ENOIA DYNAFLOW

PROJECT : RELACEMENT OF 7 DRUM SCEEN IN SWC-1 AND LCP IN SWC-2	JOB No. : **DFP-1485**
CLIENT : MARAFIQ	DOC .No. : **1485-HYD-01**

PUMP HEAD CALCULATION

REV.	DATE	DESCRIPTION	PREPARED	CHECKED	APPROVED
1	30-08-2022	Issued for Approval	PDP	RSK	AvE
0	23.06.2022	Issued for Review & Comments	PDP	RSK	AvE

☐ REVISED SHEETS ONLY ISSUED ☒ ENTIRE DOCUMENT ISSUED **12** TOTAL NUMBER OF SHEETS

1.0 PURPOSE OF THE DOCUMENT

The purpose of this document is to calculate the differential head required for the pump and to verify that the selected pump is suitable for the system under consideration.

2.0 REFERENCE PROJECT DOCUMENTS

Table 1: Reference Documents

S. No	Document Name	Document Number
1	Pipping & Instrumentation Diagram	7200043000-JSWC-MB-004 (Rev.F)
2	Isometric GA drawings	7200043000-JSWC-MB-009 (Rev.D)
3	Isometric Detail drawings for Wash water Pipeline	7200043000-JSWC-MB-009 (Rev.D)
4	Pump General Arrangement Drawing	GA-01510001 (Rev.02)
5	Pump Data Sheet	7200043000-JSWC-MD-013 (Rev.04)
6	Pump Performance Curve	DP-01510001 (Rev.03)
7	Pump Vendor System Curve	SC-01510001 (Rev.04)
8	Drum Screen Backwash Flow Requirement calculation	7200043000-JSWC-MD-002 (Rev.A)
9	Product Drawings	FPI-2022-002242-VETM-ECDE-PRD-KSA-22-013 (Rev.2)

3.0 HYDRAULIC SCHEME

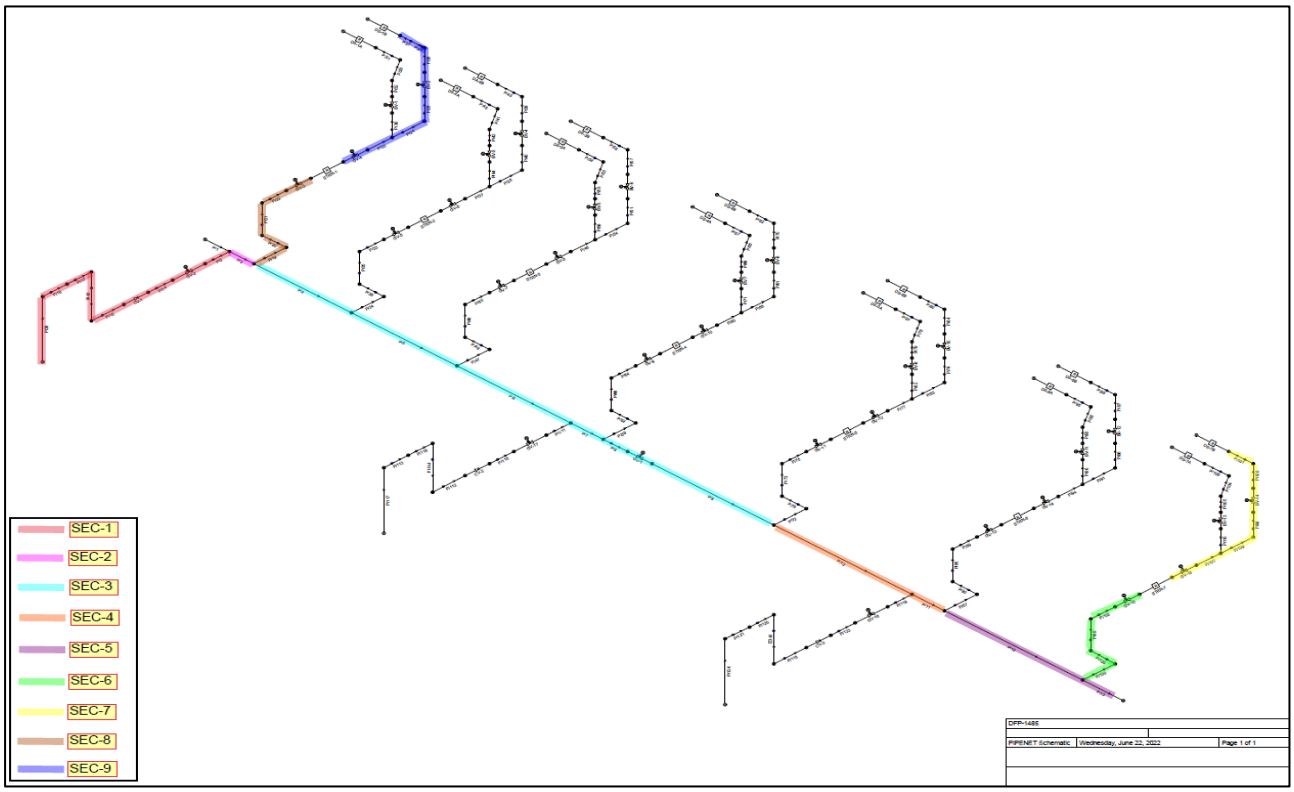
The system comprises of three Seawater Pumps (2 Duty + 1 Stand-by, each rated at 210 m^3/hr @ 52 mH) delivering sea water to seven Drum Screen's wash water line each comprising of two water spray lines.

The operating philosophy for the system is as follows:

1. One Sea Water pump with One Drum Screen Wash Water Spray Lines.
2. One Sea Water pump with Two Drum Screen Wash Water Spray Lines.
3. One Sea Water pump with Three Drum Screen Wash Water Spray Lines
4. Two Sea Water pump with Five Drum Screen Wash Water Spray lines.
5. Two Sea Water pump with Six Drum Screen Wash Water Spray lines.

6. Two Sea Water pump with Seven Drum Screen Wash Water Spray lines.

Figure 1: Hydraulic scheme



The piping information's of the system are as follows:

Table 2: Piping information

Sections	Pipe Size (DN)	Description	From	To
Sec-1	250	Pump Discharge line	Seawater Pump discharge	Header Line
Sec-2~5	300	Discharge Header	Header Line	-
Sec-6	150	Drum Screen Wash Water Line	Header Line	Strainer inlet
Sec-7	100	Drum Screen Wash Water Line	Strainer outlet	Spray nozzles
Sec-8	150	Drum Screen Wash Water Line	Header Line	Strainer inlet
Sec-9	100	Drum Screen Wash Water Line	Strainer outlet	Spray nozzles

4.0 DESIGN CONSIDERATIONS

- PIPENET software is used for the hydraulic modelling.
- 'Darcy - Weisbach Equation' is used for the frictional pressure drop calculation
- 1 The minimum water level in the Sea Water intake is considered as -0.37 m RCD.
- The fluid properties considered in the calculation are as follows.
  - Density : 1032 kg/m^3
  - Viscosity : 1.13 cP
  - Vapour pressure : 0.729 mH
- Low roughness and high roughness for GRP pipe is considered as 0.05 mm & 0.1 mm respectively.
- 1 Minimum required pressure at spray nozzle inlet is 3 barg and total required flowrate is 53 m^3/hr (Each water spray pipe requiring 48 m^3/hr + 5 m^3/hr for trough gutter flushing).
- Strainer head loss is considered as 0.7 bar (for Dirty condition) and 0.02 bar for clean condition of the strainer (for details refer appendix 1)
- The No's of fittings and their minor loss coefficient and length of pipe segment used in the calculation are as follows.

Table 3: Fittings

Section	DN	Description	K-factor	No. of Fittings	Total K-factor	Pipe length (m)
Sec-1	250	Pipe	-	-	-	7.45
		Elbow 90 deg	0.8	2	1.6	
		DN Reducer (250x150)	0.07	1	0.07	
		Check Valve	2.5	1	2.5	
		Gate Valve	0.17	1	0.17	
		Tee (300x250) branch	1.28	1	1.28	
Sec-2~5	300	Pipe	-	-		96.053
		Gate Valve	0.17	1	0.17	
Sec-6	150	Pipe	-	-	-	6.495
		Tee (300x150) branch	1.28	1	1.28	
		Elbow 90 deg	0.8	3	2.4	
		Gate Valve	0.17	2	0.34	

Table 3: Fittings						
Section	**DN**	**Description**	**K-factor**	**No. of Fittings**	**Total K-factor**	**Pipe length (m)**
		Basket Strainer	0.7	1	0.7	
Sec-7	100	Pipe	-	-	-	3.392
		Elbow 90 deg	0.8	2	1.6	
		Ball Valve	0.048	1	0.048	
		Pipe exit	1	1	1	
Sec-8	150	Pipe	-	-	-	6.495
		Tee (300x150) branch	1.28	1	1.28	
		Elbow 90 deg	0.8	3	2.4	
		Gate Valve	0.17	2	0.34	
		Basket Strainer	0.7	1	0.7	
Sec-9	100	Pipe	-	-	-	3.392
		Elbow 90 deg	0.8	2	1.6	
		Ball Valve	0.048	1	0.048	
		Pipe exit	1	1	1	

5.0 OPERATIONAL SCENARIOS

The following steady state cases have been considered in the analysis:

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Case 1: For 1 Pump in Operation – 1, 2 and 3 drum screens have been operated individually for the following scenarios:

Scenario 1: High Pipe Roughness for Clean Condition of Strainer.

Scenario 2: High Pipe Roughness for Dirty Condition of Strainer.

Scenario 3: Low Pipe Roughness for Clean Condition of Strainer.

Scenario 4: Low Pipe Roughness for Dirty Condition of Strainer.

Case 2: For 2 Pumps in Operation – 5, 6 and 7 drum screens have been operated individually for the following scenarios:

Scenario 1: High Pipe Roughness for Clean Condition of Strainer.

Scenario 2: High Pipe Roughness for Dirty Condition of Strainer.

Scenario 3: Low Pipe Roughness for Clean Condition of Strainer.

Scenario 4: Low Pipe Roughness for Dirty Condition of Strainer.

5.1 CALCULATION RESULTS

1) The NPSH(a) and differential head required for the seawater intake pumps listed in the below table:

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Table 4: For 2 Pump operation - High pipe roughness for dirty Condition of Strainer with 7 drum screens in operation (185.5 m^3/hr per pump)			
S. No	**Particulars**	**Head**	**Remarks**
Suction head			
1	Suction static head	0.13 mLC(g)	Difference between Low Tide Level (-0.37 m) and pump centre line elevation (-0.5 m)
Suction Head		**0.13 mLC(g)**	
Discharge head			
1	Discharge static head	8.978 mLC	Difference between wash water Spray Line elevation (+8.478 m) and pump centre line elevation (-0.5 m)
2	Frictional Pressure drop	1.067 mLC	Data extracted from PIPENET model (Refer Appendix-2-Pressure Nodal)
3	Strainer Head loss	6.91 mLC	From Dual Basket Strainer datasheet (Refer Appendix-3-Refernce Documents)
4	Pressure head @ nozzle inlet	29.64 mLC(g)	
Discharge Head		**46.595 mLC(g)**	
5	Differential Head	**46.465 mLC**	Discharge head- Suction head
6	NPSH(a)	9.401 mLC	(10+ suction head)- Vapour pressure (0.729 mLC(a))

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Table 5: For 1 Pump operation - High pipe roughness for dirty Condition of Strainer with 3 drum screens in operation (159 m^3/hr per pump)			
S. No	**Particulars**	**Head**	**Remarks**
Suction head			
1	Suction static head	0.13 mLC(g)	Difference between Low Tide Level (-0.37 m) and pump centre line elevation (-0.5 m)
Suction Head		**0.13 mLC(g)**	
Discharge head			
1	Discharge static head	8.978 mLC	Difference between wash water Spray Line elevation (+8.478 m) and pump centre line elevation (-0.5 m)
2	Frictional Pressure drop	0.982 mLC	Data extracted from PIPENET model (Refer Appendix-2-Pressure Nodal)
3	Strainer Head loss	6.91 mLC	From Dual Basket Strainer datasheet (Refer Appendix-3-Refernce Documents)
4	Pressure head @ nozzle inlet	29.64 mLC(g)	
Discharge Head		**46.51 mLC(g)**	
5	Differential Head	**46.38 mLC**	Discharge head- Suction head

Table 5: For 1 Pump operation - High pipe roughness for dirty Condition of Strainer with 3 drum screens in operation (159 m^3/hr per pump)			
S. No	**Particulars**	**Head**	**Remarks**
6	NPSH (a)	9.401 mLC	(10+ suction head) - Vapour pressure (0.729 mLC(a))

**mLC- Meter of liquid column.*

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Table 6							
Case	**Description**	**No. of Pumps in operation**	**No. of drum screen in operation**	**Required Flowrate (m^3/hr)**	**Suction Head (m)**	**Discharge Head (m)**	**Differential Head (m)**
1	High pipe roughness for Clean Condition of Strainer	1	1	53	0.13	39.71	39.58
			2	106	0.13	39.93	39.8
			3	159	0.13	40.27	40.14
		2	5	265	0.13	40.04	39.91
			6	318	0.13	40.20	40.07
			7	371	0.13	40.30	40.17
2	High pipe roughness for Dirty Condition of Strainer	1	1	53	0.13	45.96	45.83
			2	106	0.13	46.16	46.03
			3	159	0.13	46.51	46.38
		2	5	265	0.13	46.28	46.15
			6	318	0.13	46.44	46.31
			7	371	0.13	46.59	46.46
3	Low pipe roughness for Clean Condition of Strainer	1	1	53	0.13	39.72	39.59
			2	106	0.13	39.93	39.8
			3	159	0.13	40.27	40.14
		2	5	265	0.13	40.04	39.91
			6	318	0.13	40.20	40.07
			7	371	0.13	40.35	40.22
4	Low pipe roughness for Dirty Condition of Strainer	1	1	53	0.13	45.96	45.83
			2	106	0.13	46.17	46.04
			3	159	0.13	46.48	46.35
		2	5	265	0.13	46.28	46.15

Table 6							
Case	**Description**	**No. of Pumps in operation**	**No. of drum screen in operation**	**Required Flowrate (m^3/hr)**	**Suction Head (m)**	**Discharge Head (m)**	**Differential Head (m)**
			6	318	0.13	46.44	46.31
			7	371	0.13	46.57	46.44

2) The system curve for the various modes of operation is shown below.

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Figure 2: System Curve for 1 drum screen in operation while 1 Pump is operated

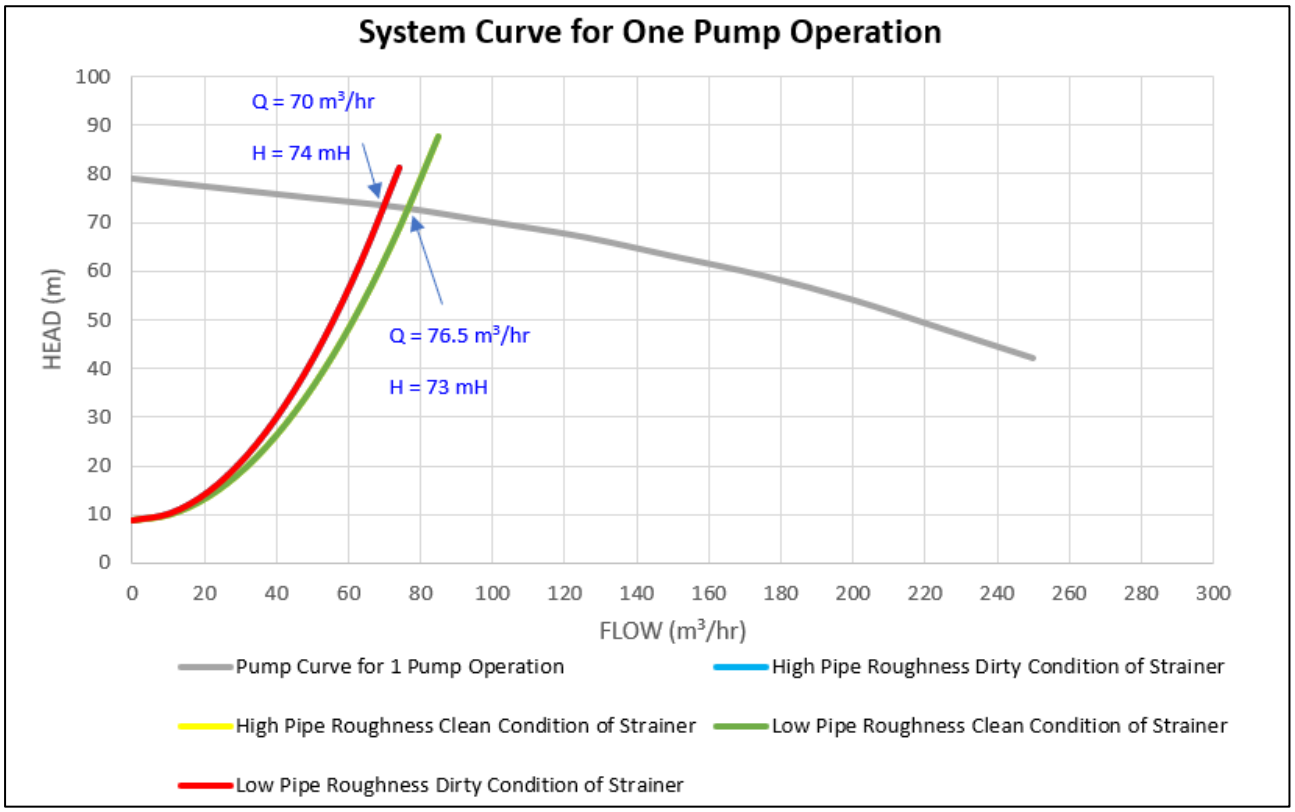

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Figure 3: System Curve for 2 drum screens in operation while 1 Pump is operated

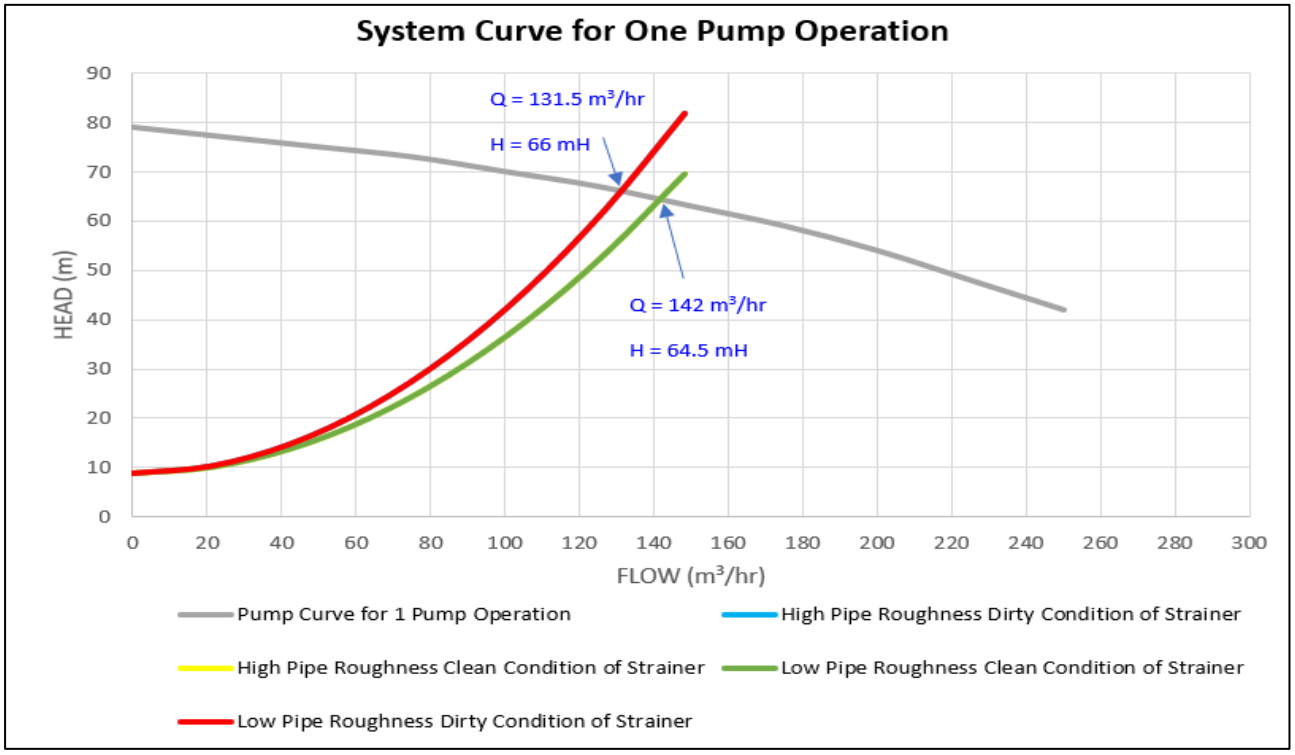

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Figure 4: System Curve for 3 drum screens in operation while 1 Pump is operated

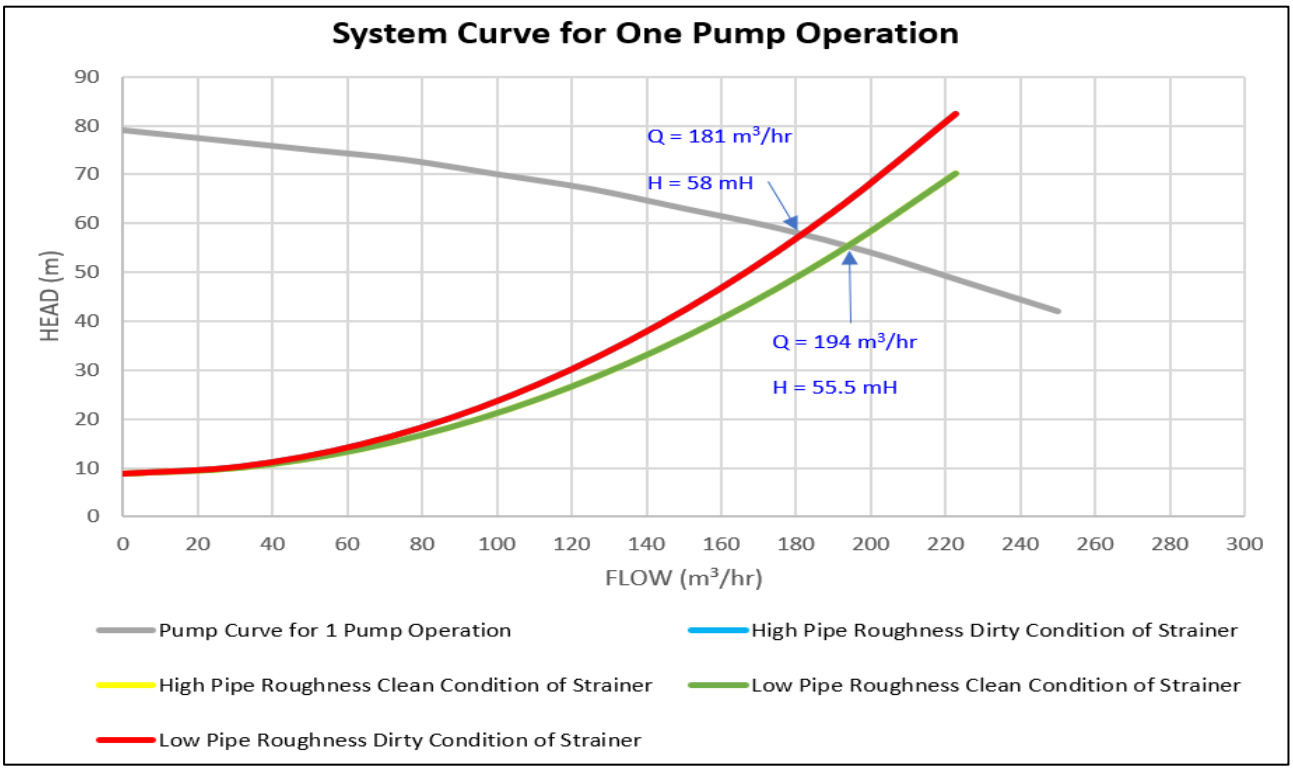

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Figure 5: System Curve for 5 drum screens in operation while 2 Pumps are operated

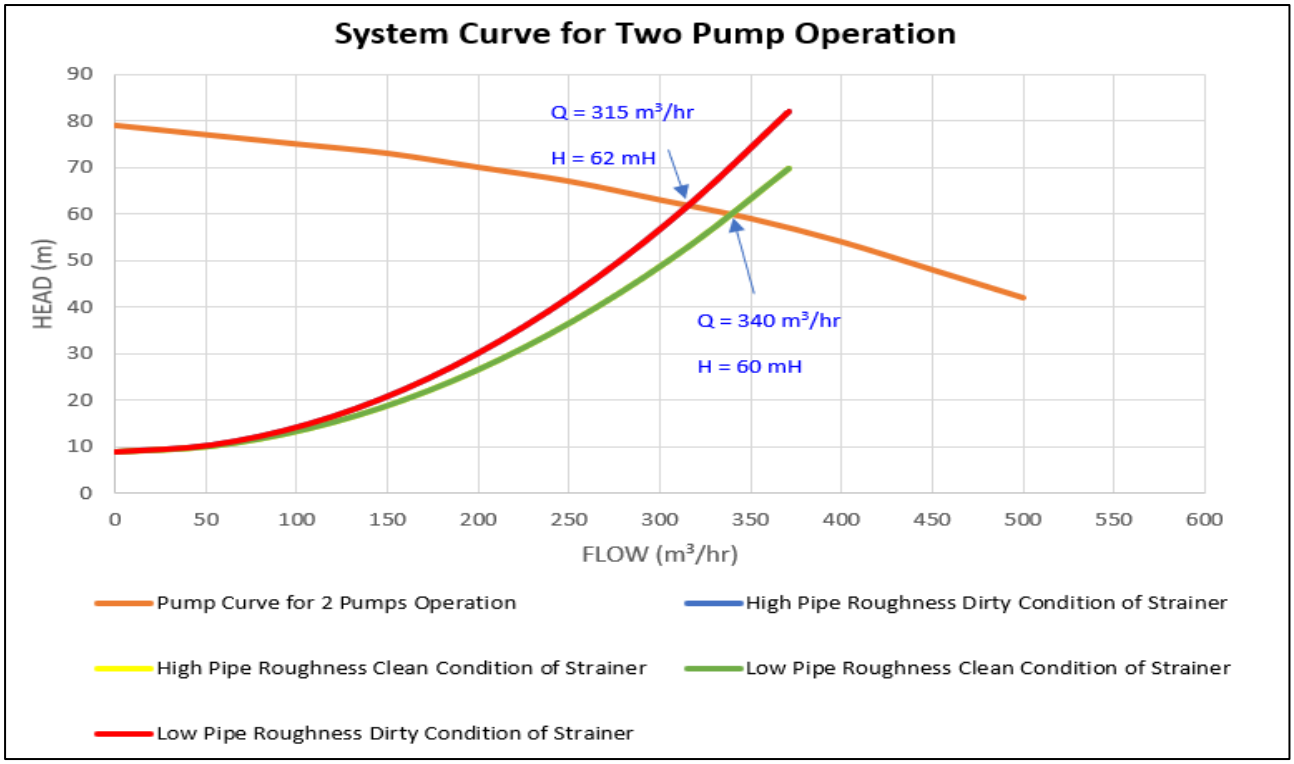

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Figure 6: System Curve for 6 drum screens in operation while 2 Pumps are operated

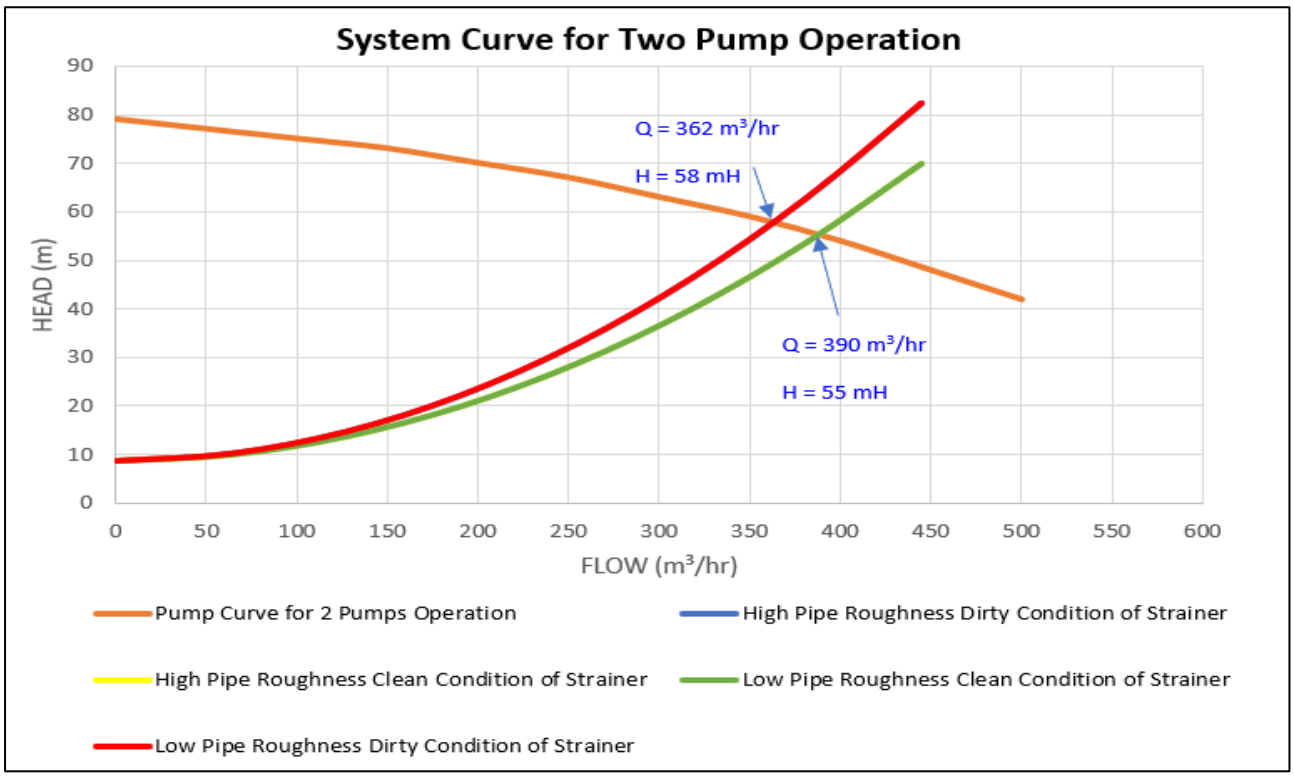

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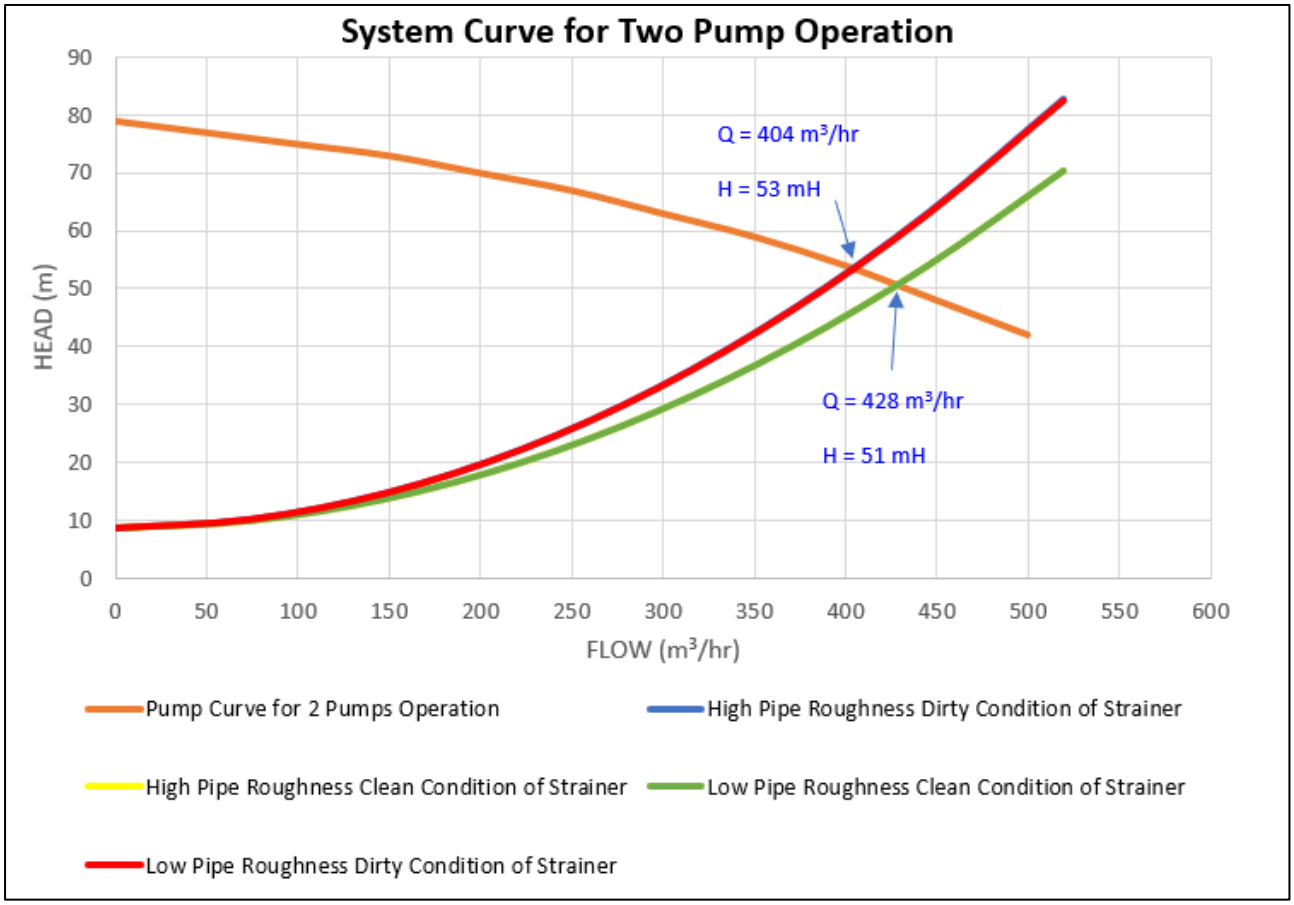
Figure 7: System Curve for 7 drum screens in operation while 2 Pumps are operated



3) From the Hydraulic calculation, the pipe velocity has been summarized in the below table:

Table 7: For 2 Pump Operation

Section	Line Size	High pipe Roughness for Dirty Condition of Strainer	Low pipe Roughness for Clean Condition of Strainer
		Velocity (m/s)	Velocity (m/s)
SEC-1	DN250	1.164	1.164
SEC-2	DN300	0.808	0.808
SEC-8	DN150	0.923	0.923
SEC-9	DN100	2.078	2.079

6.0 CONCLUSION

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1. From Table-4, the differential head required for the pump is found to be 46.465 mLC for 2-pumps in operation which is lower than the rated head of the selected pump i.e., 50.38 mLC.

2. From Table-5, the differential head required for the pump is found to be 46.38 mLC for 1-pump in operation which is lower than the rated head of the selected pump i.e., 50.38 mLC.

3. Based on the calculation, in all the possible operating combination, the pump is found to be operating within the preferred operating range recommended by the pump vendor.

4. The NPSH(a) is found to be 9.401 mLC which is greater than NPSH(r) 6.0 mLC (selected pump). Hence this shall be accepted.