Drumleague PS

PUMP AUDT SUMMARY REPORT

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Content

1 Introduction

This report summarises the key findings of the pump station audit for Drumleague Pumping Station (PS). This review is based upon the data provided by Waterways Ireland (WI) and a site visit undertaken on 19th September 2019.

Pump testing was undertaken at the site visit and the following parameters measured:

- Power (using Fluke power meter)
- Flow rate (using Panametrics PT878 ultrasonic flow meter)
- Levels and dimensions (laser/tape measure)

2 System Description

2.1 Pump Station

Drumleague PS is situated on the Lough Allen Canal, between Deffier and Lustia, Carrick-on-Shannon, County Leitrim. The pumping station is supplementary to Drumshanbo and has been made operational due to the inability of Drumshanbo to maintain level in the Lough Allen canal system.

Figure 1- Drumleague Pump Station

Drumleague PS comprises of 1 no. Xylem N3171.181 15 kW, fixed-speed, submersible pump. The pump is situated at the bottom of a circa 3.5 m deep wet well. No record drawings could be obtained for Drumleague PS and the wet well depth is based upon site measurements of the building and the water level.

The wet well is reported to have a low-level contact probe, but this could not be confirmed at the time of the audit visit. A stilling tube was found within the outfall chamber but it could not be confirmed whether any instrumentation was present.

Figure 2 -Drumleague PS Outfall viewed from the Lock (left); Rising Main outfall Farrer 12" flap valve on outlet (right)

The pump is operated manually in 'hand', with no other instrumentation present (flow meter, pressure transducer, etc.) on the system and it is reported that the pump station operates as operational back up to Drumshanbo to top up the system as Drumshanbo PS is failing to meet the required flows. Drumleague PS has only been operational for approximately 12 months and had been out of commission for a period of time.

It was reported that the pump currently operating at Drumleague had been sat in dry dock for several years before and its condition was unknown.

Table 1 – Pump Details

Parameter	Description
Pump	Xylem N3171.181
No. of Pumps	1
Duty Configuration	Duty
Rated Motor Output	15 kW
Impeller Diameter	304 mm
Drives	Fixed speed Star-Delta

Parameter	Description
Pipework	250 mm diameter
Non-Return Valves	N/A
Wet Well Level Sensor	Contact probes for low level protection (unconfirmed)
Wet Well Level	40.75 mAD
Pump Centre Line	39.75 mAD* (estimated)

**Assumed 1m of water coverage, centreline to be confirmed*

2.2 Rising Main

The pump discharge pipework is DN250 ductile iron up to the pump house and connects into a 355 mm OD brown PVCu rising main. The rising main discharges via a 12" Farrer flap valve into a concrete outfall chamber upstream of the lower Lough Allen Lock. No other isolation valves or check valves could be validated at the time of audit, but reportedly there are none on the system. There are no reports of bursts on this rising main.

Table 2 – Pump Discharge Main Details

Parameter	Description
Approx. Length	35 m
Elevation Rise	3.25 m
Pipe Diameter	OD 355 mm
Discharge Level	44m AOD
Pipe Material	PVCu (brown)
Pipe Roughness	ks = 0.03 mm assumed

3 System Description

System curves have been derived for the single pump operation.

The suction and delivery elevations, pipe roughness values have been based on the site recorded measurements as there is no SCADA system present at Drumleague PS.

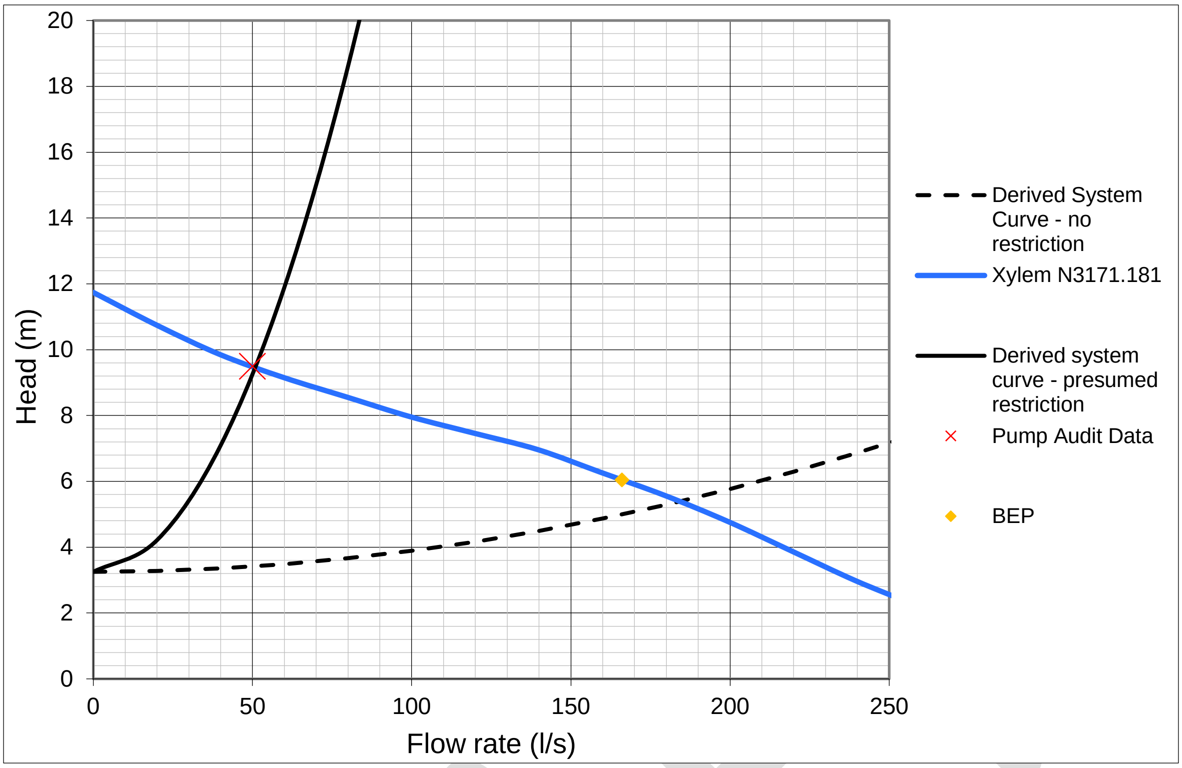


Figure 3 -Derived System Curves – Drumleague PS

The derived system curve depicted in Figure 3 has been estimated based on the N3171.181 pump curve and the power data, as no pressure measurements could be taken at the time of the audit.

The power data obtained from the on-site measurements would seem to corroborate the use of the N3171.181 as it currently draws 13 kW during operation, which based on the curves outlined in Appendix A would be very similar to the observations on site.

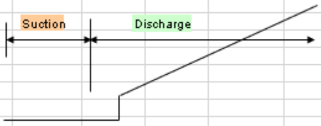
It is possible that there may be a different pump operating at Drumleague PS creating an alternative system curve, as the nameplate could not be confirmed at the time of the audit.

1 INPUT DATA

Gravity, g	9.81	m/s2
Atmos pressure	101.3	kPa
Fluid	Water	[select]
Temperature	10	°c
Kinem. viscosity	1.31E-06	m2/s
Density	999.7	kg/m³
Vap pressure	0.1245	m

Sump levels

TWL		mAOD
Design	40.75	mAOD
BWL		mAOD



Pump level:	39.75	mAOD
Pump station located before reach:	1	[select]

Assumed Hydraulic Discharge levels

TWL		mAOD
Design	44.00	mAOD
BWL		mAOD

Static lift			
	Minimum	0.00	m
	Design	3.25	m
	Maximum	0.00	m

Reach:		1	2	3	4	5	6	7	8	9	10	11	12	13
Description		CI pump discharge	CI pump discharge	uPVC discharge										
Length (m)		0.5	3	35										
Diameter (m)		0.25	0.3	0.3336										
Flow area (m²)		0.04909	0.07069	0.08741										
Roughness (mm)	Low													
	Design	0.3	0.3	0.03										
	High													
Proportion of station flow		1.00	1.00	1.00										

Global head loss factor: % (added to friction and fittings losses throughout)

Fittings Losses:	k-value	Number of fittings: 1	2	3	4
Inlet (slightly rounded)	0.25	1			
Short R 90° bend	0.75	1	1		
Taper up (4:5)	0.03	1			
Short R 90° bend	0.75				
Flap valve	1.5			1	
Gate valve	0.12				
Gate valve	0.12				
Expansion 2:3	0.35				
Expansion 3:4	0.2				
Outlet	1			1	
Elbow 45° bend	0.4				
Elbow 22.5° bend	0.2			3	
Additional K (other devices)				350	
Total K		1.03	0.75	353.10	0.00

Page 1

Figure 4 - Hydraulic Calculation Input Data for Drumleague PS

An additional K-value (fittings loss) *of 350 was required to match the system curves to the pump curves* (Figure 4)*. This gives the required head for the N3171.181 pump to operate at 50 l/s and at 13 kW.*

3.1 Key Observations

The key observations from the derived system curves are as follows:

Although no pressure data was recorded to definitively confirm, the data would indicate that there is some form of restriction on the line creating a head loss within the system. There is a discrepancy between where the pump should be operating given the levels and route and where it is currently operating which cannot be fully explained. It is suspected that there is some form of restriction within the system creating a 5.9 m head loss @ 50 l/s, and that has the effect of lowering the flow rate from the expected 185 l/s to the recorded 50 l/s.

To put the restriction into context, it would require an orifice of 97 mm within the 355 mm OD PVCu rising main to create 5.9 m of head loss within the system.

At present, an unknown restriction seems like the most likely scenario but there could be a variety of reasons for this discrepancy/head loss: -

- Blockage in the rising main caused by debris or a partially collapsed pipe;

- Unknown partially closed valve on the system that could not be seen during the audit;
- 12" Flap valve on the outlet could have limited movement creating a restriction;
- Debris within the pump casing;
- Pump impeller damage or excessive wear;
- Alternative pump operating a lower head but drawing a similar power to the 15 kW N3171.181;
- Measurement error (although this would have to be substantial to obtain these results).

Given the discrepancy in estimated (no restriction) and derived head outlined above it is difficult to comment on the actual performance of the pump. It was not possible to determine how the pump is performing from the data obtained from the site audit. It is possible that the pump is under performing and the head is reduced at the observed flow rate.

4 Net Positive Suction Head (NPSH) & Submergence

The exact pump elevation could not be ascertained during the audit and as such the water levels above the pump could not be calculated. Assuming a water depth of 1 m, the NPSH calculations undertaken suggests that there is approximately 11 m margin between NPSH required and NPSH available. The water levels above the pump should be ascertained and this calculation be revisited when more data is presented.

Due to the absence of pump level data, a submergence calculation could not be undertaken in this instance.

5 Energy Analysis

During the pump audit visit by Samatrix Ltd, a temporary "Fluke" power meter was connected at the pump starter compartment to record power into the star delta drives.

From the measured power, flow recorded, and estimated head based on system curve, an analysis of pumping efficiency and the amount of energy needed to pump flows has been undertaken.

Table 3 summarises the measured input power, and derived efficiency and specific energy findings.

Table 3 – Input power, Efficiency and Specific Energy

Pump Configuration	Measured Flow rate (l/S)	Calculated Head (m)	Measured Power Factor	Measured power (kW)	Pump Efficiency	Specific energy (kWh/1000 m^3)
Duty (Restriction)	50	9.51	0.79	13.2	35%	73.1
Ideal Unit	**185**	**5.6**	**0.85**	**13.2**	**78.7**	**19.7**

(No Restriction)						

- Table 3 shows that the pump is currently operating poorly from an efficiency point of view as the duty point lies well to the left of the Best Efficiency Point (BEP) of the pump. The duty point also lies outside of the 80-120% BEP which could reduce the life of the pump, pump reliability and affect the performance (e.g. due to damage caused by internal recirculation, heat and, or vibration).
- If the head loss can be determined and resolved the current pump would produce approximately 3 times the flow at a significantly lower head. As such, the pump would have a specific energy reduction of approximately 66%.
- As no previous data has been acquired for this site in terms of power and operation, it will difficult to ascertain a precise energy saving potential can be gained without further long-term study.

6 Potential Areas for Improvement

6.1 Pump Control and Instrumentation

The existing control does not automatically vary duty configuration or flow rate based on lock flight level. It is suggested that pumping configuration could be tailored according to a level scale, rather than a simple ON/OFF type operation to improve energy consumption. However, the practical feasibility would depend on the specific characteristics of the canal system and pumping capacity.

At present the pump is effectively run manually in “hand” and it is unconfirmed whether there is any form of control, such as an automatic stop from the low level probes contained within the wet well. This means that the pump is likely to be pumping for periods of time where flow may not be required, and therefore wasting energy.

Operation upon level would necessitate a level sensor, e.g. ultrasonic or radar type installed within a stilling well, on the Lough Allen Canal to measure the level and provide a signal back to the pump control panel and possibly SCADA. Predetermined level thresholds would be as set start and stop levels for the pump.

With regard to the type of sensors, ultrasonic or radar type sensors are recommended. Using either ultrasonic or radar type level sensors would allow the following benefits:

- Non-contact, low maintenance measurement
- Unaffected by medium properties and fouling
- Freely adjustable measuring range
- Measured level outputs can be used for both information and control

In addition, there is currently no instrumentation measuring pump performance such as a flow meter or pressure indicating device. With no instrumentation there is little way of knowing how the pump is operating day-to-day and gives no opportunity for any proactive maintenance or trends to be ascertained for the system.

It is recommended that an electromagnetic flow meter be installed on the rising main as a minimum as to ascertain flows over time. This could be included on the straight above ground sections immediately outside the pump house to minimise excavation works.

It is recommended that a pressure transducer be installed on each line to ascertain pressure over time. This could be included on any accessible section of pipework within the station for ease of access and cabling. The pump pressure could then be calculated from known levels and losses between the transducer and the pump.

An ‘intelligent’ monitoring system could be adopted at this site to encompass parameters such as flow rate, pressure, power, efficiency, etc. This could be implemented based upon SCADA/telemetry data and programmed to allow automatic adaption and correction of operation, informative data analysis reporting, and preventative fault alarms to help save energy, reduce downtime and prevent pump blocking.

It should be noted that this option would require a capital investment to upgrade the EICA components within the pump station to achieve this.

6.2 Pump Maintenance

It is recommended that the pump at Drumleague be inspected to check for any potential issues on the impeller or blockages within the pump casing to eliminate this as a possibility for the unknown head loss within the system. During this inspection it is also recommended that the pump and motor data plates be photographed and confirmed as outlined within this report as this could not be done during the time of the audit.

6.3 Rising main

Given the presence of an unknown head loss in the system, it is recommended that the rising main at Drumleague be inspected/surveyed to check for any potential issues, such as blockage, collapse or partially closed valves. It is also recommended that the Ferrer flap valve is inspected to ensure free movement over the full range of opening.

6.4 Pump Selection

On initial findings the Xylem N3171.181 pump, as installed, is suitably matched for the system, assuming that the possible restriction can be found and remedied, based on a required flow rate of 185 l/s.

The exact pump selection would require confirmation on the required flow rates as currently Drumshanbo is producing 50 l/s and is deemed sufficient. The pump without the possible restriction is capable of 185 l/s. The current flow rate at Drumleague is only required to “top up” the flow rate deficit from the Drumshanbo pump, which is currently operating at 180 l/s (approximately 45 l/s below expectation). If the pump at Drumshanbo is refurbished/replaced, especially with a duty standby system, then Drumleague PS may become redundant.

If Drumleague is regarded as a true standby replacement for Drumshanbo, then the required flow rate will need to be increased to 225 l/s to match Drumshanbo.

This decision on the required flow rate will need to be taken from an operational and resilience standpoint from WI, in conjunction with any supporting volumetric need data.

Table 4 shows the possible pump selections assuming the possible restriction in the rising main will be resolved. The pump options have been offered assuming 50 l/s, 185 l/s and a 225 l/s option, but the exact flow rate requirement will need to be confirmed.

Table 4 – Comparison of alternative pump selections

CONFIGURATION	SELECTION (XYLEM)	FLOW RATE (L/S)	HEAD (M)	INPUT POWER (KW)	PUMP AND MOTOR EFFICIENCY (%)	ESTIMATED SPECIFIC ENERGY* (KWH/1000 M³)	SAVING ON SPECIFIC ENERGY FROM CURRENT OPERATION (KWH/1000 M³)	TOTAL KWH FOR PUMP STATION -PER YEAR*
Duty (1-pump) Fixed Speed	NP3171.181 304	185	5.6	13	78.7	19.7	-53.4	13210
Duty (1-pump) Fixed Speed	NP3127.060 Adaptive 426/174	56	3.3	3.6	61.8	17.9	-55.2	12003
Duty (1-pump) Fixed Speed	NP3202.185 616/328	225	6.5	20.7	81.3	25	-48.1	16763

**Based on 2016 figures of 49,016 kWh usage and equivalent volume pumped*

7 Preliminary Recommendations

- Investigate the current pump for loss of efficiency, potential debris in pump casing/impeller damage possible motor issues.
- Investigate the rising main for potential blockages with a camera survey, check for any partially closed valves and any issues with the Ferrer flap valve.
- Determine required flows and levels and station future operational requirements.
- Install a level control system for the pumping station potentially via a radar/ultrasonic level sensor in a stilling tube.
- Install instrumentation (e.g. flow/pressure) on each rising main to allow for trend data and proactive maintenance.
- Install power monitoring.
- Install a SCADA / HMI system that can be used to remotely monitor the pumping station and record data which then can also be used to optimise operation.

APPENDIX A

XYLEM NP3171.181 15 kW (Current Operation – 50 l/s)

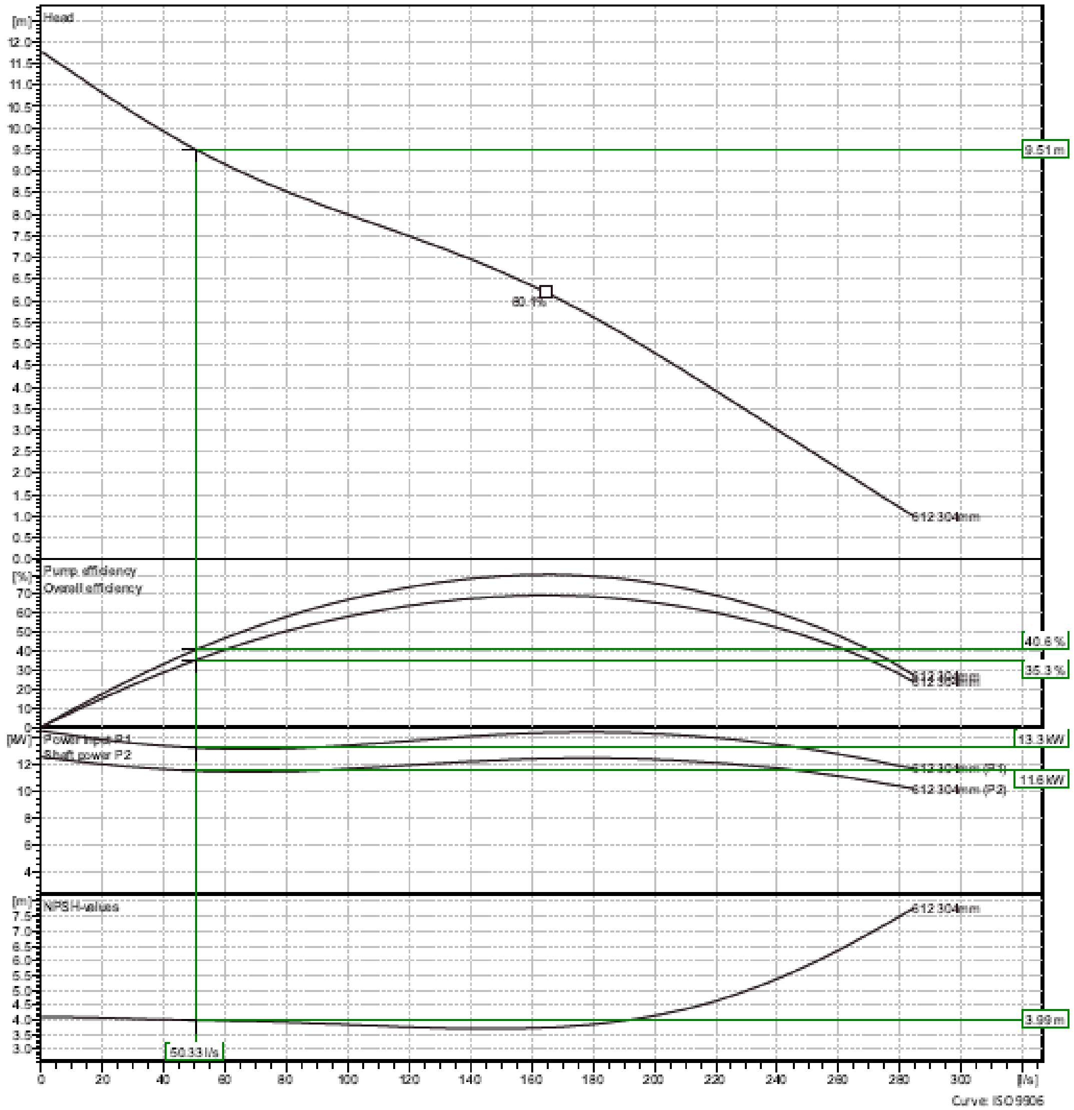
NP 3171 LT 3~ 612

Performance curve

FLYGT
a xylem brand

Duty point

Flow	Head
50.3 l/s	9.51 m



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Block		Created on	12/4/2019	

XYLEM NP3171.181 15 kW (185 l/s with no potential restriction)

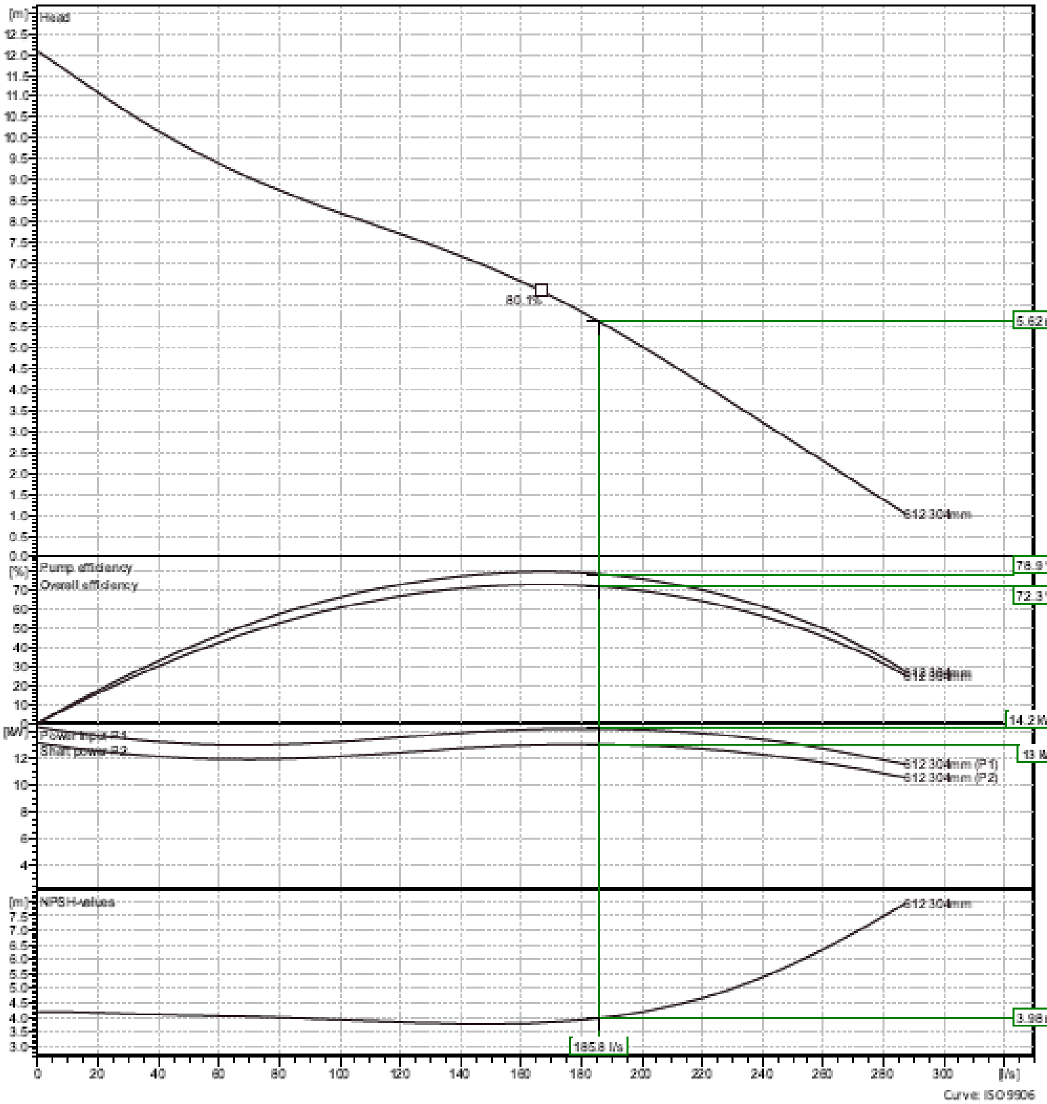
NP 3171 LT 3~ 612

Performance curve

Duty point

Flow	Head
186 l/s	5.62 m

Curves according to: Water, pure [100%],4 °C,999.9 kg/m³,1.5692 mm²/s



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Block	**Created on**	12/5/2019	

XYLEM NP3127.060 Adaptive 426/174 (50 l/s with no restriction)

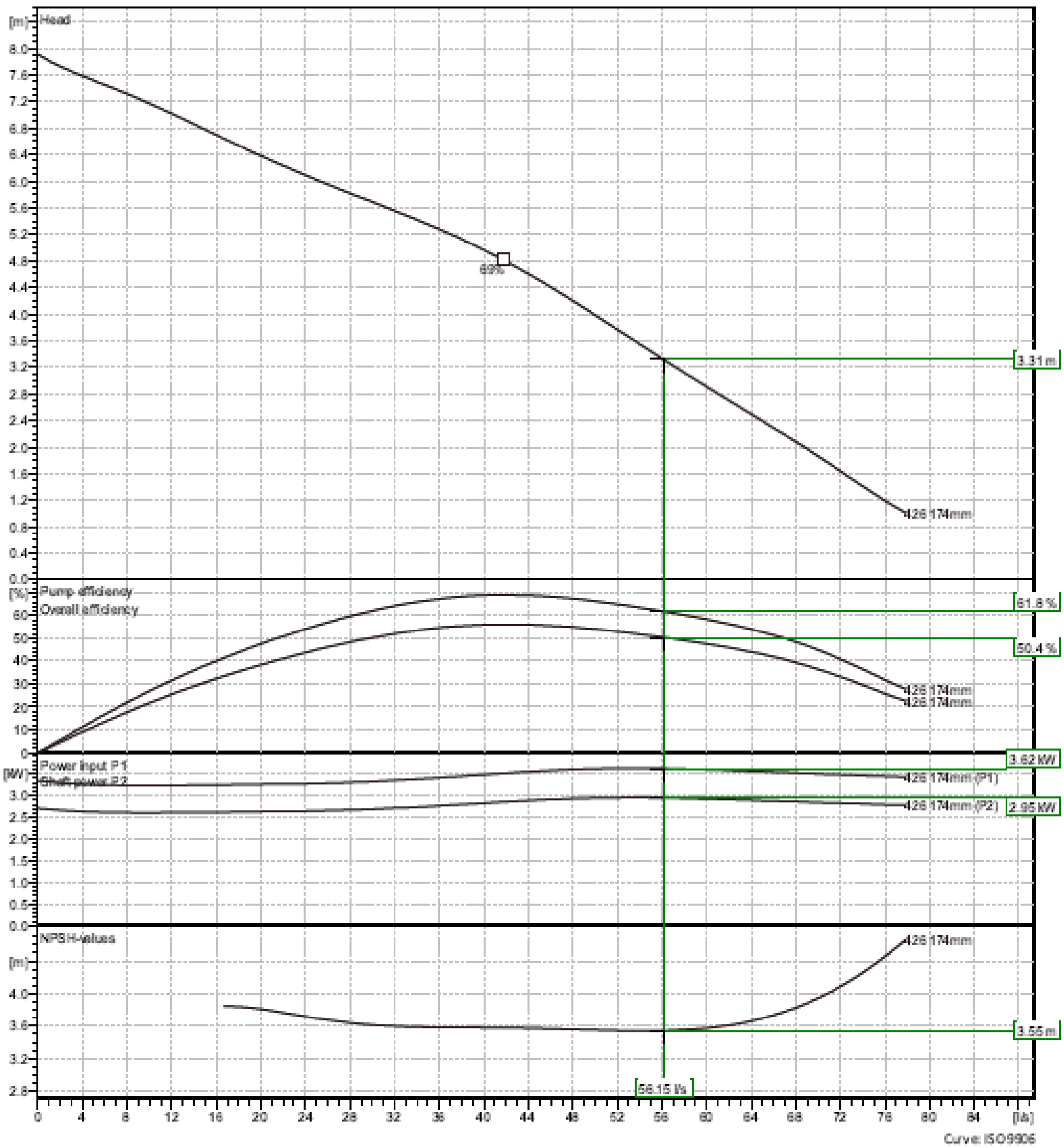
NP 3127 LT 3~ Adaptive 426

Performance curve

Duty point

Flow	Head
56.2 l/s	3.31 m

Curves according to: Water, pure [100%],4 °C,999.9 kg/m³,1.5692 mm²/s



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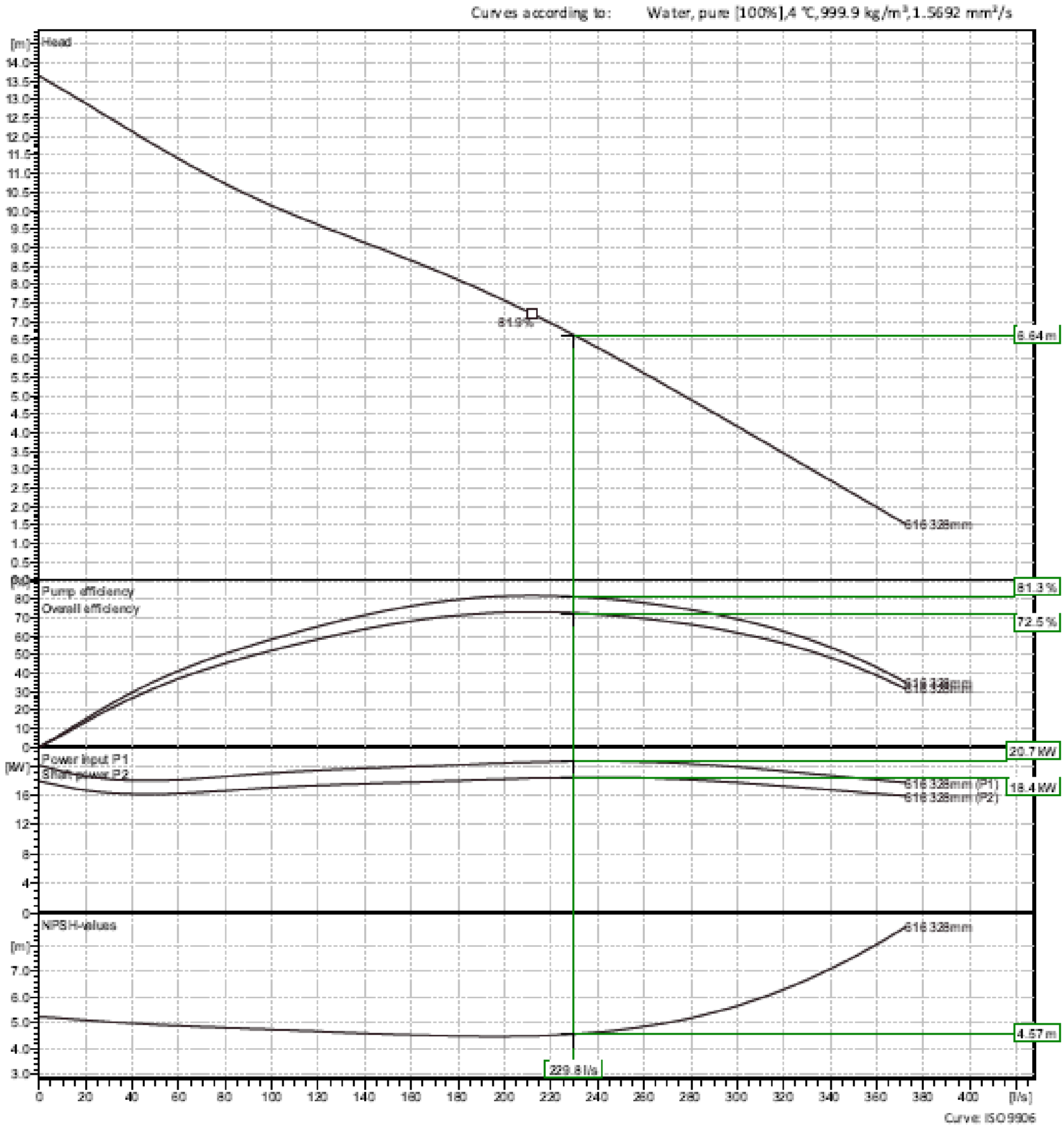
XYLEM NP3202.185 616/328 (230 l/s with no restriction)

NP 3202 LT 3~ 616

Performance curve

Duty point

Flow	Head
230 l/s	6.64 m



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VLAAMSE LAND MAATSCHAPPIJ