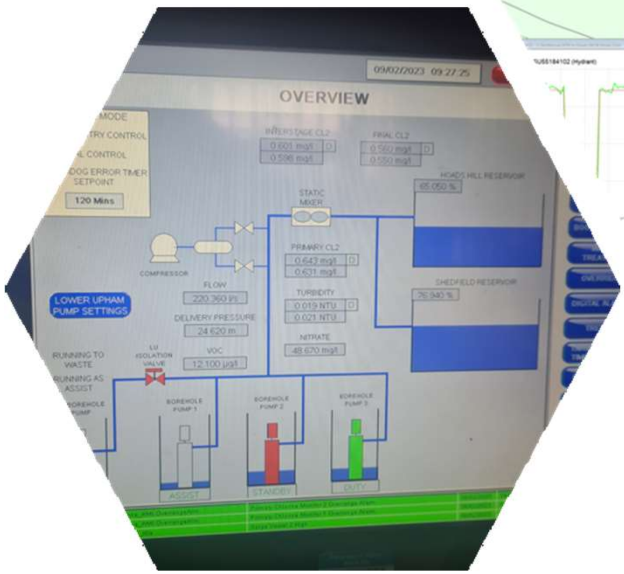
1
2
3
4
5

Measuring The Existing System

Visiting the site with the aim to:

- Understand system
- Data collection
- Data verification

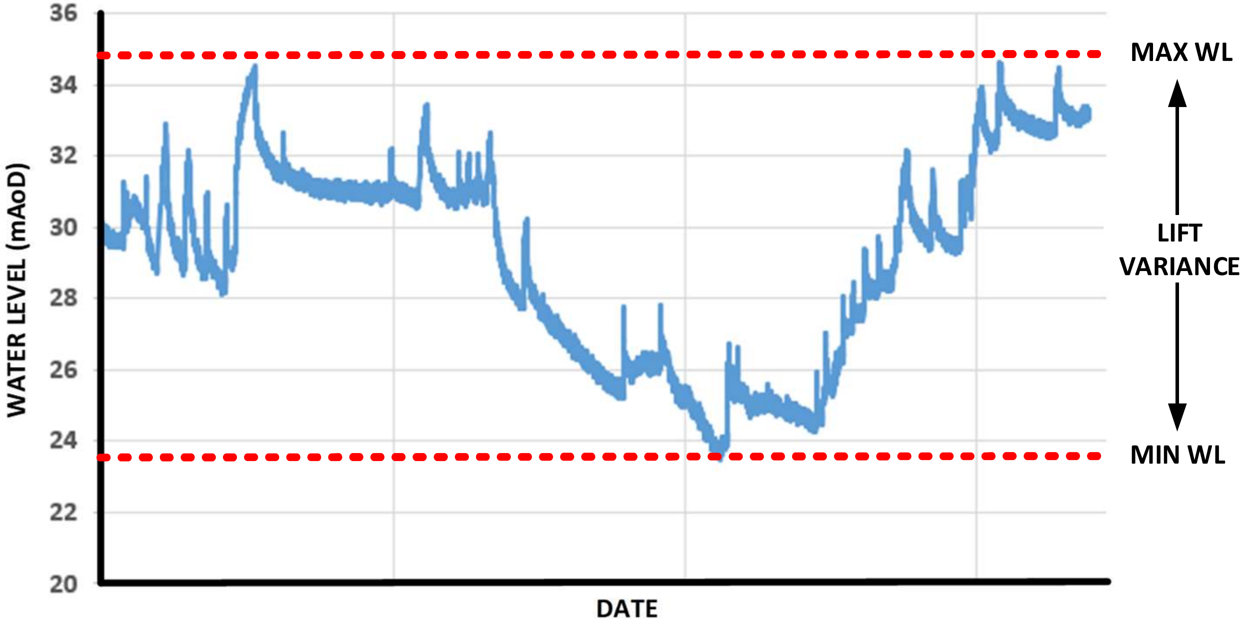


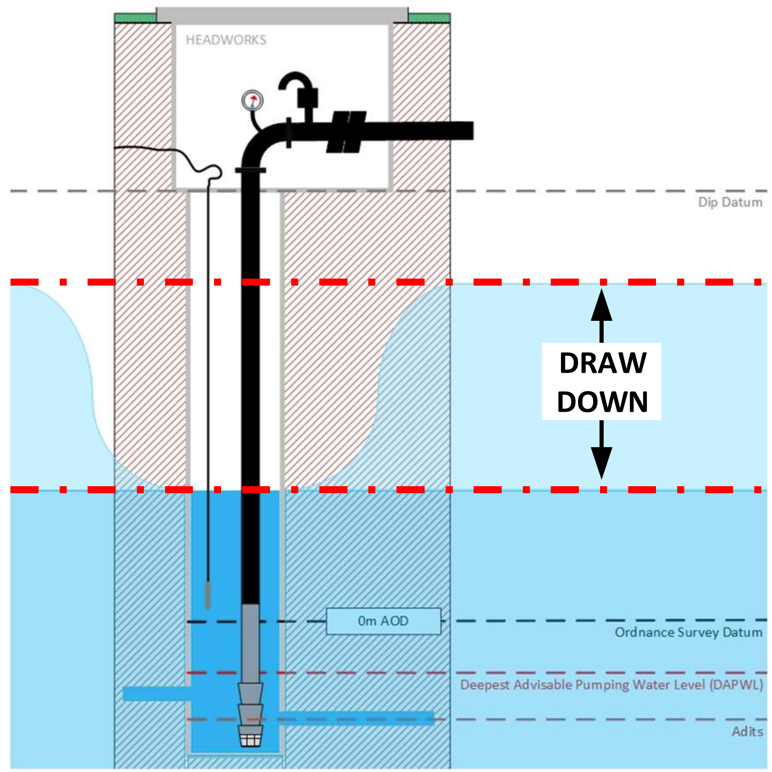


HydroCo water systems engineering

Measuring The Existing System

- Borehole pump assessment
  - Well drawdown
  - Water level variance
  - Influences maximum and minimum pump lift



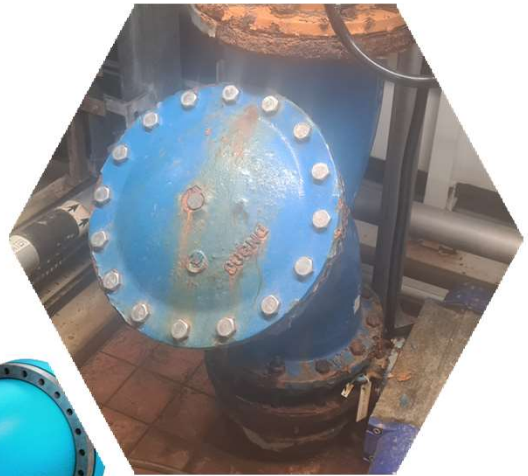
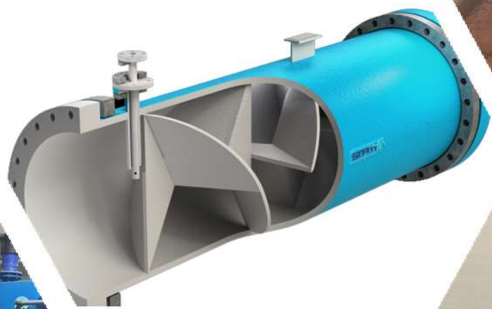


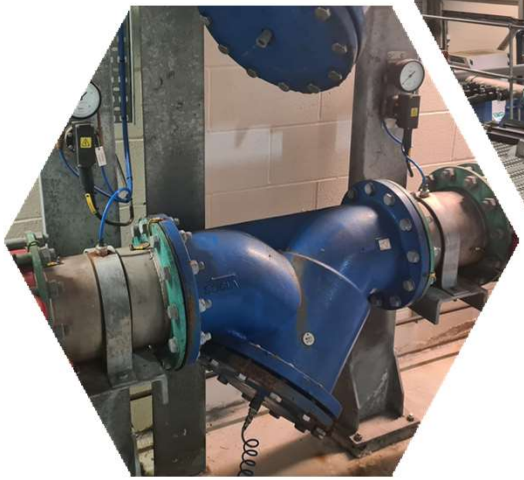
HydroCo water systems engineering

Reducing System Losses

- Condition of the assets
- Type of assets
- Remove unwanted headloss

1
2
3
4
5

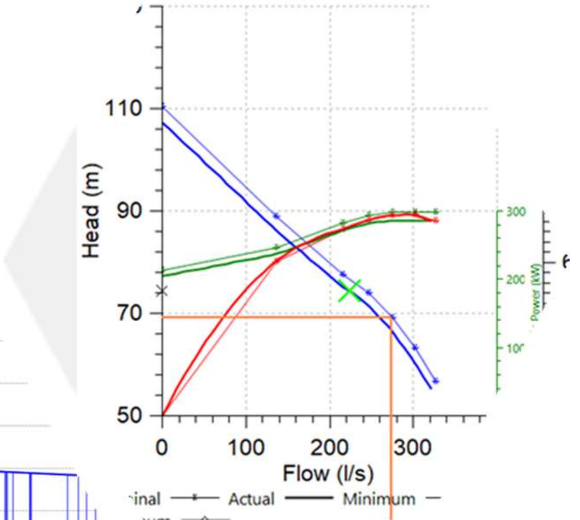



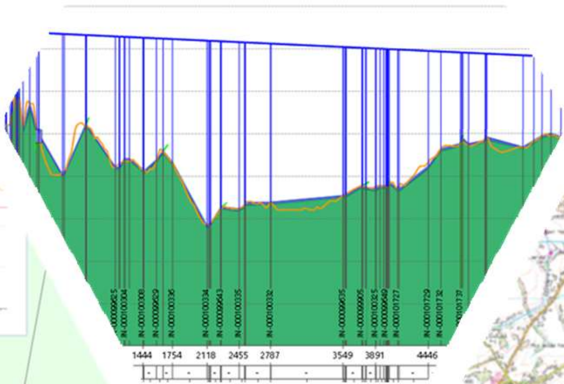



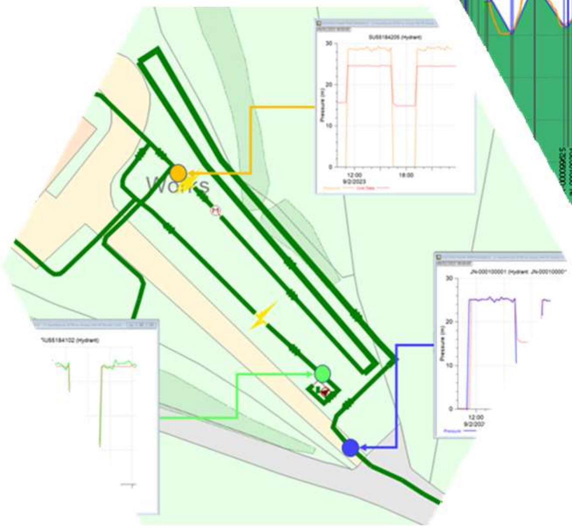

HydroCo water systems engineering

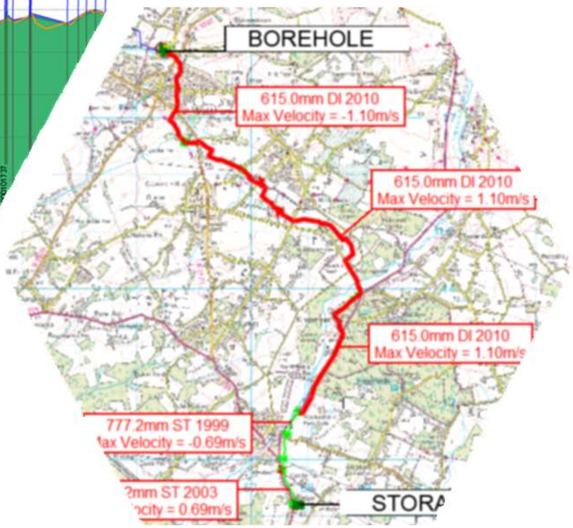
Reducing System Losses - Site Model Calibration

- Create a model of the site
- Calibrate using measured data
- Identify significant headlosses
- Assess existing pump performance







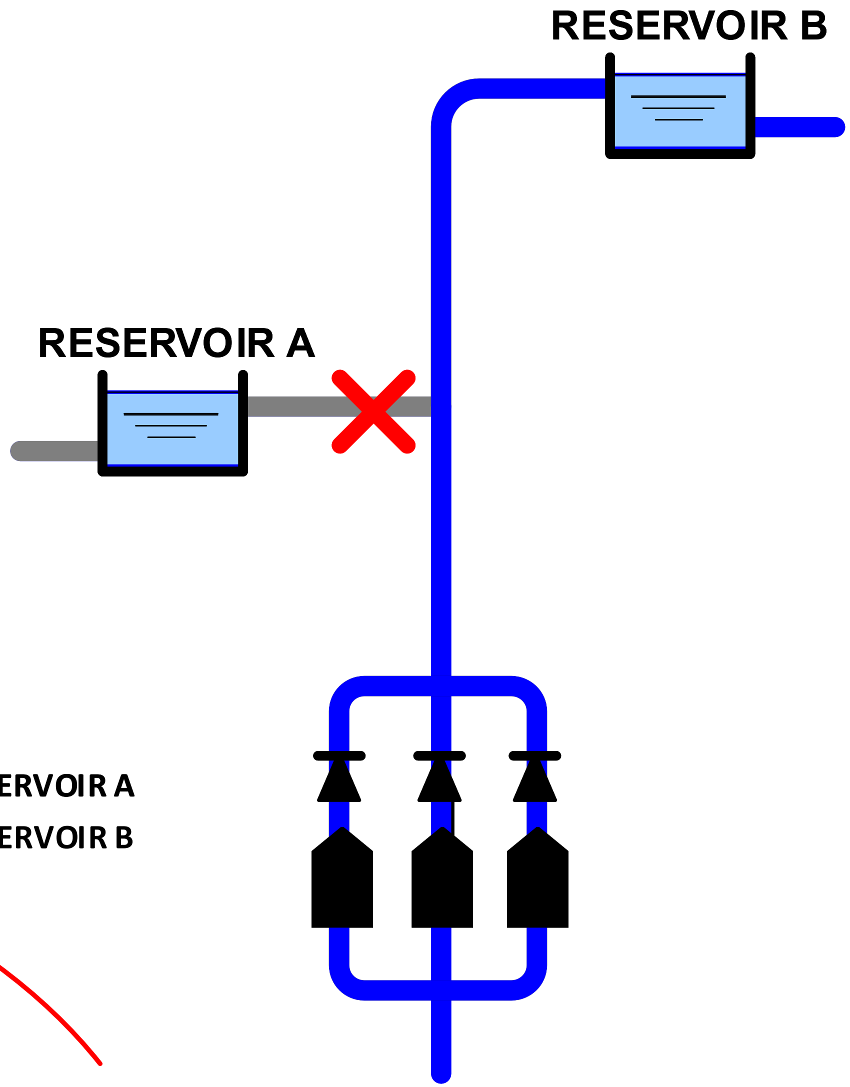


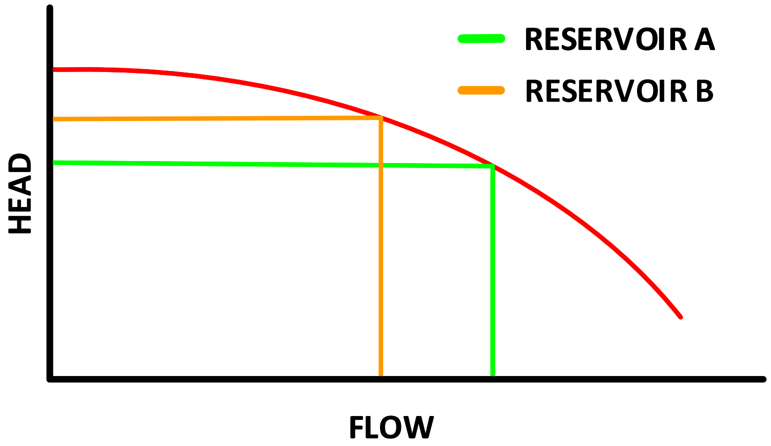
HydroCo water systems engineering

Design Optimum Pumps

What does the client want from the site?

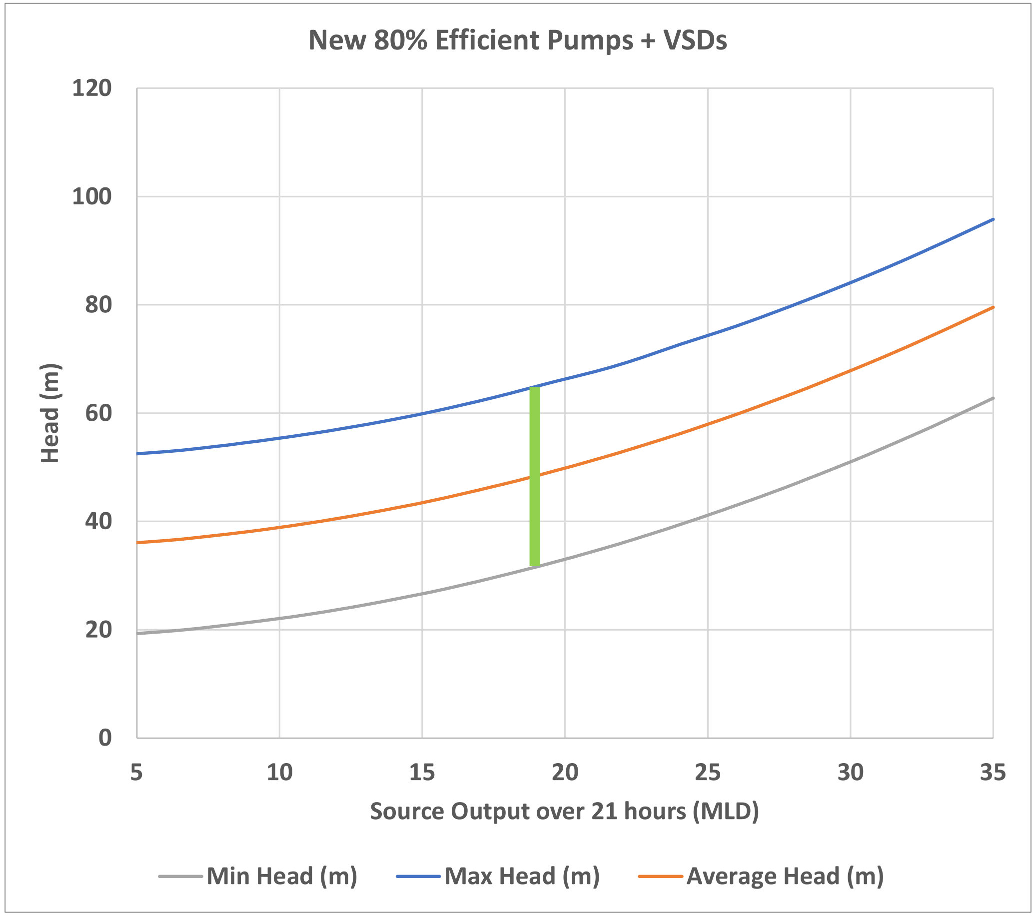
- Pumping more, or less water
- Reducing electricity bills
- Change in operation:
  - Sending water somewhere else?
- Network calming
- Backup pumps

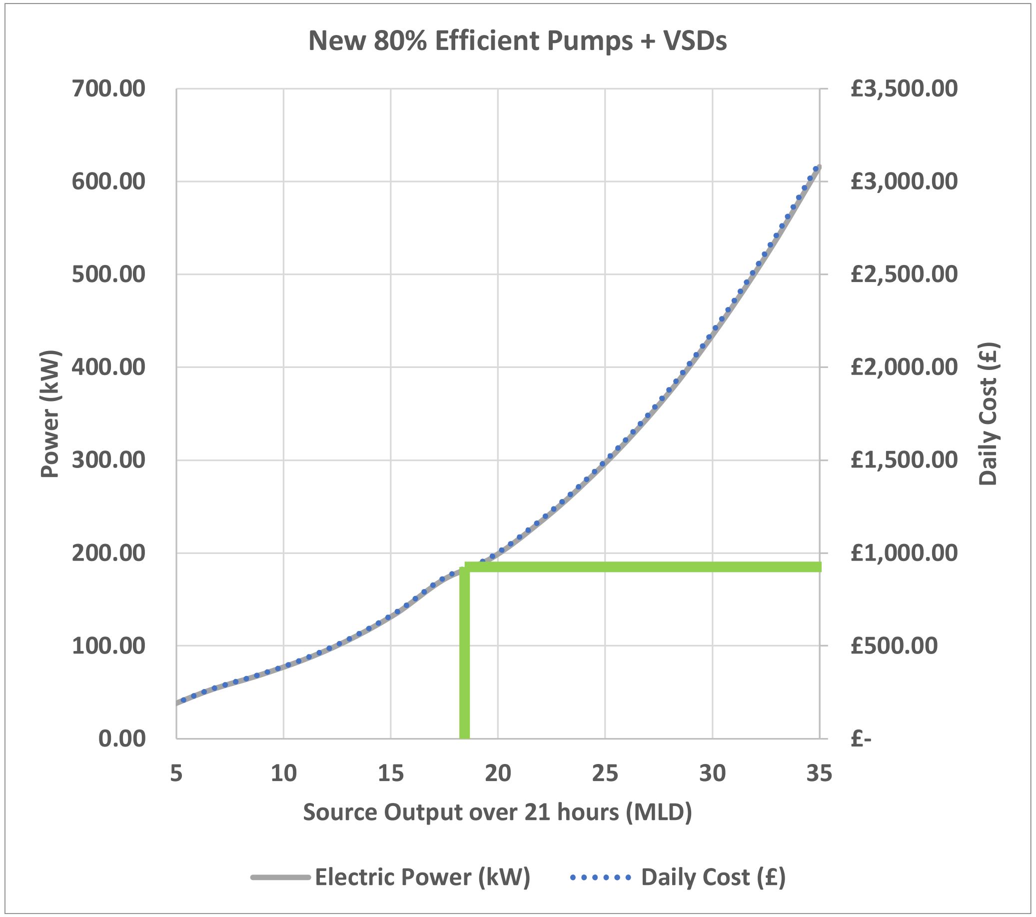




HydroCo water systems engineering

Design Optimum Pumps – Defining the system curve

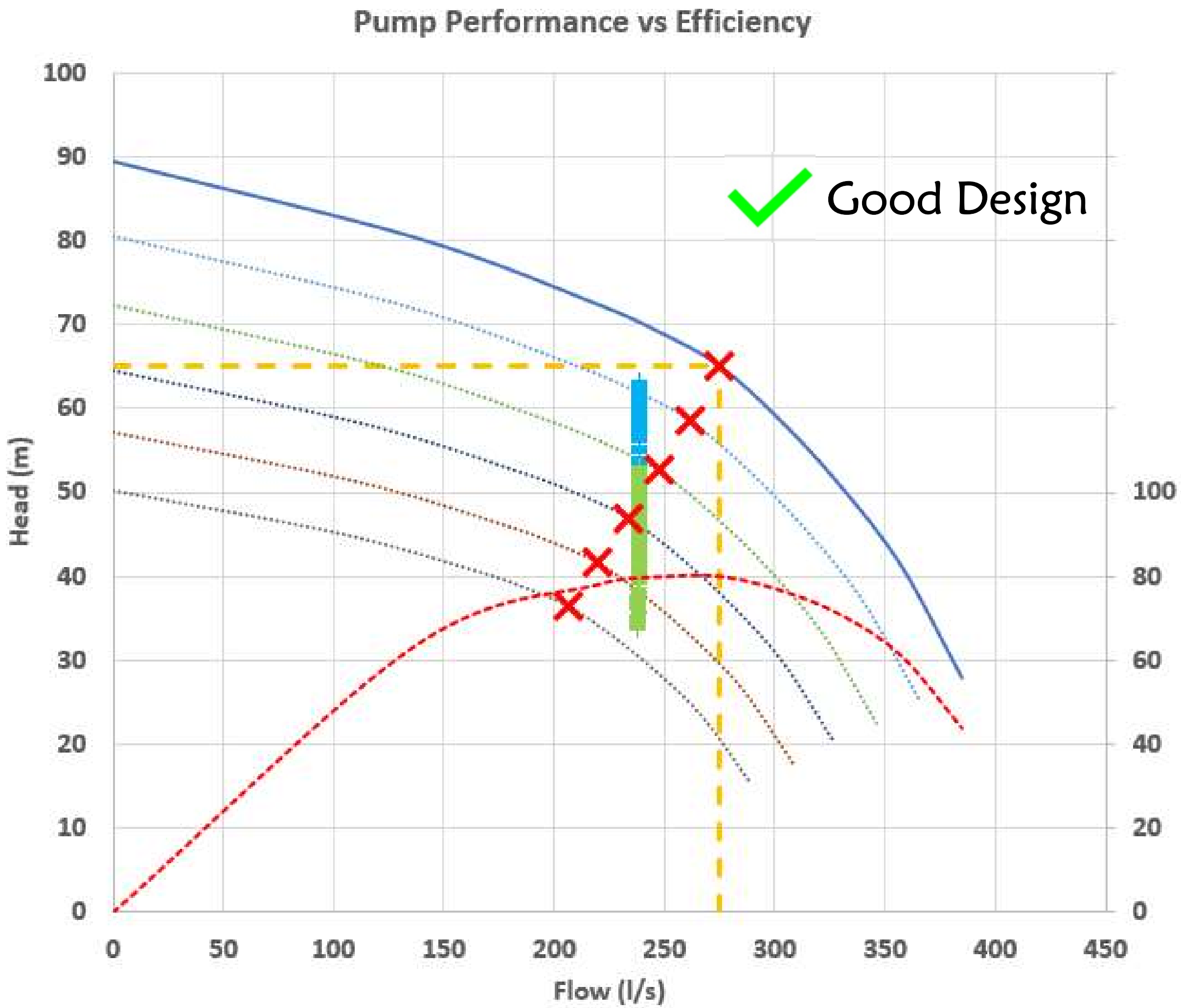


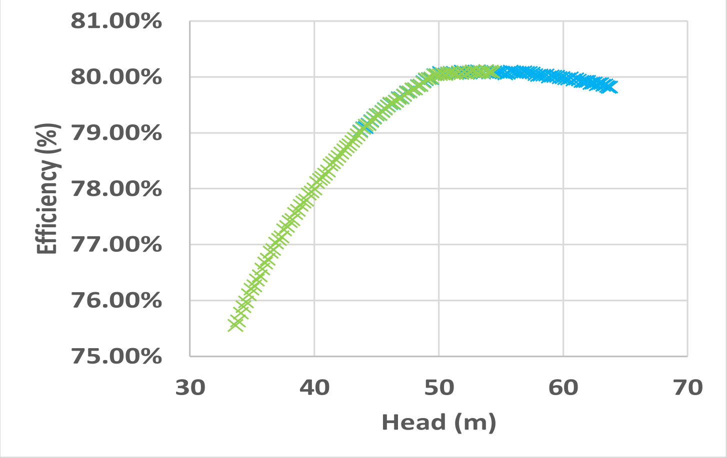


Proposed site operation: BH3, 17.99 MLD over 21 hours, 20.5 MLD over 24 hours (238 l/s)
BH3+BH1, 28 MLD over 24 hours

HydroCo water systems engineering

Design Optimum Pumps - Defining The Duty Point





BH1 & BH3 at 28MLD

BH3 at 20.55MLD

KEY

100% SPEED

90% SPEED

80% SPEED

70% SPEED

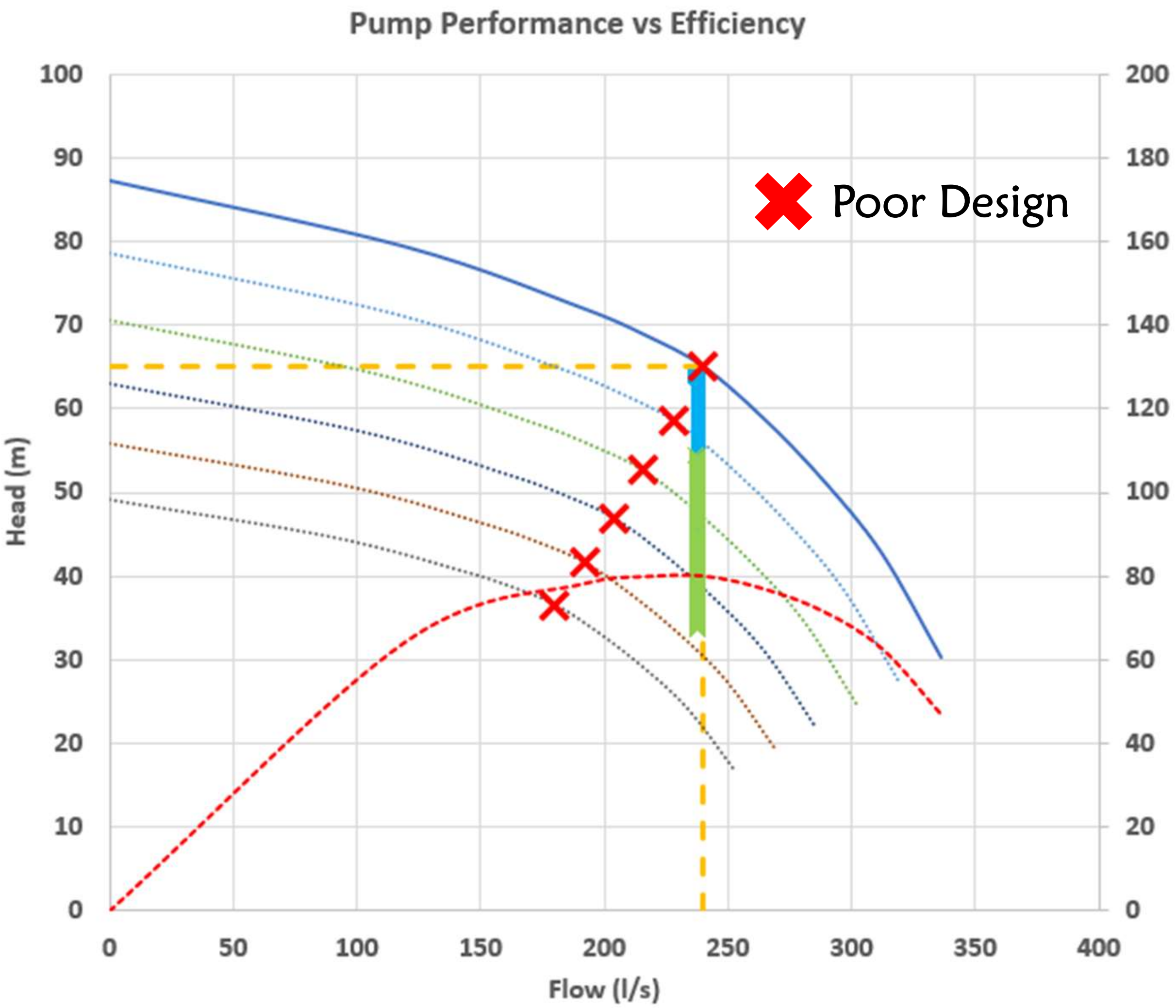
60% SPEED

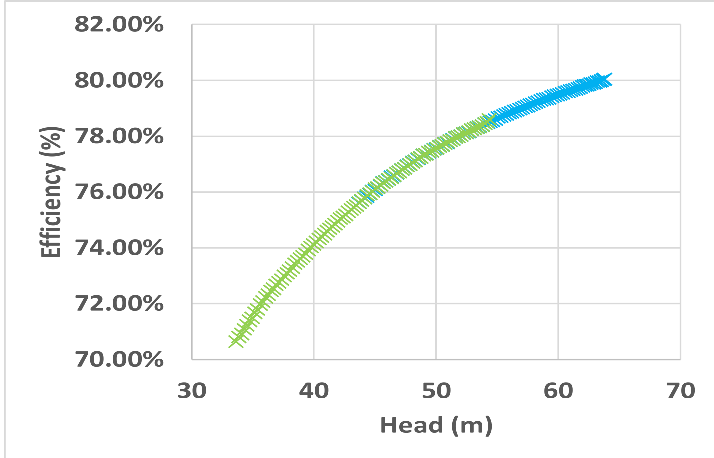
50% SPEED

MOST EFFICIENT POINT

1
2
3
4
5

Design Optimum Pumps - Defining The Duty Point





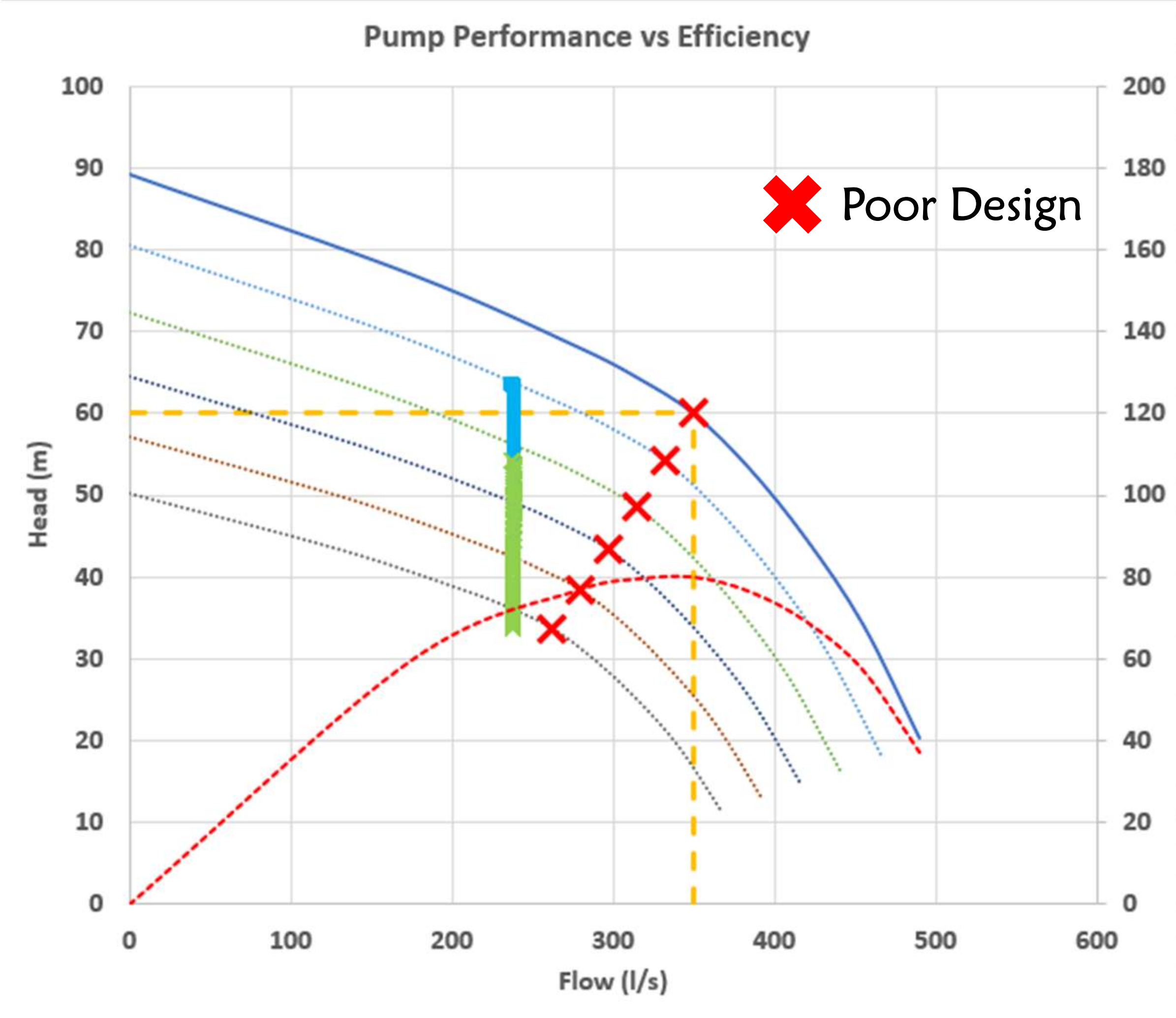
KEY

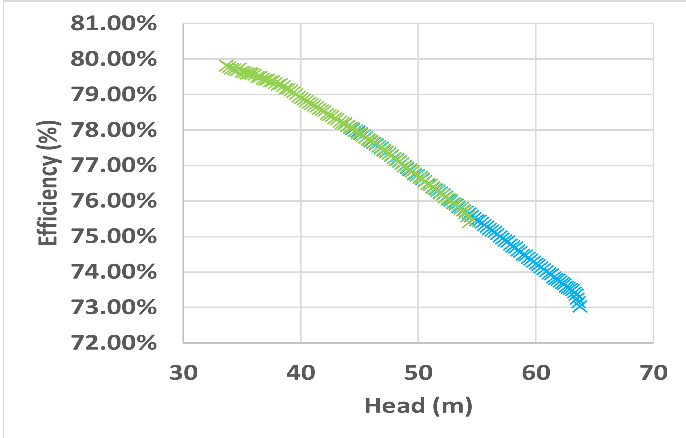
- 100% SPEED
- 90% SPEED
- 80% SPEED
- 70% SPEED
- 60% SPEED
- 50% SPEED
- MOST EFFICIENT POINT

HydroCo water systems engineering

Design Optimum Pumps - Defining The Duty Point

1
2
3
4
5





BH1 & BH3 at 28MLD

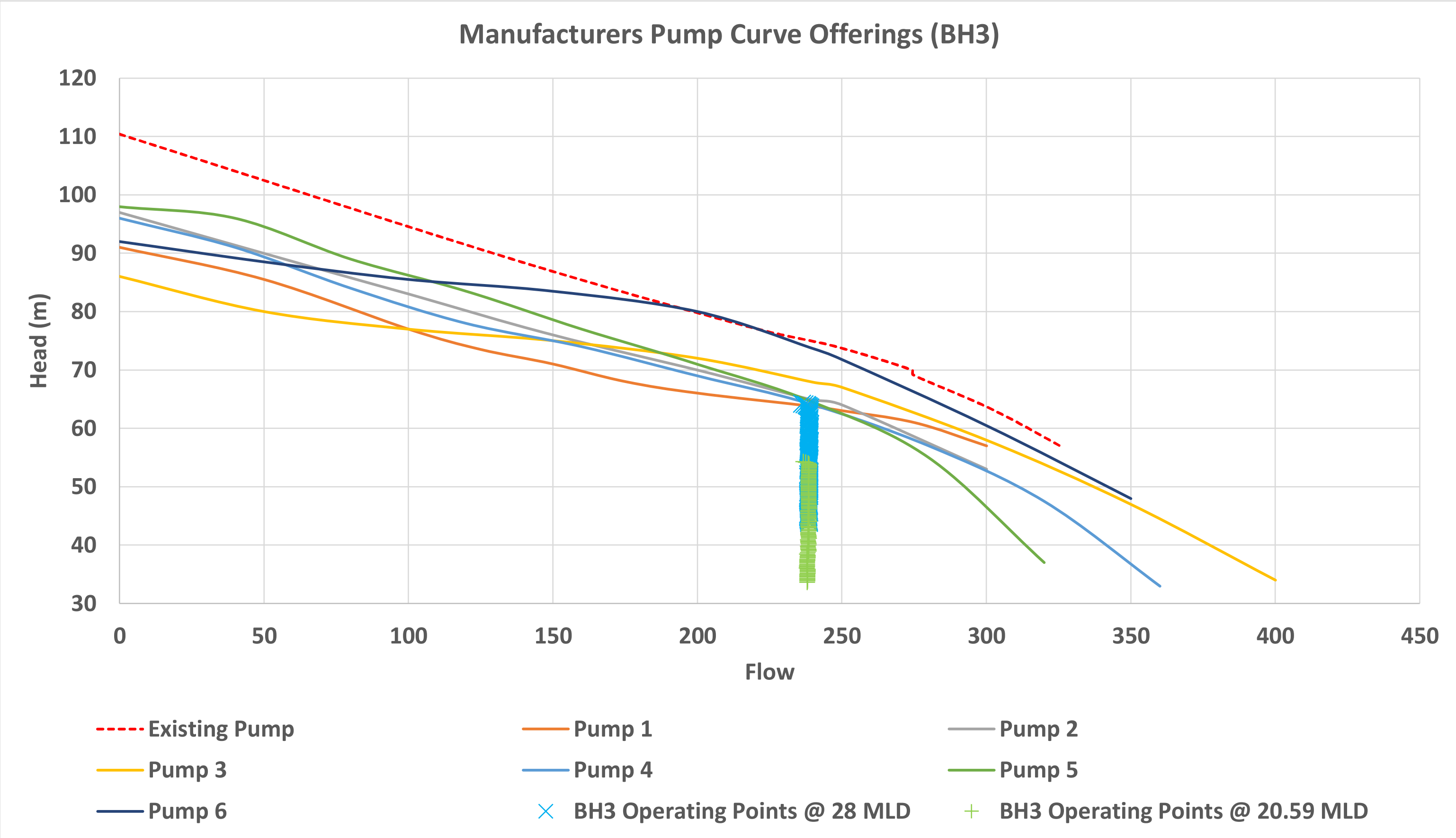
BH3 at 20.55MLD

KEY

100% SPEED		60% SPEED	
90% SPEED		50% SPEED	
80% SPEED		MOST EFFICIENT POINT	
70% SPEED			

HydroCo water systems engineering

Collect Manufacturers 'Best Offering'



Existing Pump:
275 kW
£1,395 per day
(inc. site headloss)

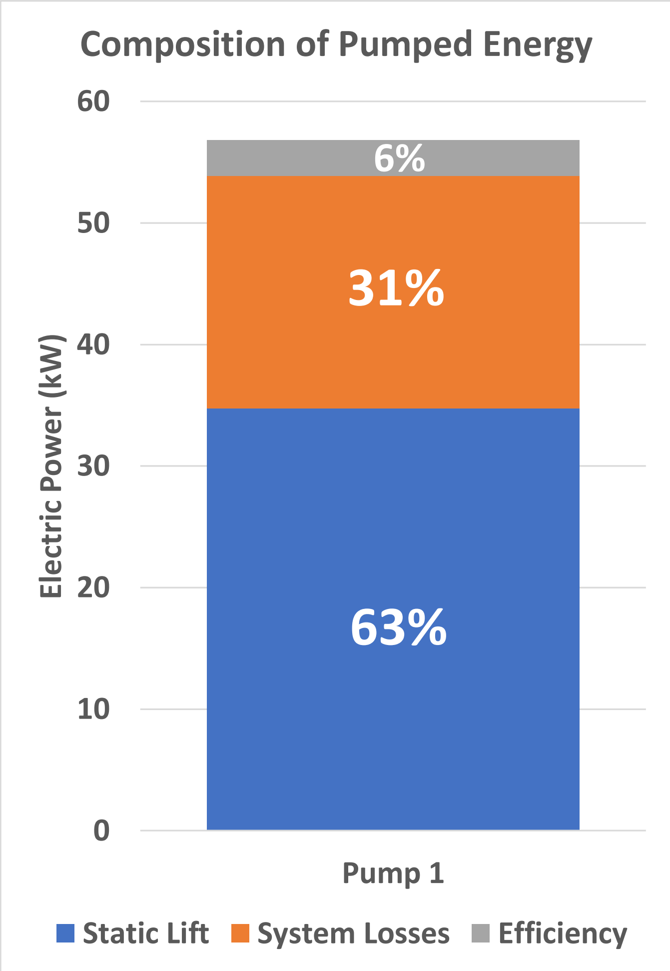
Design Pump:
163 kW
£930 per day
(exc. site headloss)

Manufacturers Best Pump:
160 kW
£912 per day

35% Saving Achieved

HydroCo water systems engineering

Optimum Pump Selection - Composition Of Pumped Energy



Pump Efficiency

Energy dependent on the efficiency of the pump

System Losses

Energy required to overcome system losses

Static Lift

Energy required to get water out of ground into storage with no headloss.

HydroCo water systems engineering

Borehole Optimsation Conclusions

The largest energy saving is achieved when poor asset conditions resolved

End-to-end tests highlight poor SCADA data

Additional tapping points required to understand individual asset losses

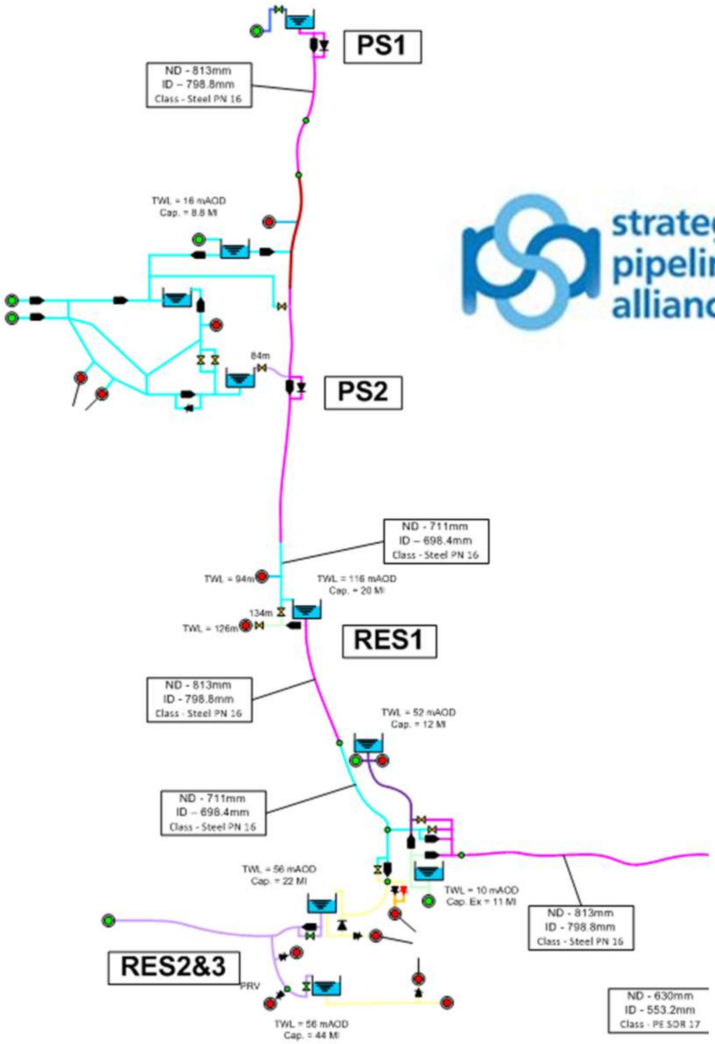
Optimum duty point selection not max head/flow operating point

Up to 10% variance in manufacturers suggested pump performance

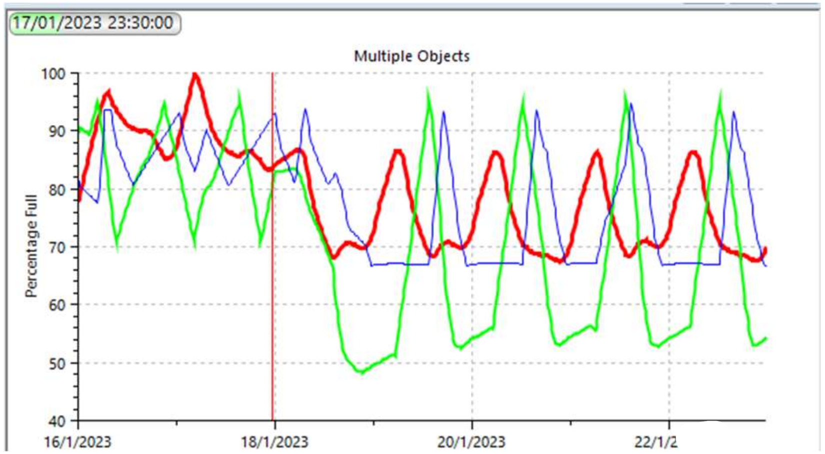
It's a challenge to make big savings by optimising pumps

HydroCo water systems engineering

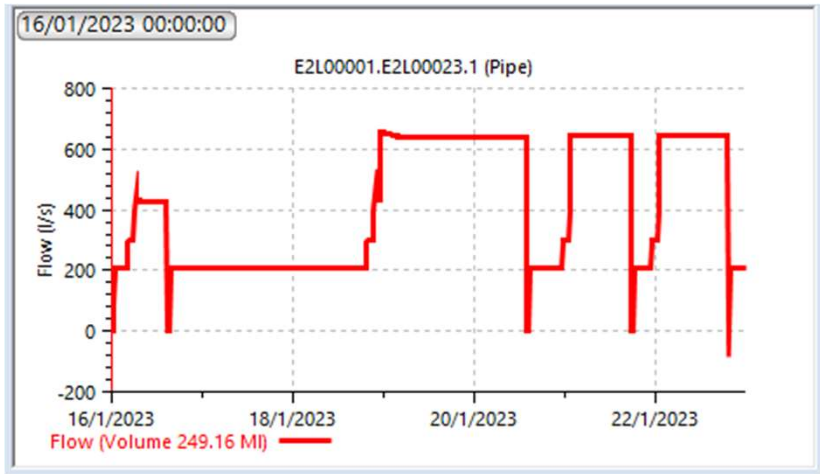
Case Study - System Step Change



Res 1,2 & 3



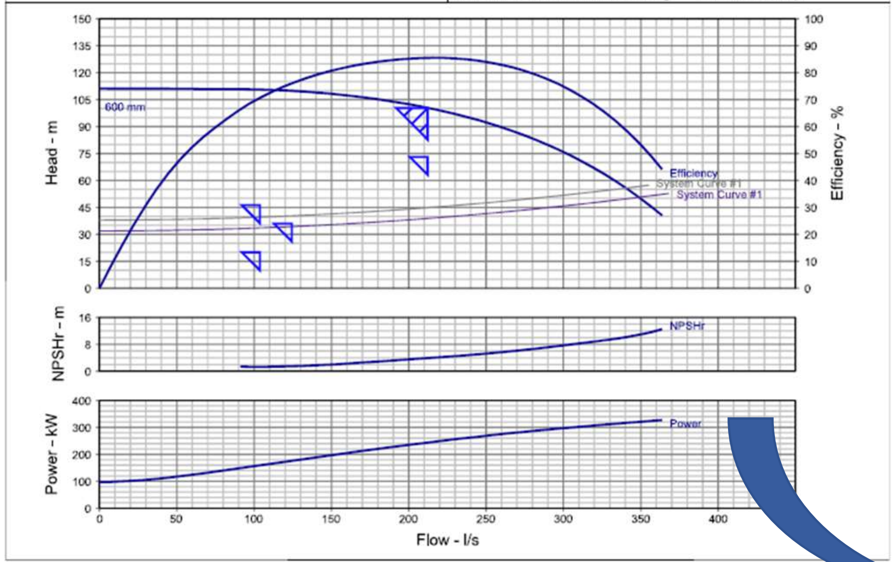
PS1

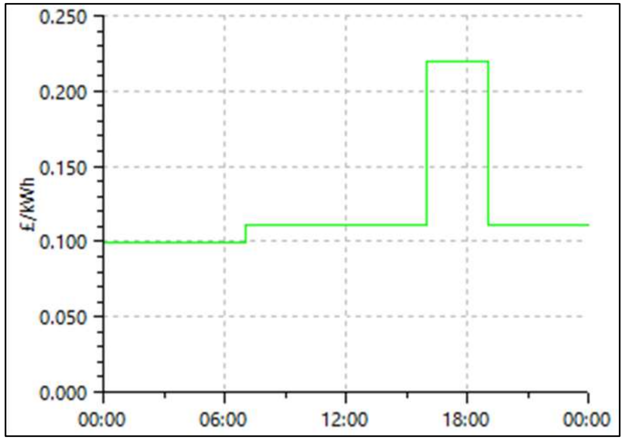


Case Study - Pump Configuration

Operating Conditions	
Flow, rated	: 212,2 l/s
Differential Head (requested)	: 100,3 m
Differential Head (actual)	: 100,4 m
Suction pressure, rated / max	: 0,00 / 0,00 bar.g
NPSH available, rated	: Ample
Site Supply Frequency	: 50 Hz
Performance	
Speed, rated	: 1346 rpm
Impeller diameter, rated (approx.)	: 600 mm
Impeller diameter, maximum	: 600 mm
Impeller diameter, minimum	: 490 mm
Efficiency	: 85,49 %
NPSH required / margin required	: 3,91 / 0,50 m
nq (imp. eye flow) / S (imp. eye flow)	: 14 / 154 Metric units
Minimum Continuous Safe Flow (MCSF)	: -
Head, maximum, rated diameter (approx.)	: 111.1 m
Head rise to shutoff (approx.)	: 10,69 %
Flow, best eff. point	: 218,2 l/s
Flow ratio, rated / BEP	: 97,27 %
Diameter ratio (rated / max)	: 100,00 %
Head ratio (rated dia / max dia)	: 100,00 %
Cq/Ch/Ce/Cn [HI2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable
Performance testing standard	: -

Liquid	
Liquid Type/ Application	: Water
Additional liquid description	:
Solids diameter, max	: 0,00 mm
Solids/Bagasse/Stock consistency by volume	: 0,00 %
Temperature, max	: 20,00 deg C
Fluid density rated	: 1,000 SG
Viscosity, rated	: 1,00 cSt
Vapor pressure, rated	: 0,02 bar.a
Material	
Material selected	: Grey Cast Iron / Stainless Steel / Stainless Steel
Pressure Data	
Maximum working pressure	: 10,88 bar.g
Maximum allowable working pressure	: 19,00 bar.g
Maximum allowable suction pressure	: 14,00 bar.g
Hydrostatic test pressure	: 16,32 bar.g
Driver & Power Data (@Max density)	
Driver sizing specification	: Rated power
Margin over specification	: 15,00 %
Service factor	: 1,00
Power, hydraulic	: 209 kW
Power, rated	: 244 kW
Power, maximum, rated diameter	: 327 kW
Minimum recommended driver rating	: 315 kW / 422 hp





Pump Curve _Pump_new_v2

Pump Curve | Notes

Pump Curve Data

_Pump_new_v2

Nominal Flow (l/s) 212.20 Pressure Diameter (mm) 700.00 Inertia Mode User valu

Nominal Speed (rpm) 1346 Suction Diameter (mm) 800.00 Total Inertia (kg.m2) 0.00

Flow (l/s)	Head (m)	Mechanical Power (kW)
0.00	110.00	100.00
73.23	109.83	128.00
107.97	109.26	156.00
142.71	107.87	184.00
177.46	105.13	212.00
212.20	100.40	240.00
250.52	91.99	260.00
288.84	79.11	280.00
327.17	60.46	300.00
365.00	35.00	320.00

Rated Values

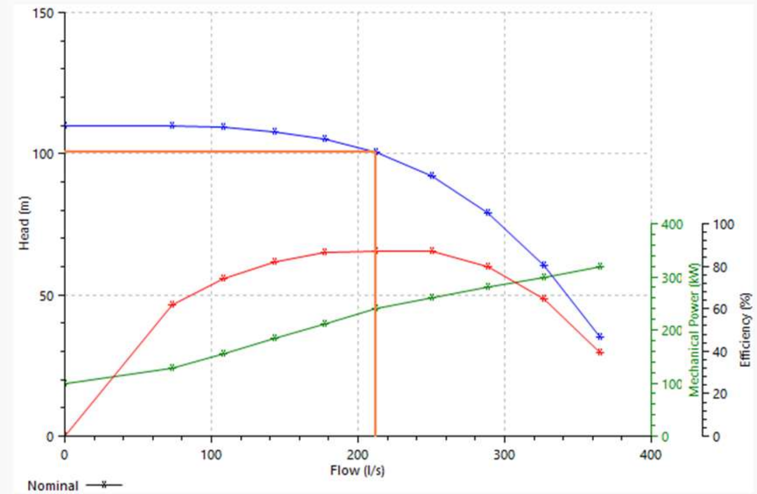
Head (m) 100.4

Mechanical Power 240

Efficiency (%)

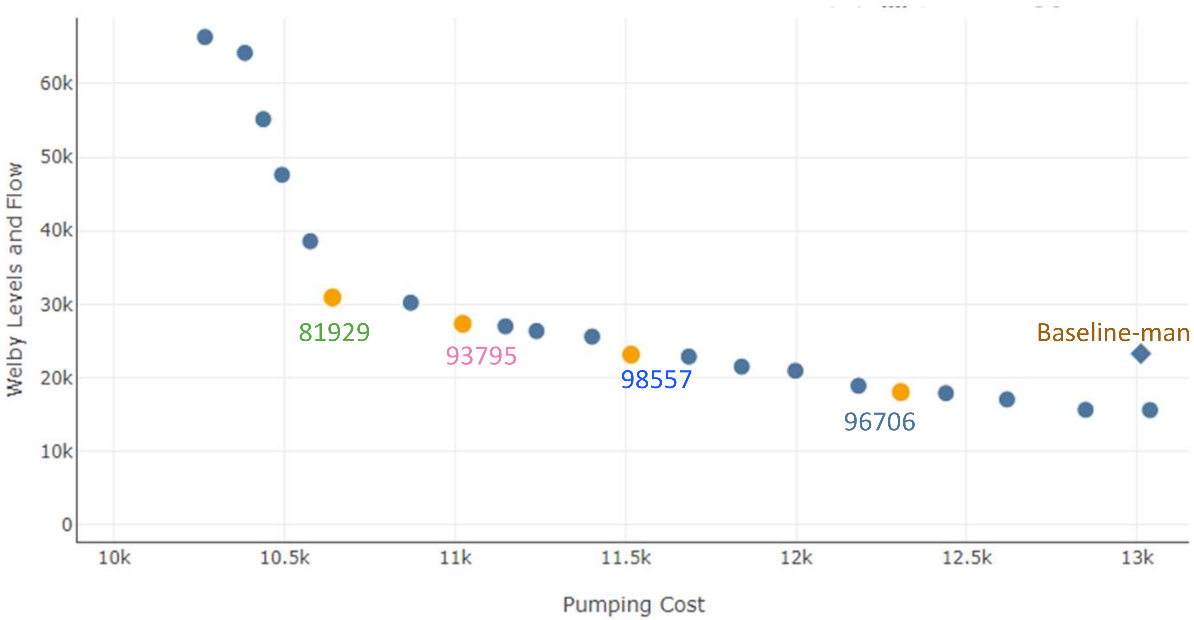
Generate Synthetic Pump Curve

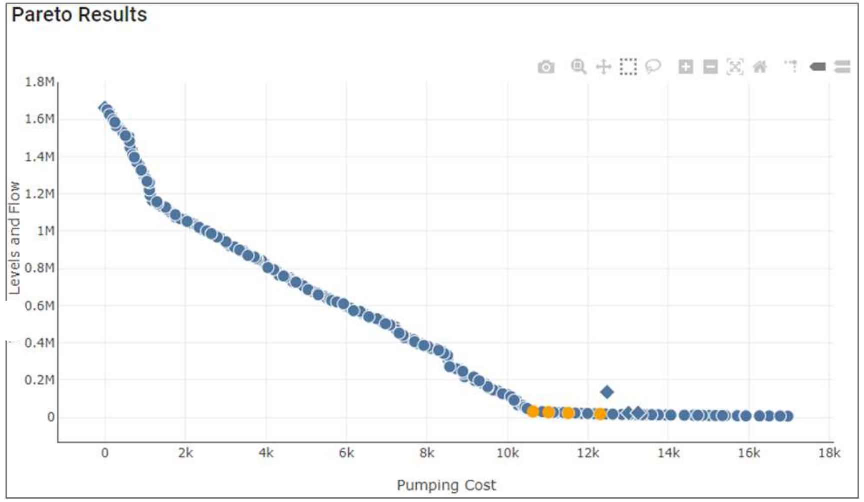
Genera

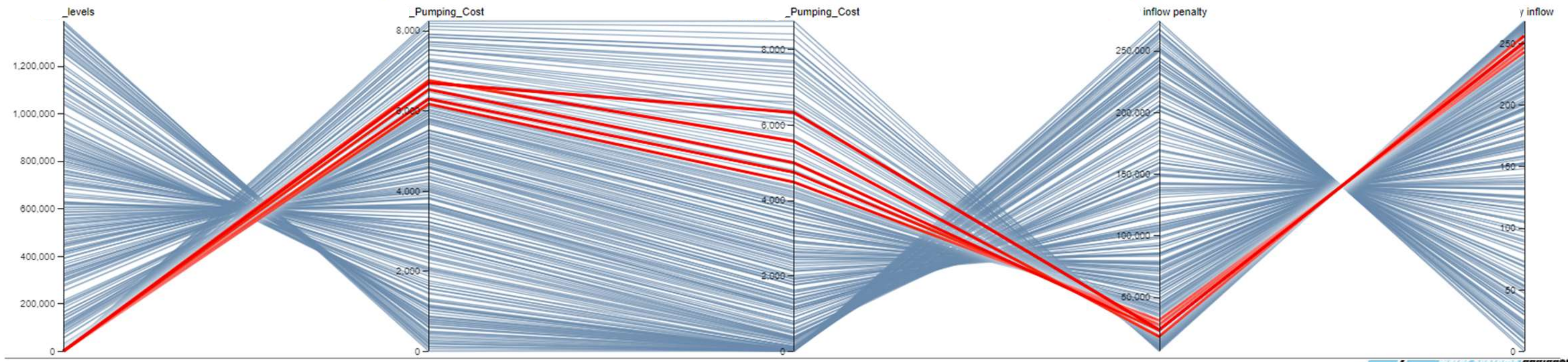


HydroCo water systems engineering

Case Study - Optimizer Plans

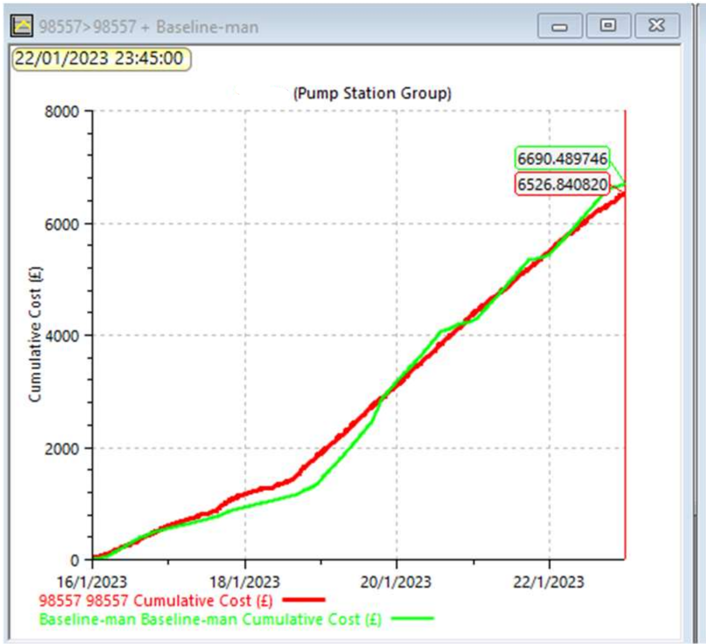




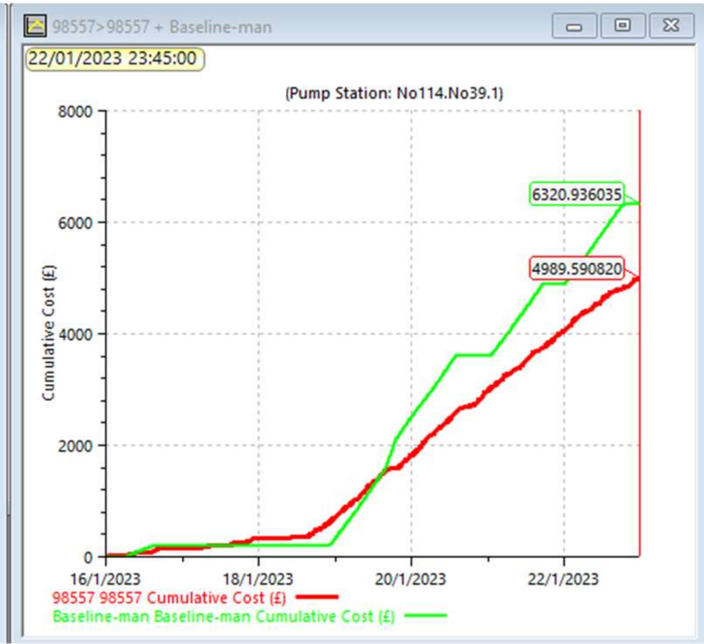


Case Study - 7 day Cost Comparisons

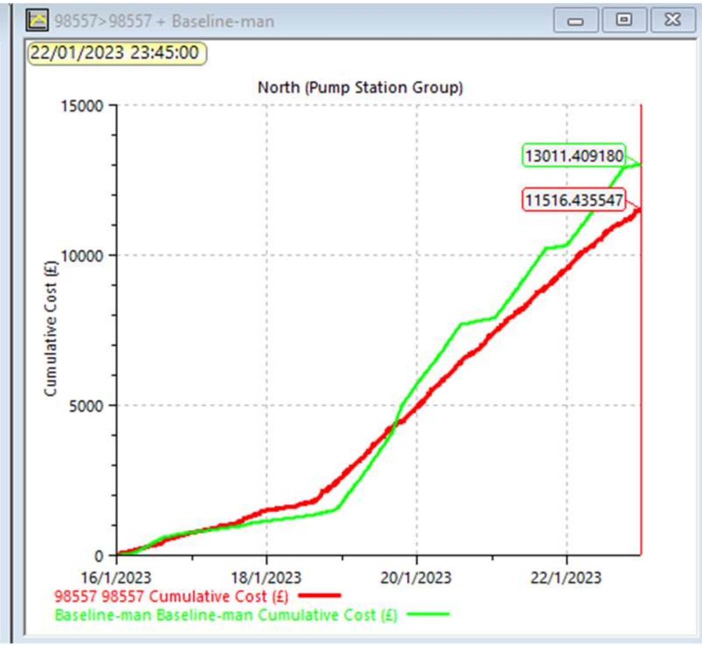
Pumping Station 1 – 2.5% saving



Pumping Station 2 – 21.1 % Saving



Total – 11.5 % saving

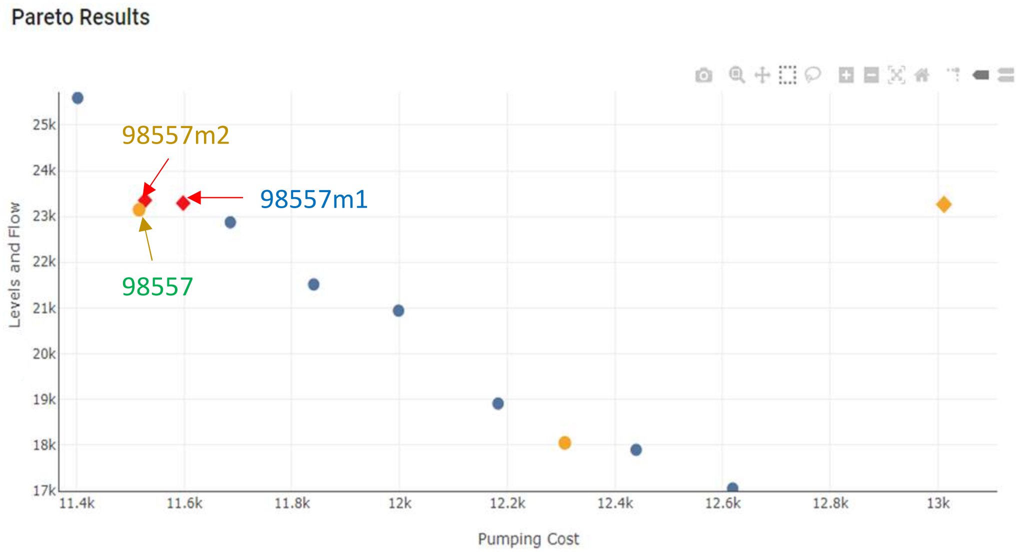


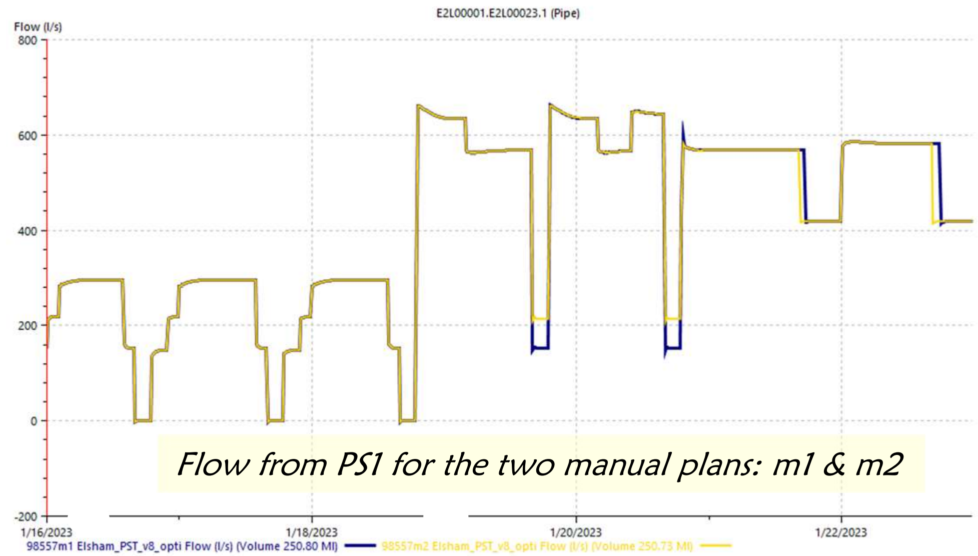
Optimised

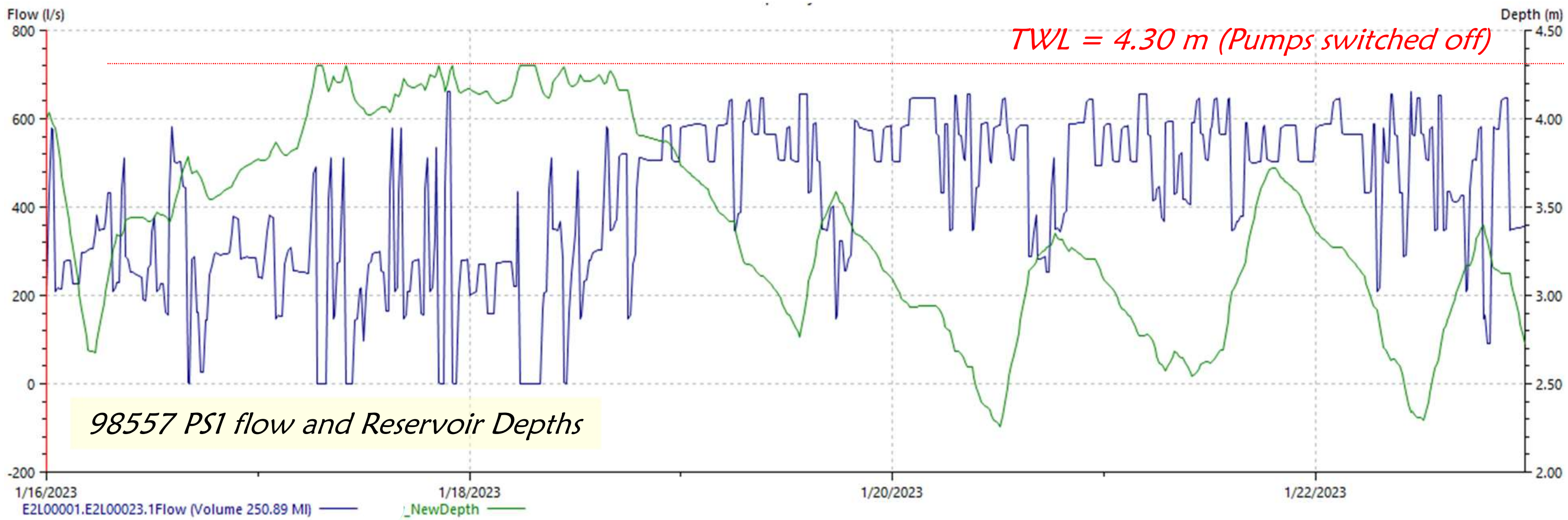
Baseline

7 day saving = £1.5k

Case Study - Manual Plans Derived after the optimisation:







HydroCo water systems engineering

Optimisation Study Conclusions

Optimisation improves efficiency of the network

Provides the ability to find new ways to run the system

Next step towards near-real-time modelling capabilities

HydroCo water systems engineering

cwmag

clean water modelling advisory group

Thank you for listening

Are there any Questions?

HydroCo water systems engineering