

Theoretical

Results

Treatment Plant:		
Treungen		
		Flow 0,023
Date	July 1, 2016	Viscosity 1,31E-06
		K 1,50E-05
Section	Total Loss Per Section	Units
Raw Water	1,706226433	Meters
Filter	0,667718756	Meters
Clean Water	1,751647167	Meters
Total Loss Experienced	4,125592356	Meters

Plant Altercations	#
Intake Pumps: 1 or 2	1
Filters in operation: 3 or 4	4
UV in operation: 1 or 2	1

Raw / Clean Lasso

Major Losses Due to Friction			
Flow	0,023		
Viscosity	1,31E-06		
k steel	0,000015		
k PE	0,0000015		

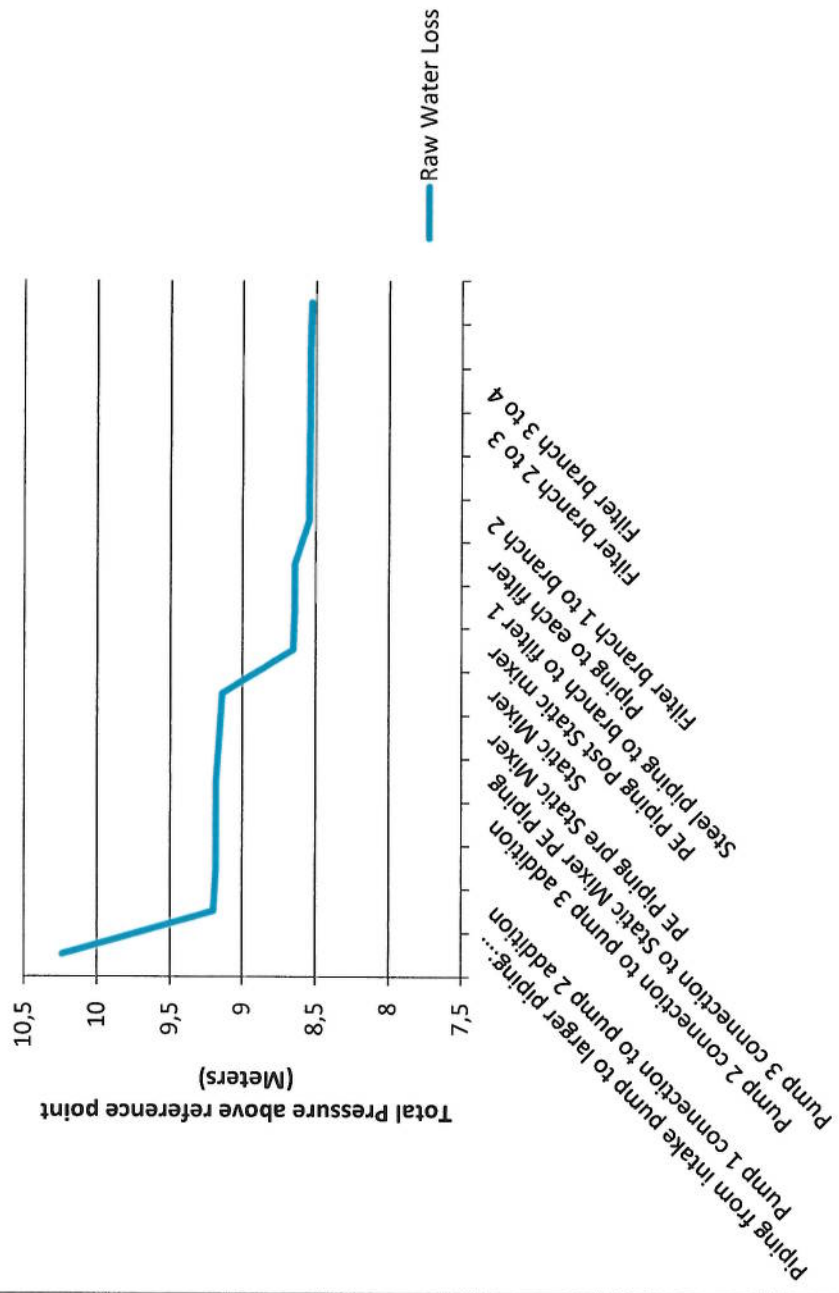
Plant Altercations		#
Intake Pumps: 1 or 2		1
Filters in operation: 3 or 4		4
UV in operation: 1 or 2		1

Reference	Section	Diameter (m)	Pipe Length/Section (m)	Split Flow? Yes/No	Split into	Split Flow (m ³ /s)	Reduced flow? Yes/No
Raw Water	Piping from intake pump to larger piping: Split=number of pumps in operation	0,15	1,546	No	1	0,023	no
	Pump 1 connection to pump 2 addition	0,15	1,247	No	1	0,023	yes
	Pump 2 connection to pump 3 addition	0,25	0,246	No	1	0,023	yes
	Pump 3 connection to Static Mixer PE Piping	0,25	0,558	No	1	0,023	yes
	PE Piping pre Static Mixer	0,25	5,783	No	1	0,023	No
	Static Mixer	0	1,289	No	1	0,023	No
	PE Piping Post Static mixer	0,25	0,000	No	1	0,023	No
	Steel piping to branch to filter 1	0,25	2,256	No	1	0,023	No
	Piping to each filter	0,125	0,893	Yes	4	0,00575	no
	Filter branch 1 to branch 2	0,25	0,284	No	1	0,023	yes
	Filter branch 2 to 3	0,2	1,273	No	1	0,023	yes
	Filter branch 3 to 4	0,2	1,767	No	1	0,023	yes
		0,2	0,434	No	1	0,023	yes
		0,125	1,444	No	1	0,023	yes

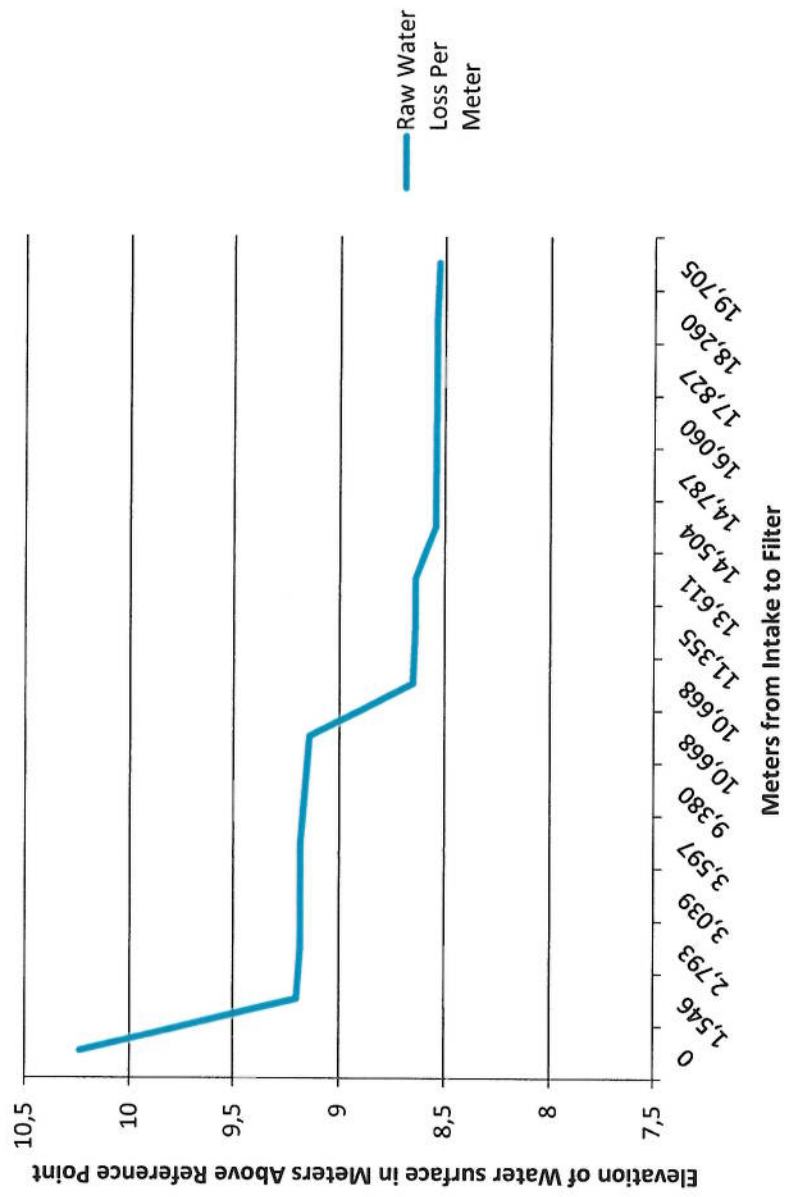
% of Total flow (0-100)	Reduced Flow (m ³ /s)	Area (m)	Velocity (m ² /s)	D(h)	Re	K	K/D(h)	1	f	Repa-tions	Major Loss Per Split	Total Major loss
100	0,023	0,017671	1,301534	0,15	149030,6	0,000015	0,0001	0,999953	0,017229	1	0,01533599	0,015335992
50	0,0115	0,017671	0,650767	0,15	74515,29	0,000015	0,0001	0,999699	0,019577	1	0,00351235	0,003512352
50	0,0115	0,049087	0,234276	0,25	44709,17	0,000015	0,00006	0,999443	0,021602	1	5,9391E-05	5,93907E-05
0	0	0,049087	0	0,25	0	0,000015	0,00006	1	0,015	1	0	0
100	0,023	0,049087	0,468552	0,25	89418,35	0,000015	0,00006	0,9997	0,018704	1	0,00484114	0,004841141
100	0,023	0,049087	0,468552	0,25	89418,35	1,5E-06	0,000006	0,999596	0,018434	1	0,00106318	0,001063185
100	0,023	0	0	0	0	0,000015	0	1	0,015	1	0	0
100	0,023	0,049087	0,468552	0,25	89418,35	1,5E-06	0,000006	0,999596	0,018434	1	0,00056637	0,000566369
100	0,023	0,049087	0,468552	0,25	89418,35	0,000015	0,00006	0,9997	0,018704	1	0,00188882	0,00188882
100	0,00575	0,012272	0,468552	0,125	44709,17	0,000015	0,00012	0,999515	0,021802	4	0,00174226	0,006969059
75	0,01725	0,049087	0,351414	0,25	67063,76	0,000015	0,00006	0,999598	0,019823	1	0,00014149	0,000141492
75	0,01725	0,031416	0,549085	0,2	83829,7	0,000015	0,000075	0,999703	0,019017	1	0,00185926	0,001859255
50	0,0115	0,031416	0,366056	0,2	55886,47	0,000015	0,000075	0,999551	0,020649	1	0,00124598	0,001245977
25	0,00575	0,031416	0,183028	0,2	27943,23	0,000015	0,000075	0,999256	0,024042	1	8,8976E-05	0,000089
25	0,00575	0,012272	0,468552	0,125	44709,17	0,000015	0,00012	0,999515	0,021802	1	0,00281896	0,002818958

k-total for Minor Loss	Minor Loss for Diameter transition flow	Minor Loss per Split	Total Minor loss	Unit preoress	Total Major+Minor Loss
11,80882721	0	1,0195737	1,01957373	0	1,034909724
0,7	0,02594415	0,0151095	0,01510949	0	0,018621846
0	0	0	0	0	5,93907E-05
0	0	0	0	0	0
1,4	0	0,0156655	0,01566552	0	0,020506664
1,74	0	0,01947	0,01947001	0	0,020533192
0	0	0	0	0,4902263	0,490226293
0,84	0	0,0093993	0,00939931	0	0,009965683
0	0	0	0	0	0,00188882
2	0	0,0223793	0,08951728	0	0,096486335
0,02	0,02	0,0001259	0,00012588	0	0,000267375
0	#REF!	0	0	0	0,001859255
0	0	0	0	0	0,001245977
0,02	0,02	3,415E-05	3,4148E-05	0	0,000123125
0,6	#REF!	0,0067138	0,0067138	0	0,009532754
				Sum=	1,706226433

Raw Water Loss



Raw Water Loss Per Meter



Major Losses Due to Friction		
Flow	0,023	
Viscosity	1,31E-06	
K	0,000015	

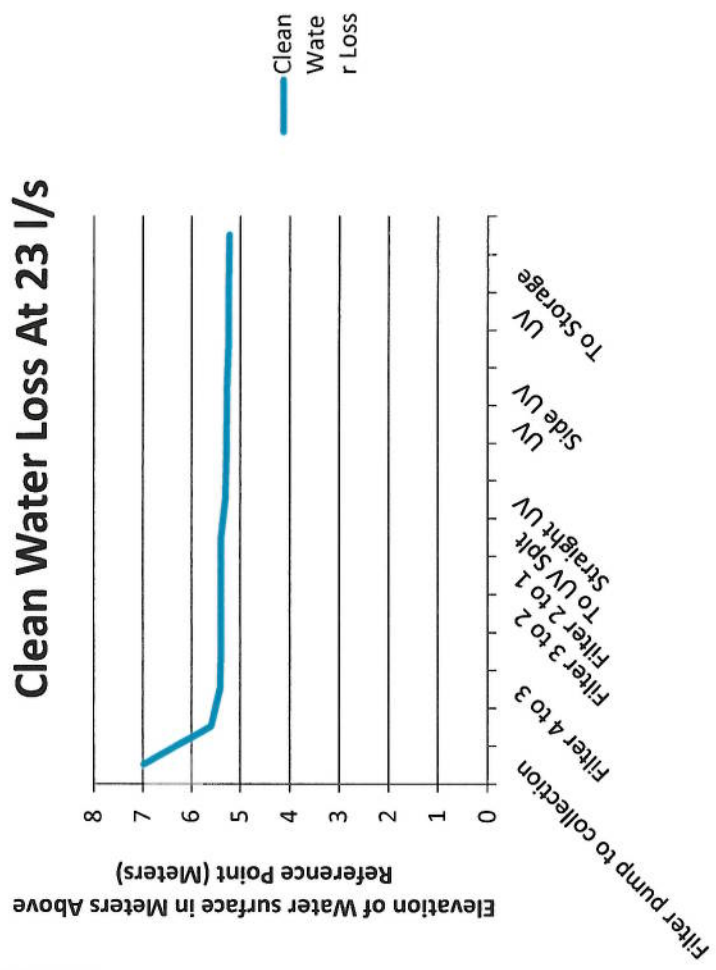
Plant Altercations		#
Intake Pumps: 1 or 2		1
Filters in operation: 3 or 4		4
UV in operation: 1 or 2		1

Reference	Section	Diameter (m)	Pipe Length/Section (m)	Split Flow? Yes/No	Split into	Split Flow (m ³ /s)	Reduced flow? Yes/No
Clean Water	Filter pump to collection	0,08	0,295	yes	4	0,00575	no
		0,1	1,966	yes	4	0,00575	no
	Filter 4 to 3	0,1	0,270	No	2	0,023	yes
		0,2	1,754	No	1	0,023	yes
	Filter 3 to 2	0,2	1,900	No	1	0,023	yes
	Filter 2 to 1	0,2	1,900	No	1	0,023	yes
	To UV Split	0,2	7,233	no	1	0,023	No
	Straight UV	0,2	1,220	No	1	0,023	no
		0,3	0,877	No	1	0,023	no
	UV			no	1	0,023	Yes
	Side UV	0,2	1,624	No	1	0,023	no
		0,3	1,406	No	1	0,023	no
	UV			No	1	0,023	Yes
	To Storage	0,3	1,495	No	1	0,023	no

% of Total flow (0-100)	Reduced Flow (m ³ /s)	Area (m)	Velocity (m ² /s)	D(h)	Re	K	K/D(h)	1	f	Repartitions	Major Loss Per Split	Total Major loss
100	0,00575	0,005027	1,143926	0,08	69858,09	0,000015	0,000188	0,999793	0,02019	4	0,00496374	0,019854946
100	0,00575	0,007854	0,732113	0,1	55886,47	0,000015	0,00015	0,999649	0,020929	4	0,01123885	0,044955406
25	0,00575	0,007854	0,732113	0,1	55886,47	0,000015	0,00015	0,999649	0,020929	1	0,00154302	0,001543019
25	0,00575	0,031416	0,183028	0,2	27943,23	0,000015	0,000075	0,999256	0,024042	1	0,00036004	0,000360039
50	0,0115	0,031416	0,366056	0,2	55886,47	0,000015	0,000075	0,999551	0,020649	1	0,00133976	0,00133976
75	0,01725	0,031416	0,549085	0,2	83829,7	0,000015	0,000075	0,999703	0,019017	1	0,0027761	0,002776098
100	0,023	0,031416	0,732113	0,2	111772,9	0,000015	0,000075	0,999805	0,017993	1	0,01777666	0,017776658
100	0,023	0,031416	0,732113	0,2	111772,9	0,000015	0,000075	0,999805	0,017993	1	0,00299843	0,00299843
100	0,023	0,070686	0,325383	0,3	74515,29	0,000015	0,00005	0,99962	0,019356	1	0,00030535	0,000305353
100	0,023	0	0	0	0	0,000015	0	1	0,021	1	0	0
100	0,023	0,031416	0,732113	0,2	111772,9	0,000015	0,000075	0,999805	0,017993	1	0,00399009	0,003990086
100	0,023	0,070686	0,325383	0,3	74515,29	0,000015	0,00005	0,99962	0,019356	1	0,00048963	0,000489629
0	0	0	0	0	0	0,000015	0	1	0,015	1	0	0
25	0,023	0,070686	0,325383	0,3	74515,29	0,000015	0,00005	0,99962	0,019356	1	0,00052063	0,000520629

k-total for Minor Loss	Minor Loss for Diameter Transition flow	Minor Loss per Split	Total Minor loss	Unit Process	Total Major+Minor Loss
5,145775344	0,025775344	0,3432004	1,37280164	0	1,392656584
1,2	0	0,0327822	0,13112882	0	0,176084229
0,642435097	0,042435097	0,0175504	0,01755037	0	0,019093385
0	0	0	0	0	0,000360039
0	0	0	0	0	0,00133976
0	0	0	0	0	0,002776098
2,28	0	0,0622862	0,06228619	0	0,080062849
0,701591047	0,021591047	0,0191664	0,01916642	0	0,022164848
1,1		0,0059359	0,00593587	0	0,006241226
0	0	0	0	0	0,01
0,621591047	0,021591047	0,0169809	0,01698094	0	0,020971024
1,7	0	0,0091736	0,00917362	0	0,00966325
0	0	0	0	0	0
1,8	0	0,0097132	0,00971325	0	0,010233876
Sum					1,751647167

Clean Water Loss At 23 l/s



Static Mix

This is Martin's Work. Make sure credit is given both within Excel Sheet and in Paper when referring to the Static Mixer

Trykktap i strupesliver		
Diameter Main Pipe [mm]		250
Diameter Orifice Plate [mm]		130
Flow [m ³ /h]		82,8
Area pipe [m ²]		0,0490875
Area nozzle [m ²]		0,01327326
Velocity pipe [m/s]		0,468551057
Velocity nozzle [m/s]		1,732807163
Reynolds number (Re)		89 554,87
$m=(d/D)^2$		0,2704
Flow through number		0,63
Pressure loss through orifice plate [mV/S]		0,490226293

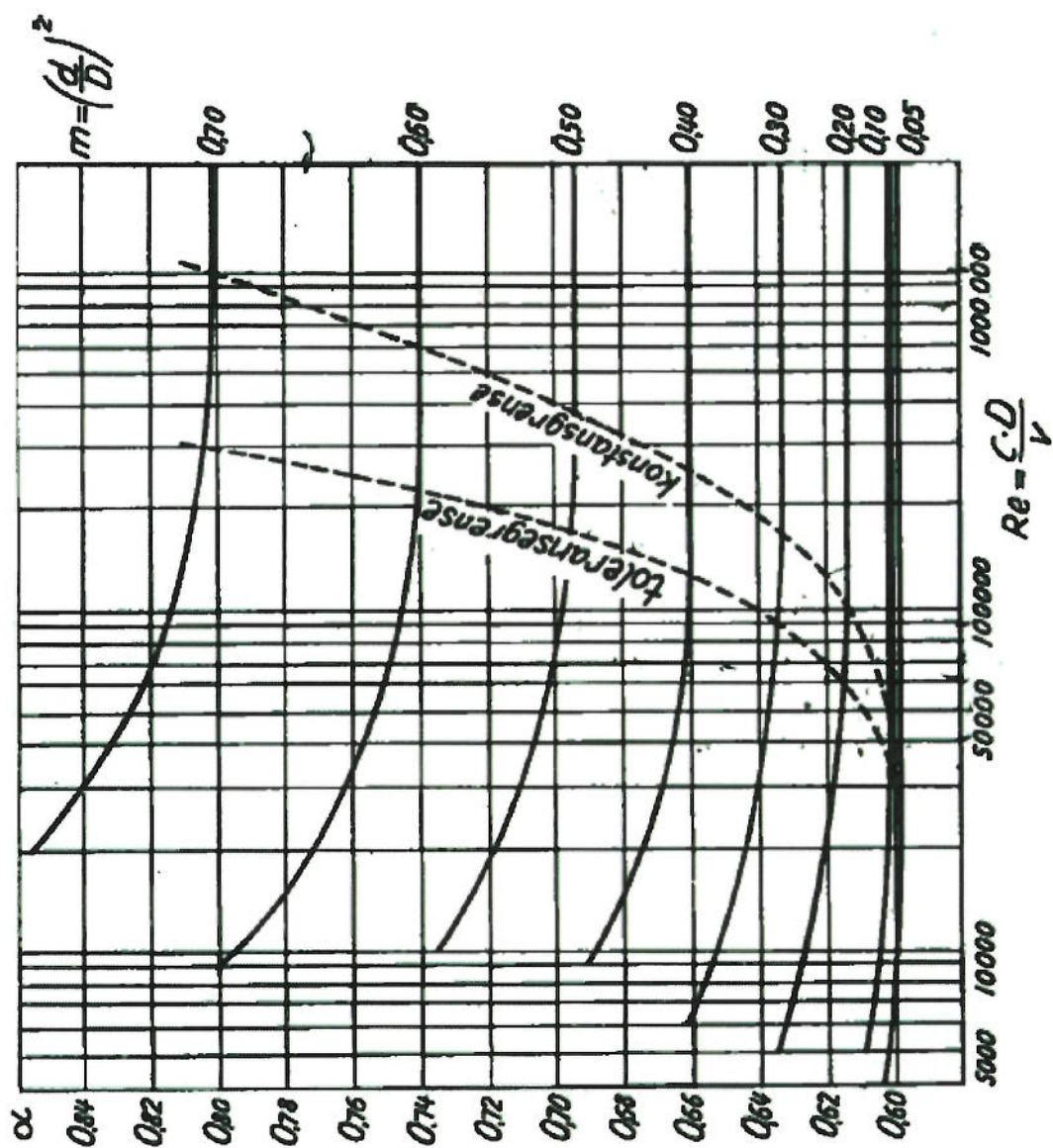
Trykktap i strupesliver		
Diameter Main Pipe [mm]		50
Diameter Orifice Plate [mm]		130
Flow [m ³ /h]		82,8
Area pipe [m ²]		0,0019635
Area nozzle [m ²]		0,01327326
Velocity pipe [m/s]		11,7137764
Velocity nozzle [m/s]		1,73280716
Reynolds number (Re)		447 774,33
$m=(d/D)^2$		6,76
Flow through number		0,63
Pressure loss through orifice plate [mV/S]		0,49022629

Total Loss	0,490226293	Meters
Validation of numbers		
	0,25	A
	0,12	Q
	0,000001308	Viscosity
	89 554,87	Re
	0,000001308	

OBS! Formelene er egentlig utviklet for bruk ved mengdemåling med måleblende, men er her brukt baklengs for å beregne tap ved en kjent vannmengde. Reelt tap blir antagelig litt høyere den det beregningene viser på grunn av turbulens utenfor måleblenden.

DISCLAIMER: This section of the workbook was developed by Martin Meltzer. I take no credit for developing this myself, other than translating the writing from Norwegian to English.

Gjennomstrømningstallet α for blende



Filter

Filter						
Variables						
hl	Head Loss	pw	Density of Water	μ	Viscosity	
Kv	hl coe viscous	d	Effective Size	v	Filtration Rate	
K	hl coe inertial	ϵ	Porosity	g	Gravity Constant	
Operating Temp Theory		Real		Time Conv.	3600	s/h

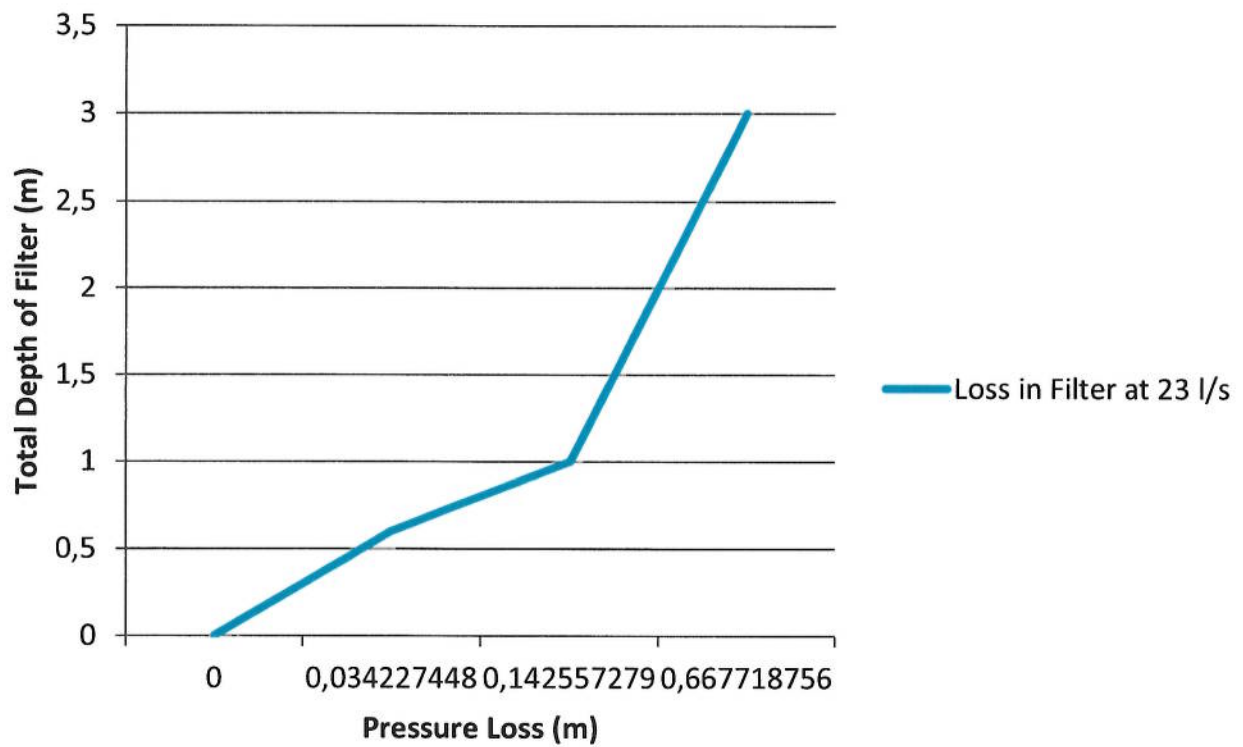
Reynolds Number			Re	1546,196
pw	999,7	kg/m		
v	4,042969	m/h		
d	0,0005	m		
μ	0,001307	kg/m*s		

Head Loss (Meters)	
Filtrite	0,03423
Sand	0,10833
Marble	0,52516
Total Loss	0,66772

Filtralite			Sand			Marble		
hl	0,034227	m	hl	0,10833	m	hl	0,525161	m
Kv	319		Kv	112,5		Kv	114	
K	6		K	2,25		K	1,22	
pw	999,7	kg/m	pw	999,7	kg/m	pw	999,7	kg/m
d	0,0008	m	d	0,00055	m	d	0,0004	m
ϵ	0,6		ϵ	0,415		ϵ	0,48	
μ	0,00131	kg/m*s	μ	0,00131	kg/m*s	μ	0,00131	kg/m*s
v	4,04297	m/h	v	4,04297	m/h	v	4,04297	m/h
g	9,81	m/s^2	g	9,81	m/s^2	g	9,81	m/s^2
L	0,6	m	L	0,4	m	L	2	m

L	Depth	
Re	Reynolds Number	
Velocity for given area		
Area	5,12	m2
Flow	0,00575	m3/s
Velocity	4,042969	m/h

Loss in Filter at 23 l/s



u v

UV Disinfection

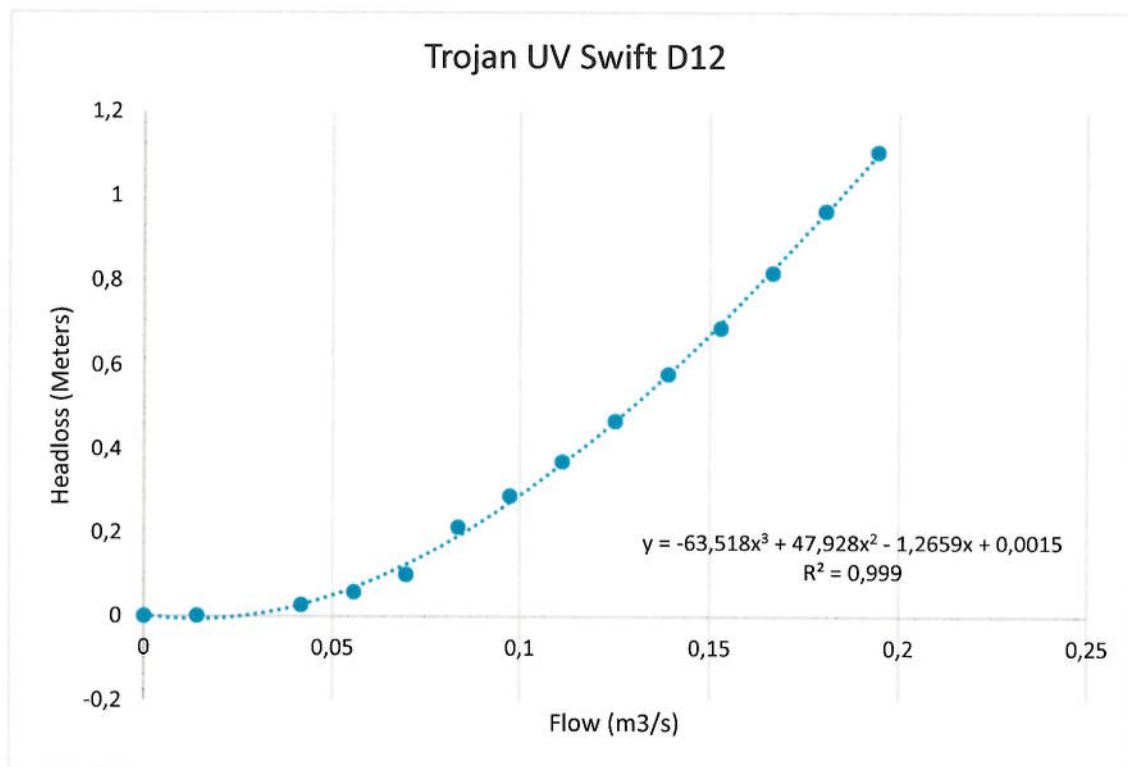
Headloss		Flow	
cm	m	m3/hr	m3/s
0	0	0	0
0,08	0,0008	50	0,01388889
2,66666667	0,02666667	150	0,04166667
5,73333333	0,05733333	200	0,05555556
9,86666667	0,09866667	250	0,06944444
21,33333333	0,21333333	300	0,08333333
28,8	0,288	350	0,09722222
37,06666667	0,37066667	400	0,11111111
46,8	0,468	450	0,125
58	0,58	500	0,13888889
68,93333333	0,68933333	550	0,15277778
81,86666667	0,81866667	600	0,16666667
96,53333333	0,96533333	650	0,18055556
110,53333333	1,10533333	700	0,19444444

Values taken by measuring with a millimeter ruler and then transposing to the correct values using a ratio from the length to 100 cm loss

Q	Length	hl	mm	Q
100	7,5	0,08	0,006	50
		2,66666667	0,2	150
13,33333333	Ratio	5,73333333	0,43	200
		9,86666667	0,74	250
		21,33333333	1,6	300
		28,8	2,16	350
		37,06666667	2,78	400
		46,8	3,51	450
		58	4,35	500
		68,93333333	5,17	550
		81,86666667	6,14	600
		96,53333333	7,24	650
		110,53333333	8,29	700

Equation for Loss Through UV

$$Y = -63,518x^3 + 47,928x^2 - 1,2659x + 0,0015$$



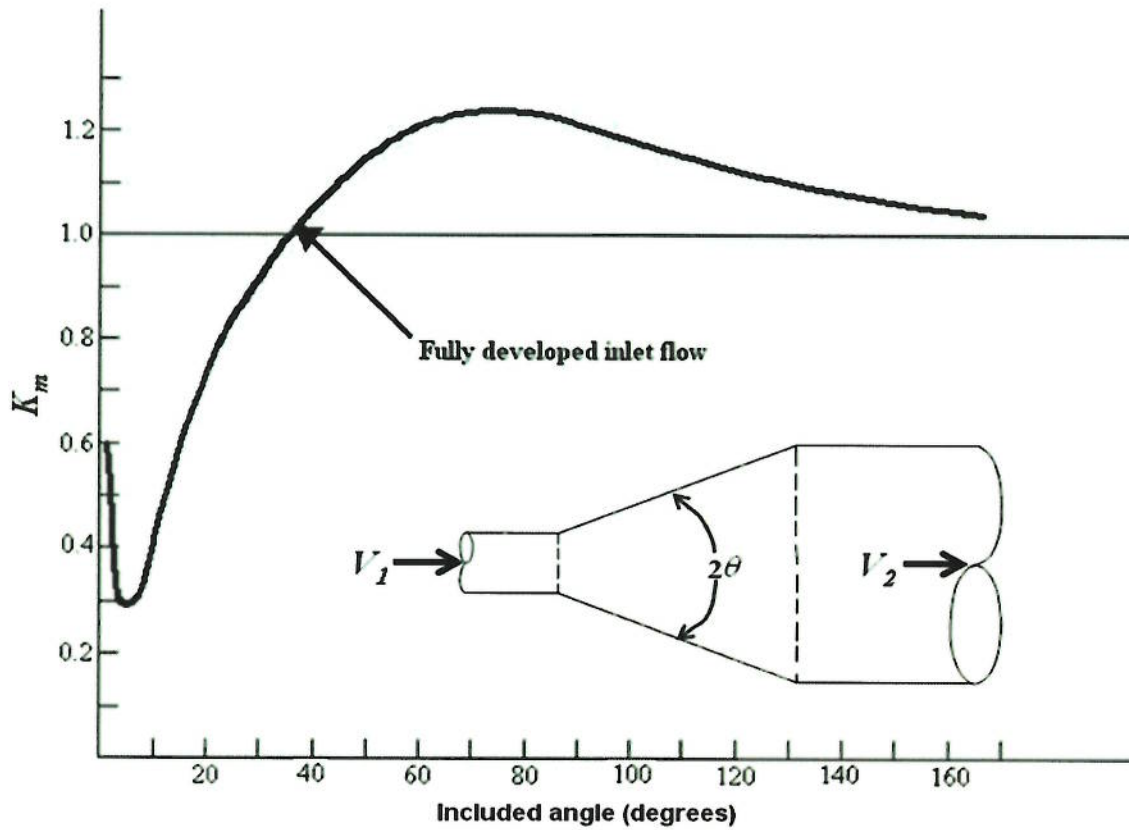
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Values Provided By Engineeringtoolbox.com

Tee, Flanged, Dividing Line Flow	0,2
Tee, Threaded, Dividing Line Flow	0,9
Tee, Flanged, Dividing Branched Flow	1
Tee, Threaded , Dividing Branch Flow	2
Union, Threaded	0,08
Elbow, Flanged Regular 90°	0,3
Elbow, Threaded Regular 90°	1,5
Elbow, Threaded Regular 45°	0,4
Elbow, Flanged Long Radius 90°	0,2
Elbow, Threaded Long Radius 90°	0,7
Elbow, Flanged Long Radius 45°	0,2
Return Bend, Flanged 180°	0,2
Return Bend, Threaded 180°	1,5
Globe Valve, Fully Open	10
Angle Valve, Fully Open	2
Gate Valve, Fully Open	0,15
Gate Valve, 1/4 Closed	0,26
Gate Valve, 1/2 Closed	2,1
Gate Valve, 3/4 Closed	17
Swing Check Valve, Forward Flow	2
Ball Valve, Fully Open	0,05
Ball Valve, 1/3 Closed	5,5
Ball Valve, 2/3 Closed	200
Diaphragm Valve, Open	2,3
Diaphragm Valve, Half Open	4,3
Diaphragm Valve, 1/4 Open	21
Water meter	7

Values from wikiengineer.com, reference: Larock, Jeppson, & Watters, "Hydraulics of Pipeline Systems", 2000

Globe valve (fully open)	6,4
Globe valve (half open)	9,5
Angle valve (fully open)	5,0
Swing check valve (fully open)	2,5
Butterfly valve (fully open)	0,4
Gate valve (fully open)	0,2
Gate valve (3/4 open)	1,0
Gate valve (half open)	5,6
Gate valve (one-quarter open)	24,0
Check valve, swing type (fully open)	2,3
Check valve, lift type (fully open)	12,0
Check valve, ball type (fully open)	70,0
Foot Valve (fully open)	15,0
Close return bend (180°)	2,2
Standard tee	1,8
Standard (short radius) elbow (90°)	0,9
Medium radius elbow (90°)	0,7
Long sweep elbow (90°)	0,6
45 degree elbow	0,4
Pipe entrance (Square-edged)	0,5
Pipe entrance (Re-entrant)	0,8
Pipe entrance (Rounded, $r/D < 0.16$)	0,1
Pipe exit	1,0
Sudden contraction (2 to 1)	0,3
Sudden contraction (5 to 1)	0,4
Sudden contraction (10 to 1)	0,5
Orifice plate (1.5 to 1)	0,9
Orifice plate (2 to 1)	3,4
Orifice plate (4 to 1)	29,0
Sudden enlargement	$(1-A_1/A_2)^2$
90 degree miter bend (without vanes)	1,1
90 degree miter bend (with vanes)	0,2
General contraction (30 degree included angle)	0,02
General contraction (70 degree included angle)	0,07



Comparison

Soups

Flow

23 l/s

Raw Water Loss

P 2 Collect 1,1522948

Post pump

Collection P 9,0857052

0,05

Static 0,129

0,05

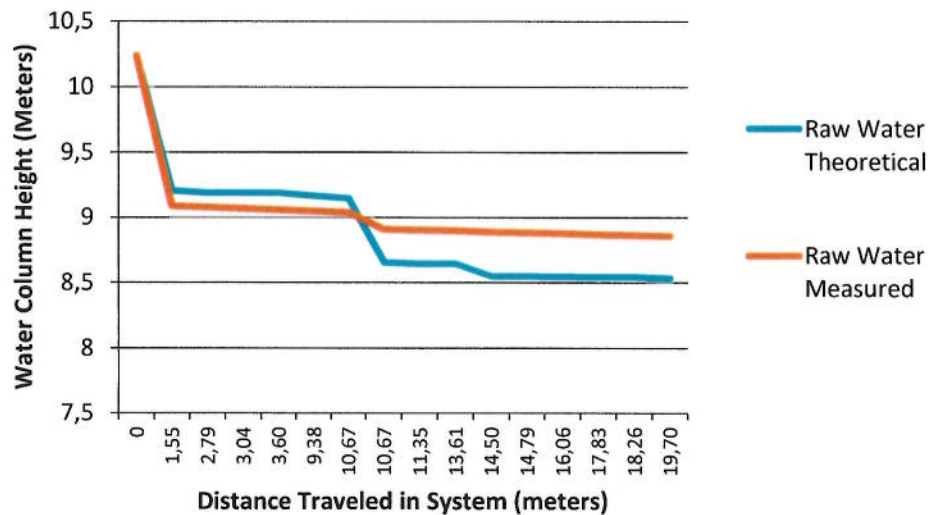
10,238

0 10,238

10,238

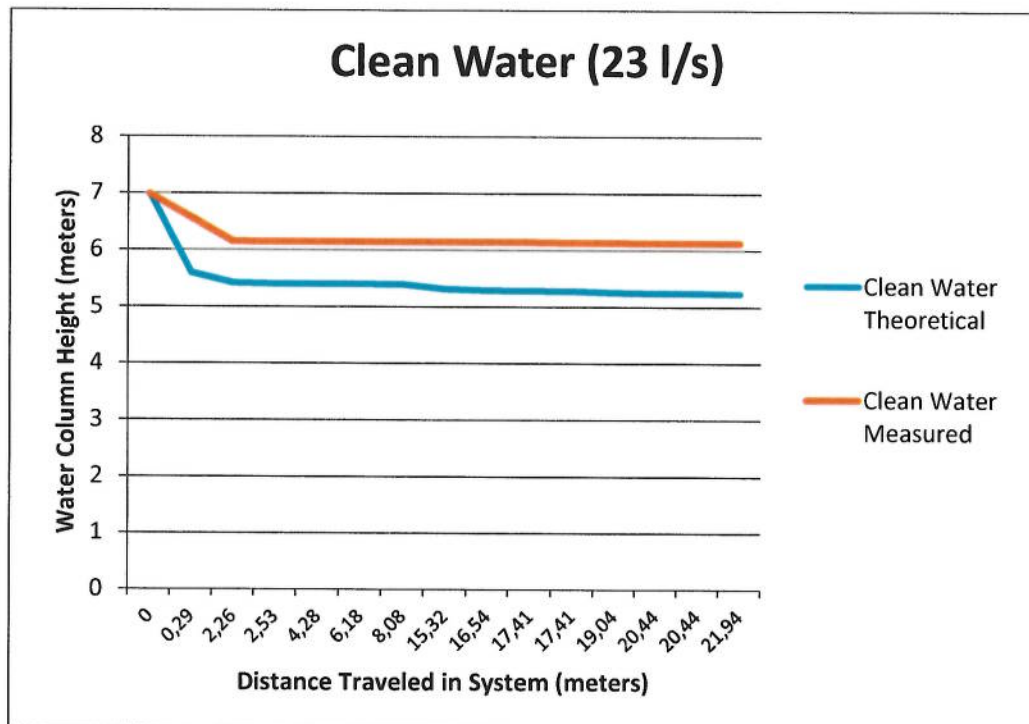
Piping from intake pump to	1,55	9,20309028	1,152	9,086	
Pump 1 connection to	2,79	9,18446843	0,01	9,076	0,65269486
pump 2 addition	3,04	9,18440904	0,01	9,066	0,219
Pump 2 connection to	3,60	9,18440904	0,01	9,056	
Pump 3 connection to	9,38	9,16390238	0,01	9,046	
PE Piping pre Static Mixer	10,67	9,14336918	0,01	9,036	
Static Mixer	10,67	8,65314289	0,129	8,907	
PE Piping Post Static mixer	11,35	8,64317721	0,005	8,902	
Steel piping to branch to	13,61	8,64128839	0,005	8,897	
Piping to each filter	14,50	8,54480205	0,01	8,887	
Filter branch 1 to branch 2	14,79	8,54453468	0,005	8,882	
Filter branch 2 to 3	16,06	8,54267542	0,005	8,877	
Filter branch 2 to 3	17,83	8,54142945	0,01	8,867	
Filter branch 3 to 4	18,26	8,54130632	0,005	8,862	
	19,70	8,53177357	0,005	8,857	

Raw Water (23 l/s)

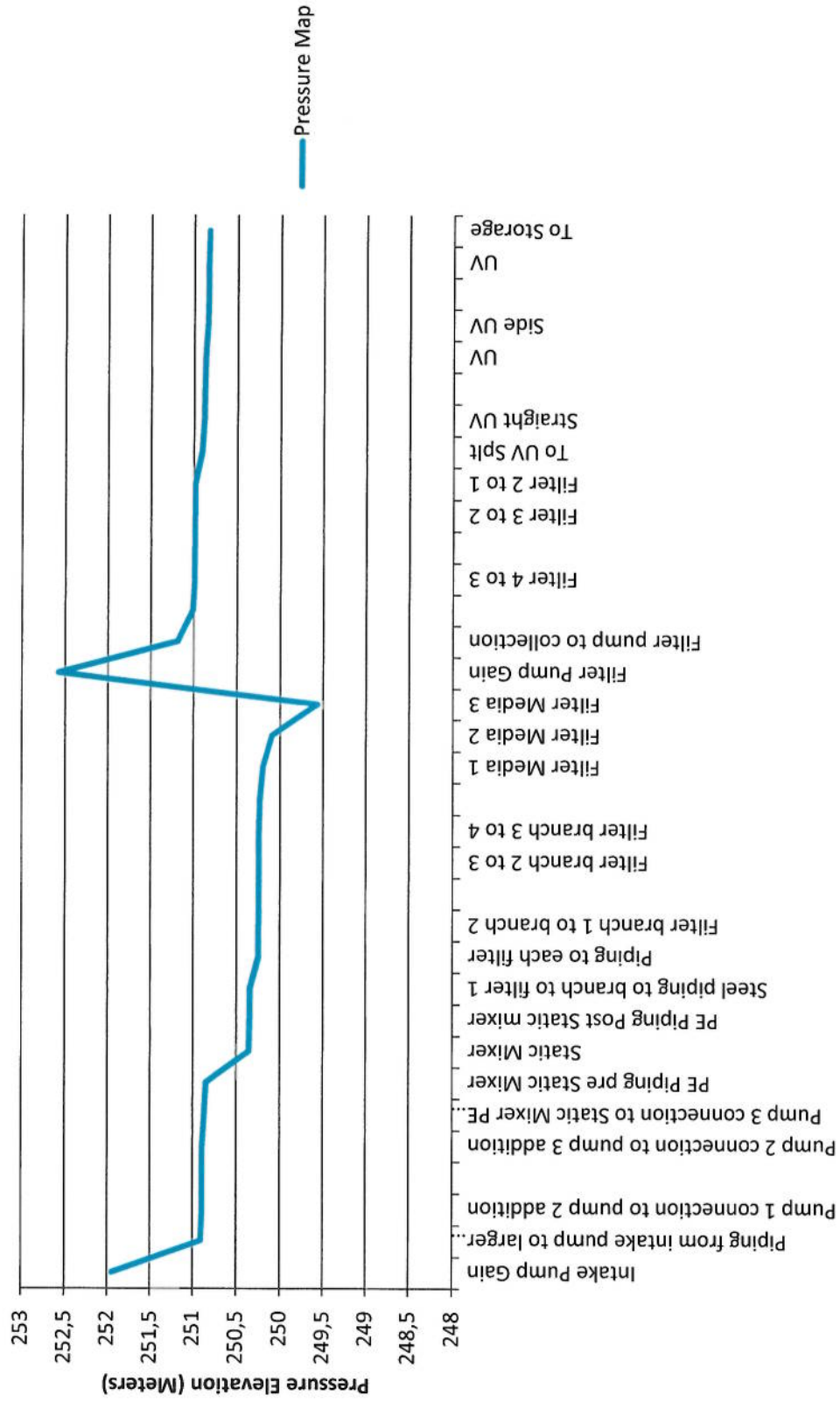


Clean Water	Loss		
Filter	1,745		
Check Valve	1,64	Pump to collection	0,836
To Tank	0,0192		

	0	6,985	6,985	
Filter pump to collection	0,29	5,59234342	0,418	6,567
	2,26	5,41625919	0,418	6,149
Filter 4 to 3	2,53	5,3971658	0,00083636	6,14816364
	4,28	5,39680576	0,00083636	6,14732727
Filter 3 to 2	6,18	5,395466	0,00083636	6,14649091
Filter 2 to 1	8,08	5,39268991	0,00083636	6,14565455
To UV Splt	15,32	5,31262706	0,00083636	6,14481818
Straight UV	16,54	5,29046221	0,00083636	6,14398182
	17,41	5,28422098	0,00083636	6,14314545
UV	17,41	5,27422098	0,01	6,13314545
Side UV	19,04	5,25324996	0,00083636	6,13230909
	20,44	5,24358671	0,00083636	6,13147273
UV	20,44	5,24358671	0,00083636	6,13063636
To Storage	21,94	5,23335283	0,00083636	6,1298



Pressure Map



Intake Pump Gain
Piping from intake pump to
Pump 1 connection to
pump 2 addition
Pump 2 connection to
Pump 3 connection to
PE Piping pre Static Mixer
Static Mixer
PE Piping Post Static mixer
Steel piping to branch to
Piping to each filter
Filter branch 1 to branch 2
Filter branch 2 to 3
Filter branch 3 to 4
Filter Media 1
Filter Media 2
Filter Media 3
Filter Pump Gain
Filter pump to collection
Filter 4 to 3
Filter 3 to 2
Filter 2 to 1
To UV Splt
Straight UV
UV
Side UV
UV
To Storage

9,024522
1,034909724
0,018621846
5,93907E-05
0
0,020506664
0,020533192
0,490226293
0,009965683
0,00188882
0,096486335
0,000267375
0,001859255
0,001245977
0,000123125
0,009532754
0,034227448
0,108329831
0,525161477
6,63
1,392656584
0,176084229
0,019093385
0,000360039
0,00133976
0,002776098
0,080062849
0,022164848
0,006241226
0,01
0,020971024
0,00966325
0
0,010233876

Pressure
Elevation
251,944522
250,909612
250,89099
250,890931
250,890931
250,870424
250,849891
250,359665
250,349699
250,34781
250,251324
250,251057
250,249197
250,247951
250,247828
250,238296
250,204068
250,095738
249,570577
252,58
251,187343
251,011259
250,992166
250,991806
250,990466
250,98769
250,907627
250,885462
250,879221
250,869221
250,84825
250,838587
250,838587
250,828353