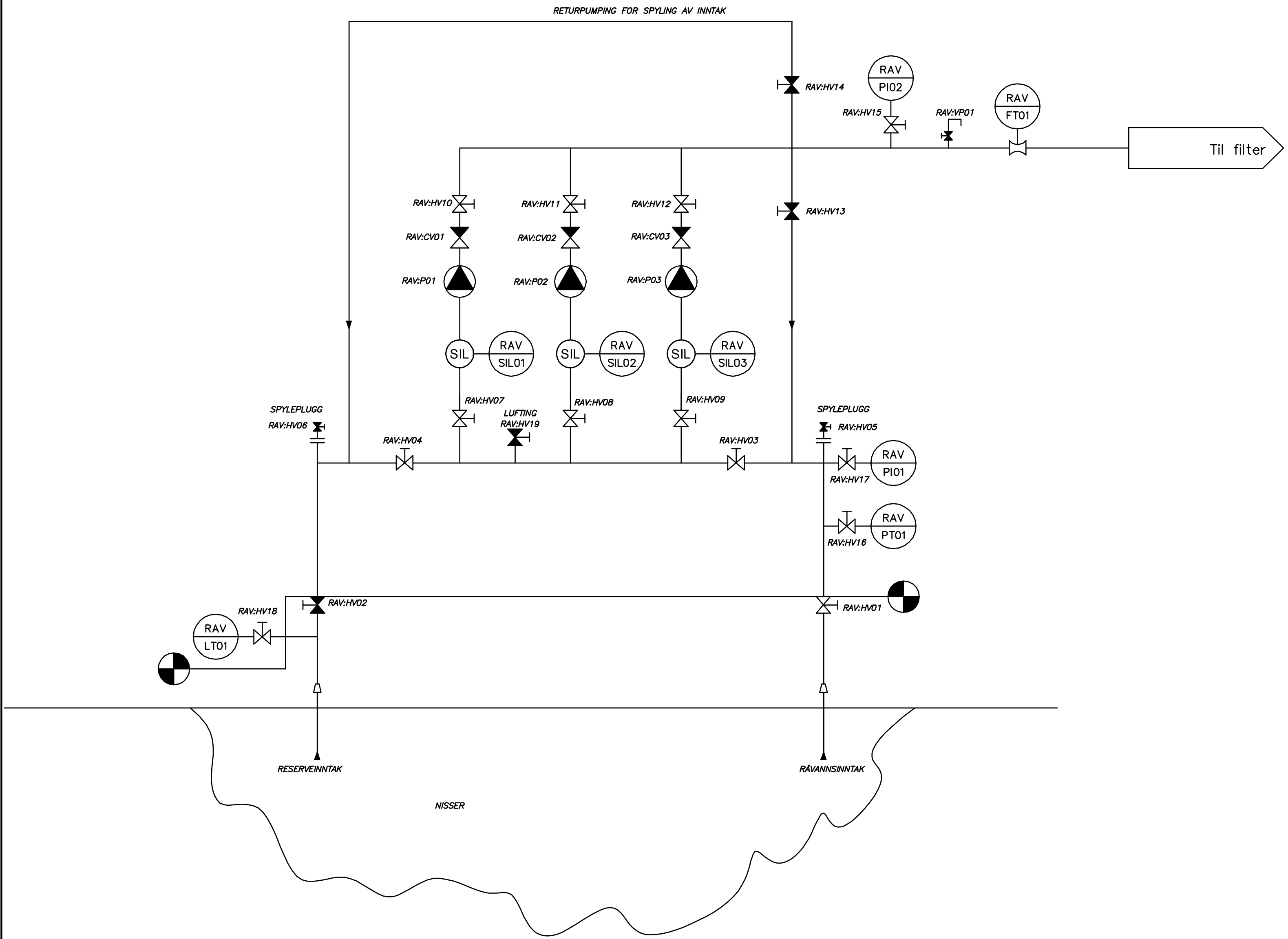
Appendix A:

Treungen Treatment Plant Design



Tegningsnummer:
P M---- 001

Revisjon:

Rev.		Tekst:	Rev.dato:	Kontr:
-	#	-	-	-
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TILBUDSTEGNING

asplan viak

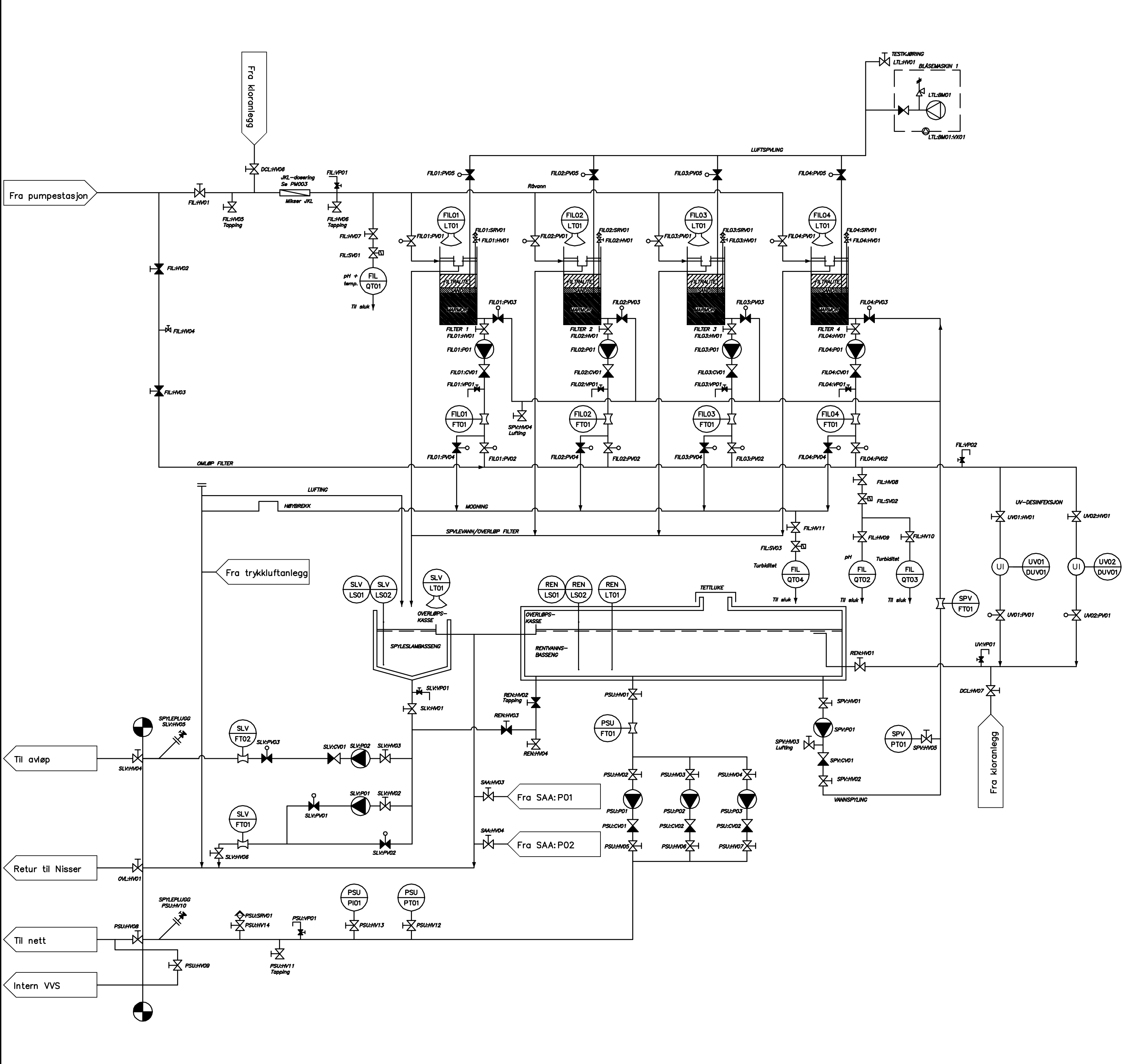
Prosjekt:
Treungen VV
Oppdragsgiver:
Nissedal kommune

Flytskjema
Vannbehandlingsanlegg
Råvannspumpestasjon

Oppdragsleder:	Tegn:	Målestokk
PHT	MM	-
Oppdragsnr.:	Kontr:	Dato:
527056	PHT	2013-10-21

Tegn. nr:
P M 001
Fag Type Etg. Løpenr.

Rev.
-- -A



Tegningsnummer: **P M ---- 002**

Revisjon:

Rev.	Tekst	Rev.dato:	Kontr:
- =	-	-	-
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TILBUDSTEGNING

asplan viak

Prosjekt:
Treungen VV

Oppdragsgiver:
Nissedal kommune

Flytskjema

Vannbehandlingsanlegg

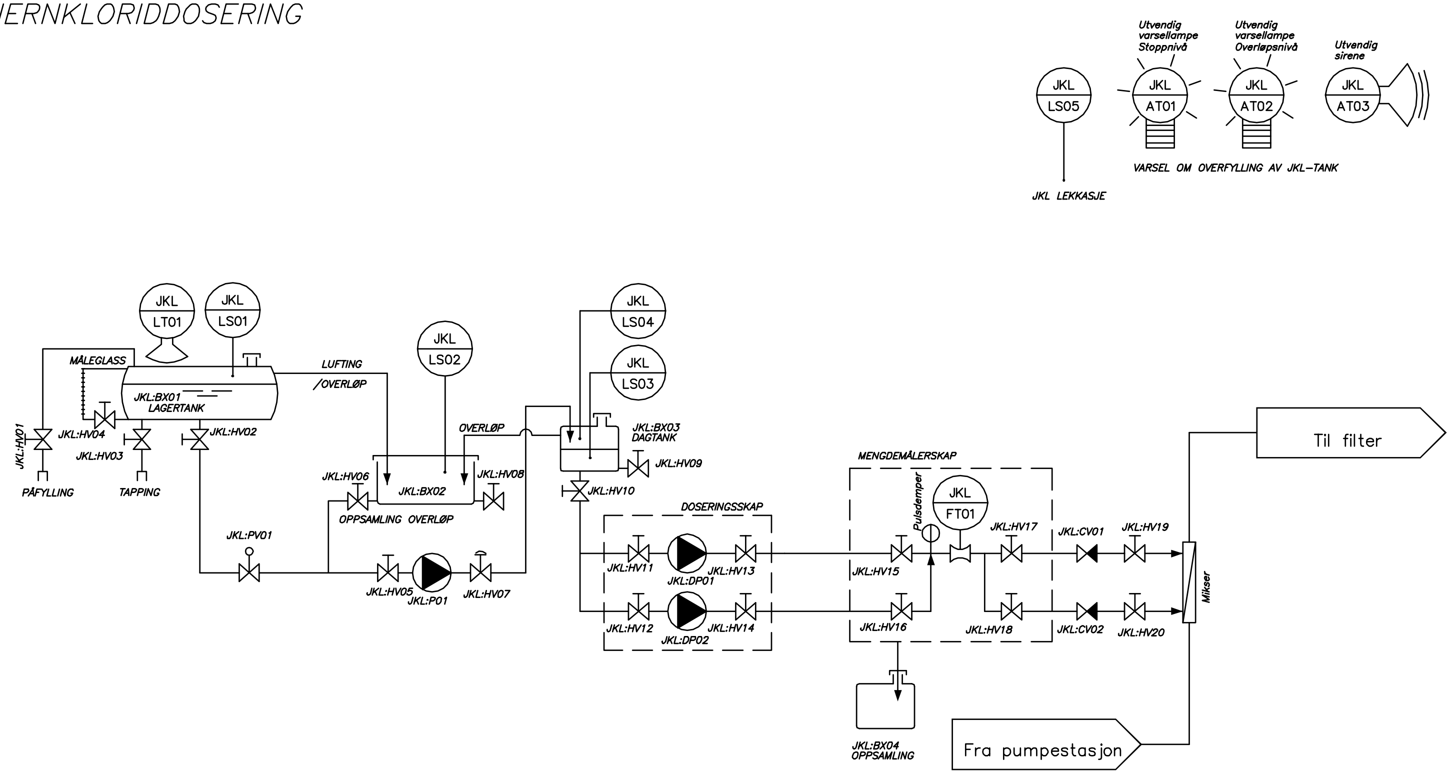
Filter, slam og rentvann

Oppdragsleder:	Tegn:	Målestokk
PHT	MM	-
Oppdragsnr.: 527056	Kontr: PHT	Dato: 2013-10-21

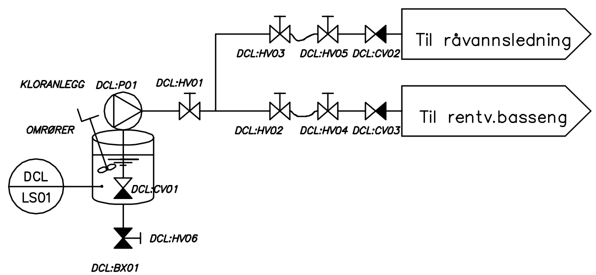
Tegn. nr: **P M 002** (Fag, Type, Etg., Løpenr.)

Rev. **-- -A**

JERNKLORIDDOSERING



KLORDOSERING



Tegningsnummer: **P M---- 003**

Revisjon:

Rev.	Tekst	Rev.dato:	Kontr:
- =	-	-	-
- =	-	--	-
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TILBUDSTEGNING

asplan viak

Prosjekt:
Treungen VV

Oppdragsgiver:
Nissedal kommune

Flytskjema

Vannbehandlingsanlegg

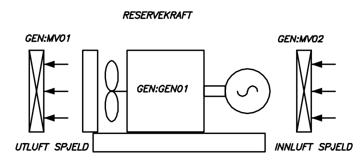
Dosering JKL, og klor

Oppdragsleder:	Tegn:	Målestokk
PHT	MM	-
Oppdragsnr.:	Kontr:	Dato:
527056	PHT	2013-10-21

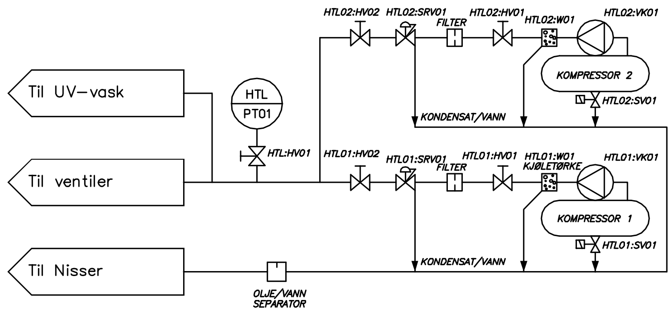
Tegn. nr: **P M 003** (Fag Type Etg. Løpenr.)

Rev. **-- -A**

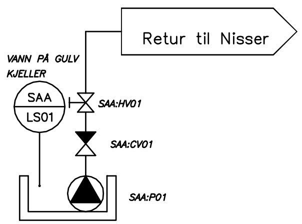
ELEKTRISK ANLEGG



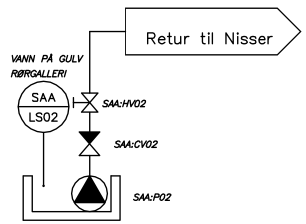
TRYKKLUFTANLEGG



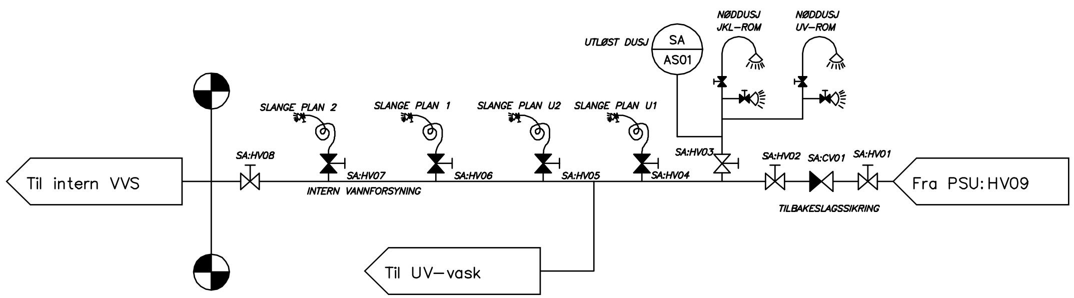
SPILLVANNSPUMPESTASJON I KJELLER



SPILLVANNSPUMPESTASJON I RØRGALLERI



INTERN VANNFORSYNING



Tegningsnummer:
P M ---- 004

Revisjon:

Rev.	Tekst	Rev.dato:	Kontr:
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TILBUDSTEGNING

asplan viak

Prosjekt:
Treungen VV
Oppdragsgiver:
Nissedal kommune

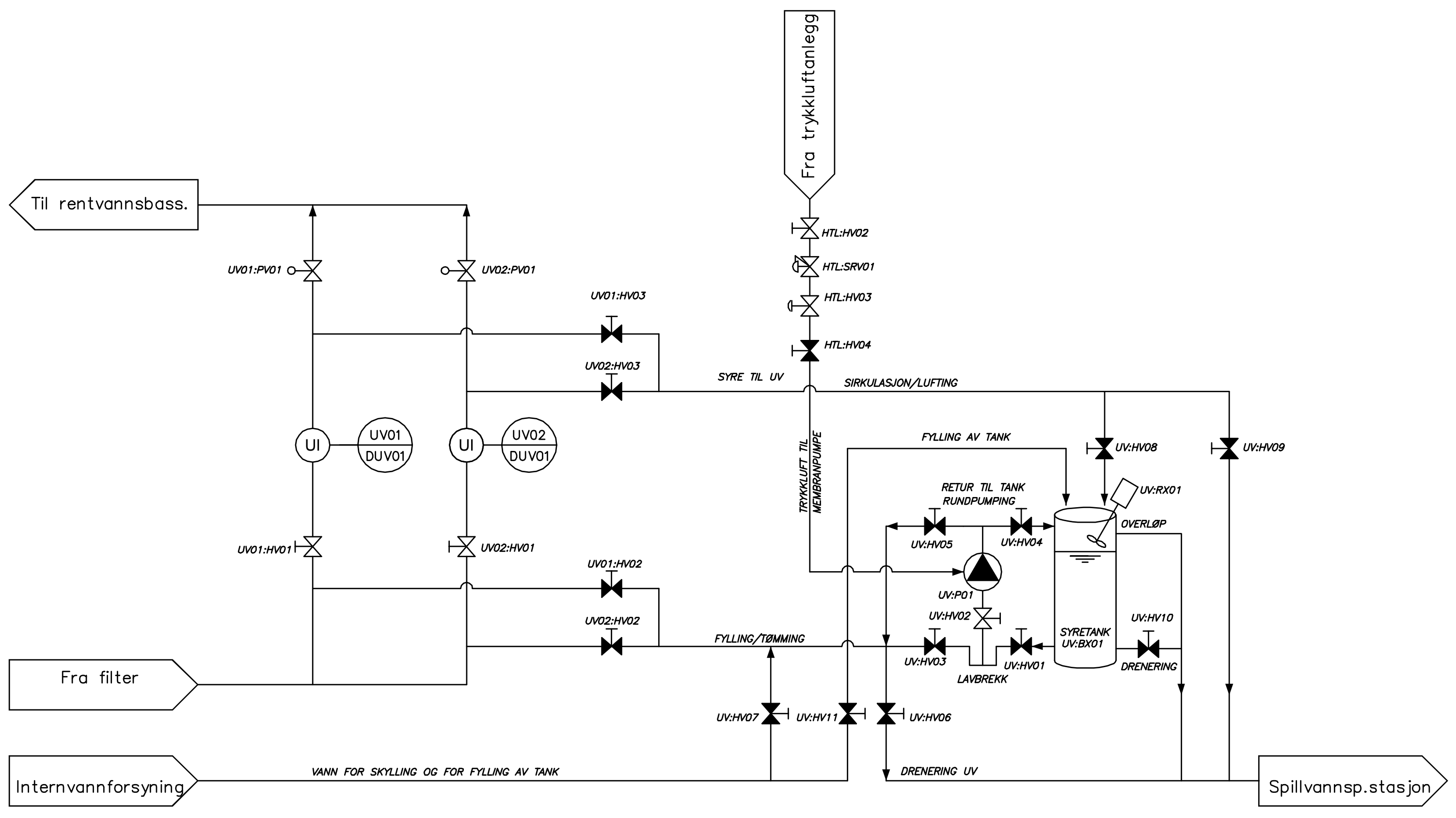
Flytskjema

Vannbehandlingsanlegg
Støttesystemer: Trykkluft, VVS, El

Oppdragsleder:	Tegn:	Målestokk
PHT	MM	-
Oppdragsnr.:	Kontr:	Dato:
527056	PHT	2013-10-21

Tegn. nr: **P M 004** (Fag, Type, Etg., Løpenr.)

Rev. **-- -A**



Tegningsnummer:
P M---- 005

Revisjon:

Rev.	Tekst	Rev.dato:	Kontr:
- =	-	-	-
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TILBUDSTEGNING

asplan viak

Prosjekt:
Treungen VBA

Oppdragsgiver:
Nissedal kommune

Flytskjema

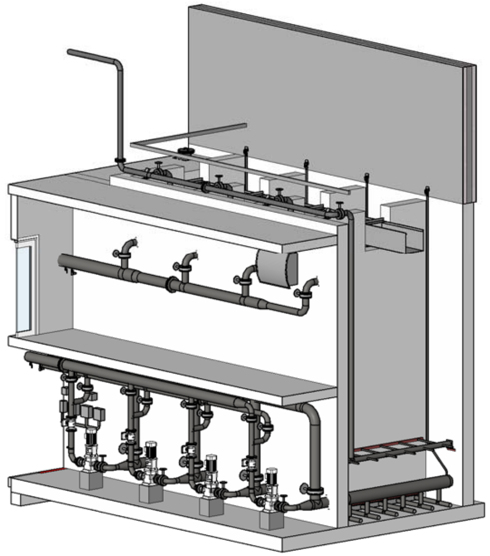
Vannbehandlingsanlegg

UV-vaskeanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk -
Oppdragsnr.: 527056	Kontr: PHT	Dato: 2013-10-21

Tegn. nr:
P M 005 (Fag Type Etg. Løpenr.)

Rev.
-- -A



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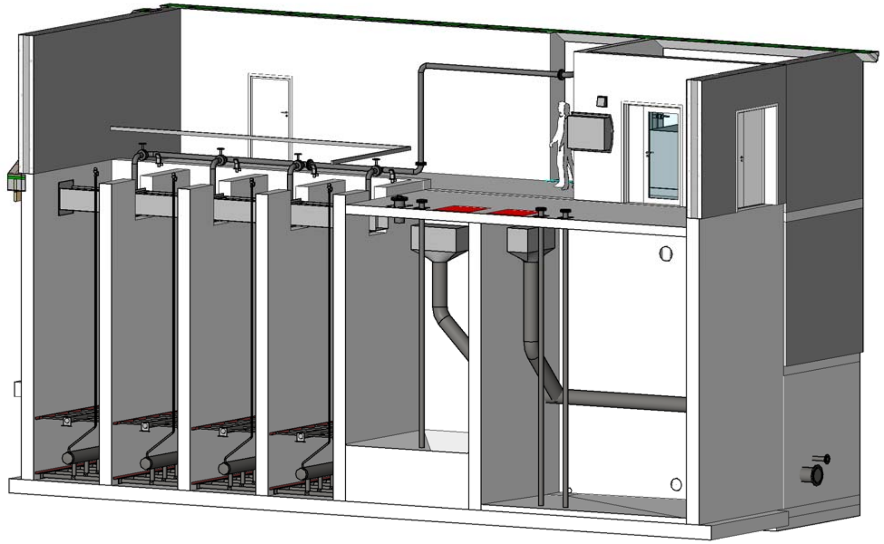
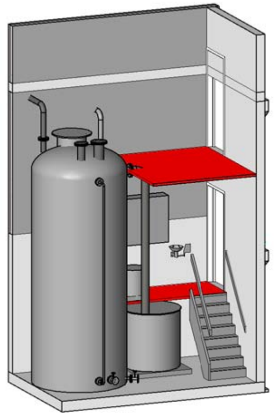
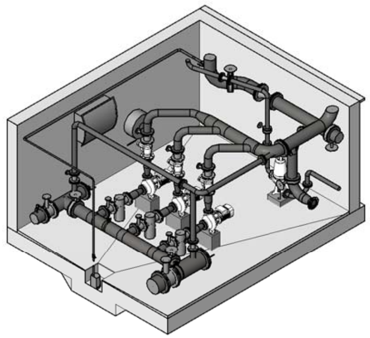


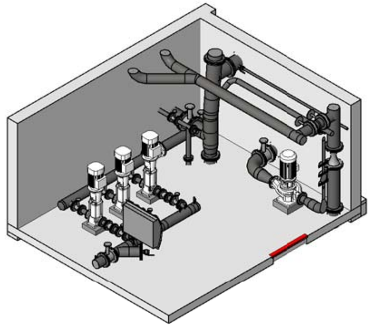
2 Bassenger og filter



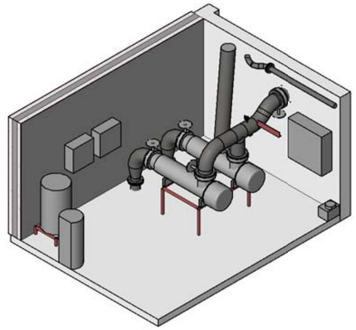
3 JKL-rom



4 Råvannspumper



5 Rentvannspumper



6 UV

Tegningsnummer:			Revisjon:
PC001			0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A-	TILBUDSTEGNING	2013-10-21		
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TILBUDSTEGNINGER

asplan viak

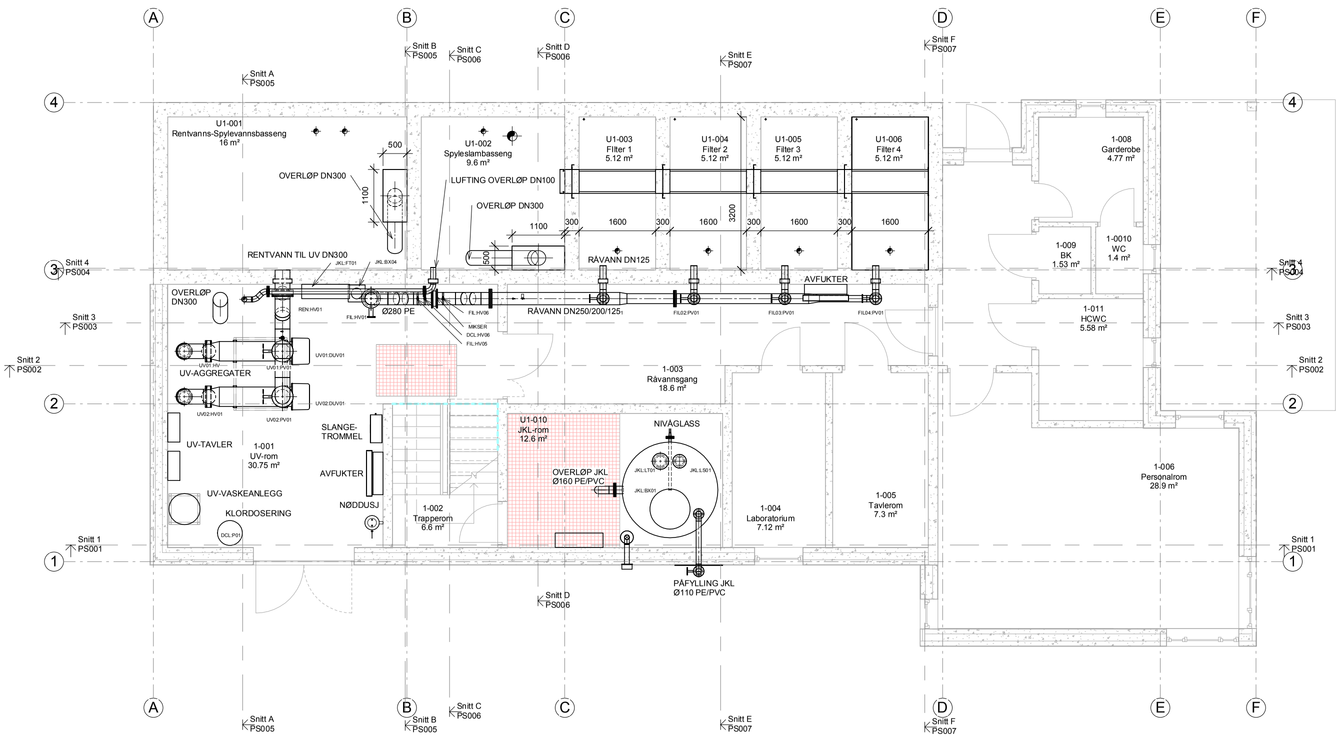
Prosjekt:
Treungen vv

Oppdragsgiver:
Nissedal kommune

3D visninger

Prosessanlegg

Oppdragsleder:	Tegn:	Målestokk
PHT	MM	(A1)
Oppdragsnr.:	Kontr:	Dato:
527056	PHT	2013-10-21
Tegn. nr:		Rev.
PC001		**0A**



1 Nivå 1
1 : 50

Tegningsnummer: PP01001	Revisjon: 0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		

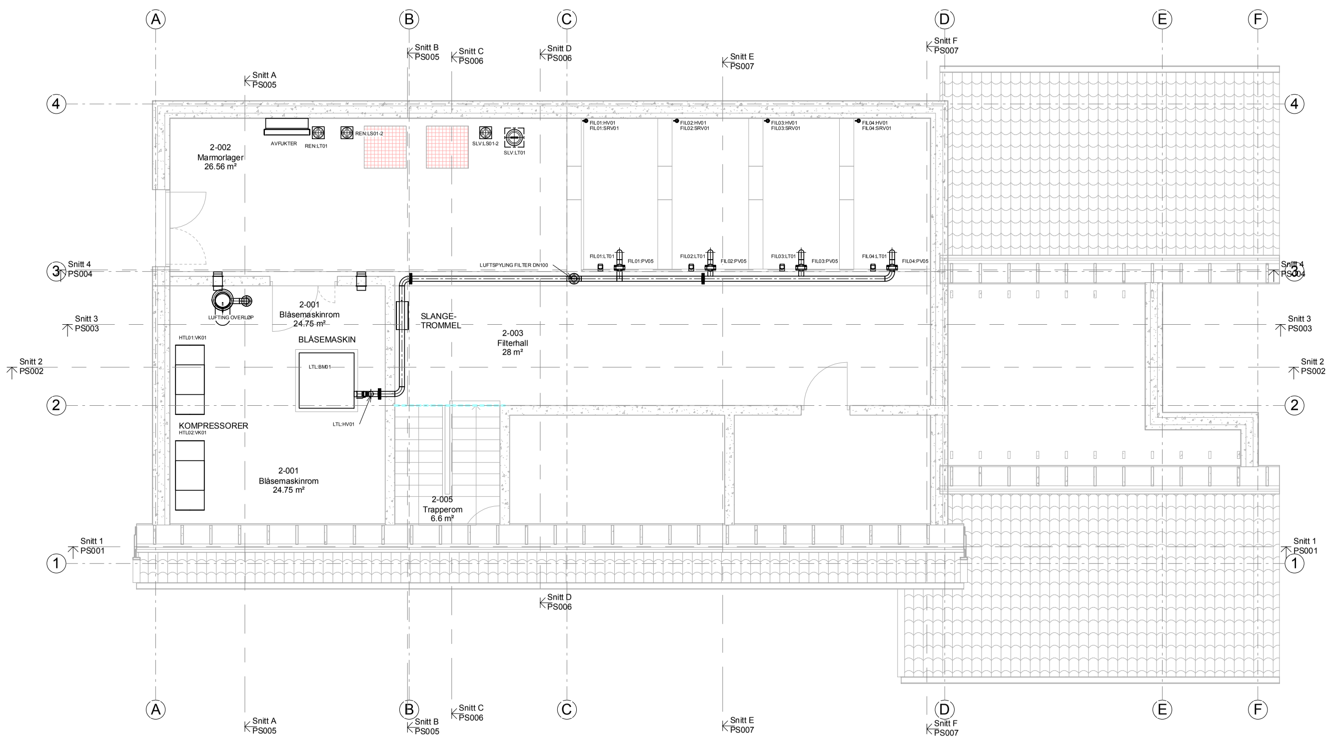
TILBUDSTEGNINGER

asplan viak

Prosjekt: Treungen vv
Oppdragsgiver: Nissedal kommune

Plan 1
Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PP01001**		Rev: **0A**



1 Nivå 2
1 : 50

Tegningsnummer: PP02001	Revisjon: 0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		

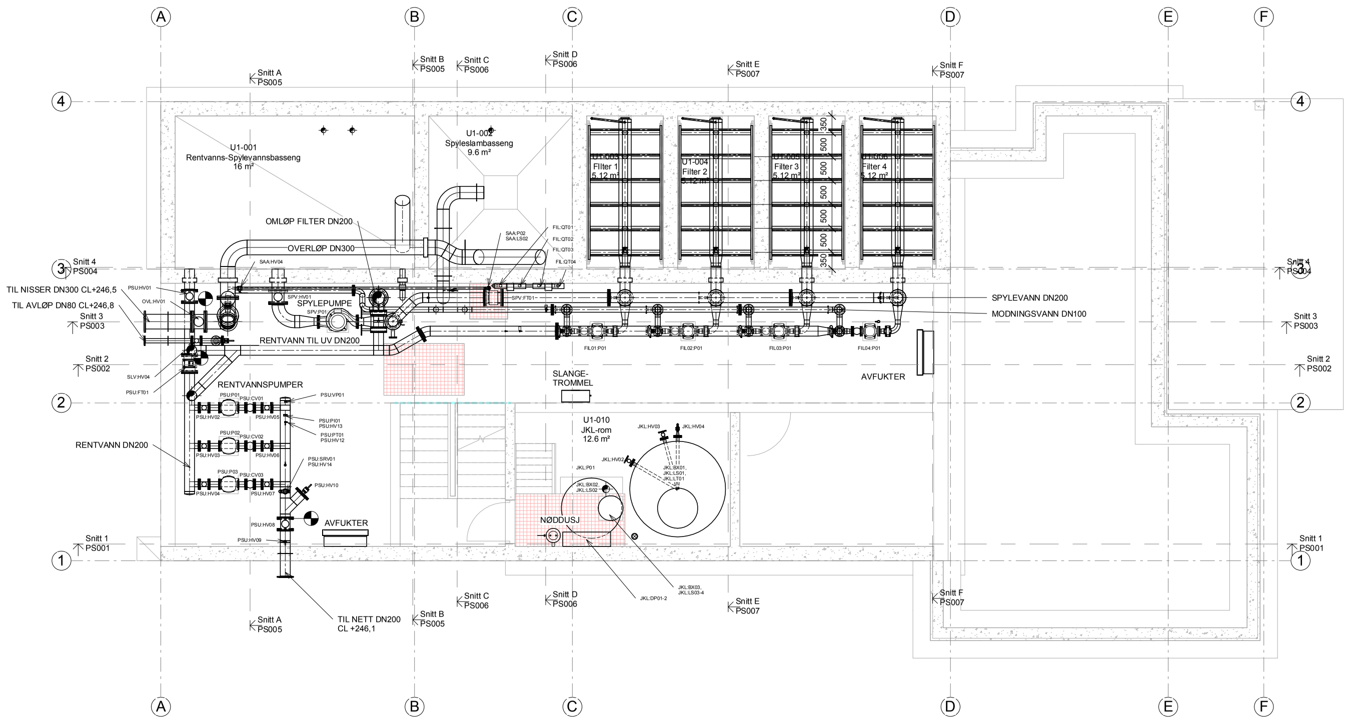
TILBUDSTEGNINGER

asplan viak

Prosjekt:
Treungen vv
Oppdragsgiver:
Nissedal kommune

Plan 2
Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PP02001**		Rev: **0A**



1 Nivå U1
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Tegningsnummer: PPU1001	Revisjon: 0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		

TILBUDSTEGNINGER

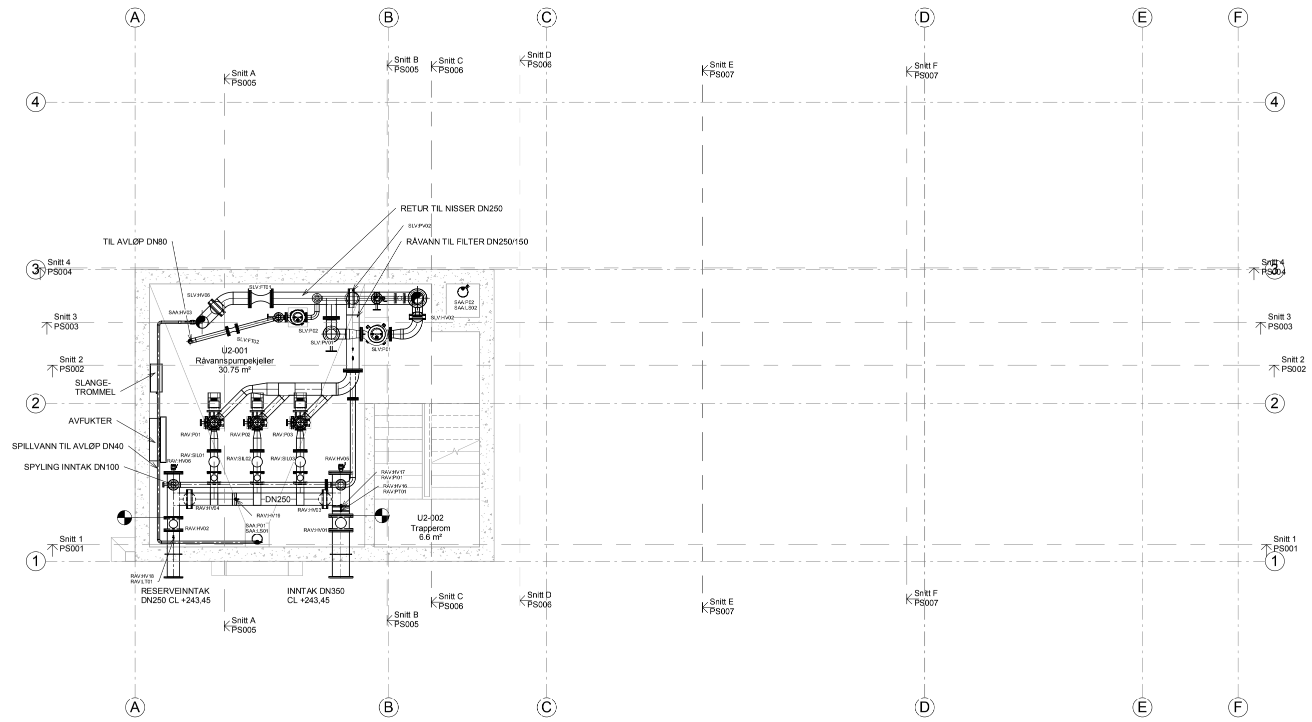
asplan viak

Prosjekt:
Treungen vv
Oppdragsgiver:
Nissedal kommune

Plan U1
Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr: 527056	Kontr: PHT	Dato: 2013-10-21

Tegn. nr: **PPU1001**
Rev: **0A**



1 Nivå U2
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Tegningsnummer: PPU2001	Revisjon: 0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		

TILBUDSTEGNINGER

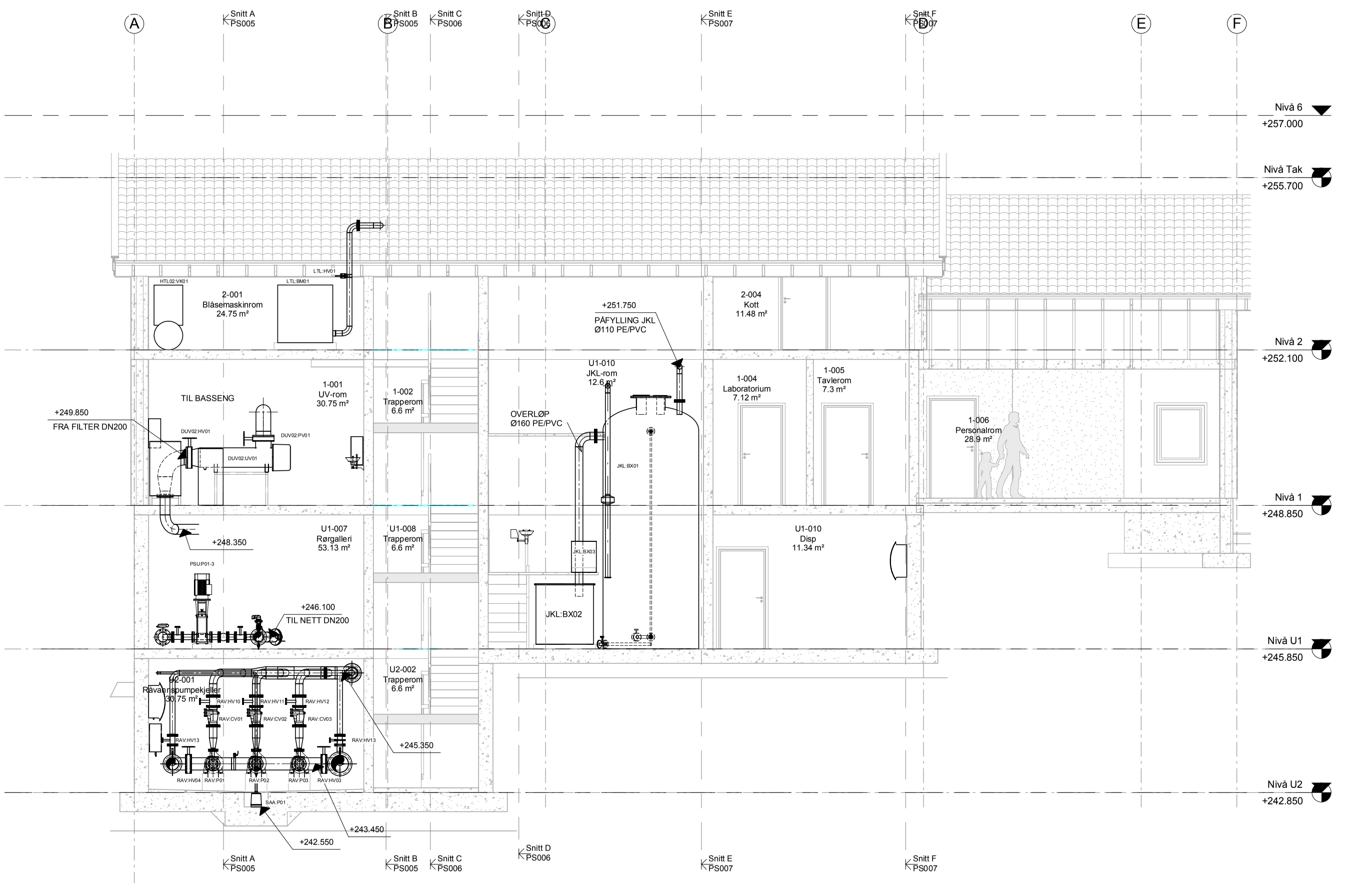
asplan viak

Prosjekt: Treungen vv
Oppdragsgiver: Nissedal kommune

Plan U2
Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr.: 527056	Kontr: PHT	Dato: 2013-10-21

Tegn. nr: **PPU2001** Rev: **0A**
Fag Type Etg. Løpenr.



1 **Snitt 1**
1 : 50

Tegningsnummer:	Revisjon:
PS001	0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A -	TILBUDSTEGNING	2013-10-21		
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TILBUDSTEGNINGER

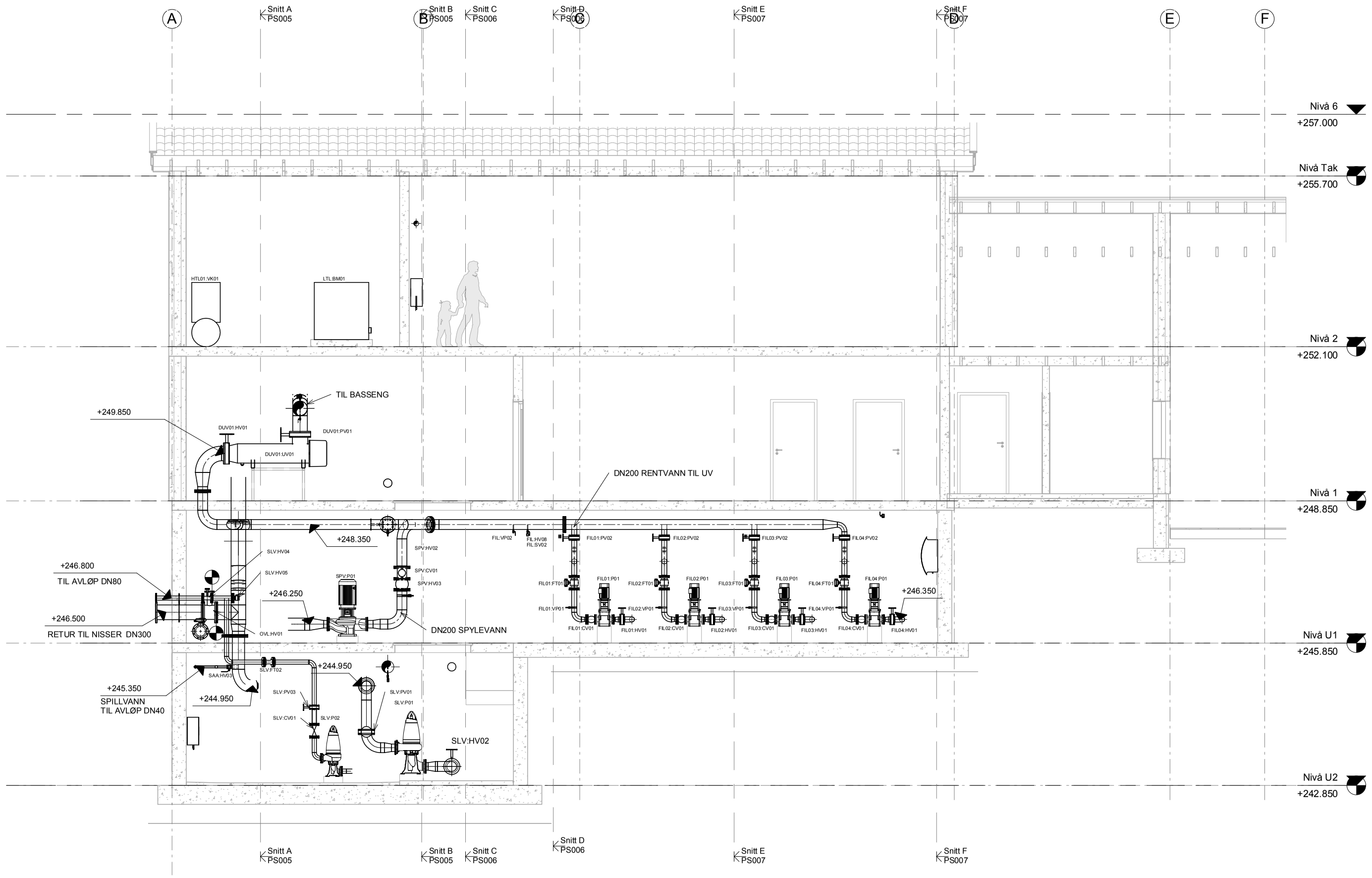
asplan viak

Prosjekt:
Treungen vv
Oppdragsgiver:
Nissedal kommune

Snitt 1
Prosessanlegg

Oppdragsleder:	Tegn:	Målestokk
PHT	MM	1 : 50 (A1)
Oppdragsnr.:	Kontr:	Dato:
527056	PHT	2013-10-21

Tegn. nr: **PS001** Rev. **0A**



1 Snitt 2
1 : 50

Tegningsnummer: PS002	Revisjon: 0A
Rev. 0A	Tekst: TILBUDSTEGNING
Rev.dato: 2013-10-21	

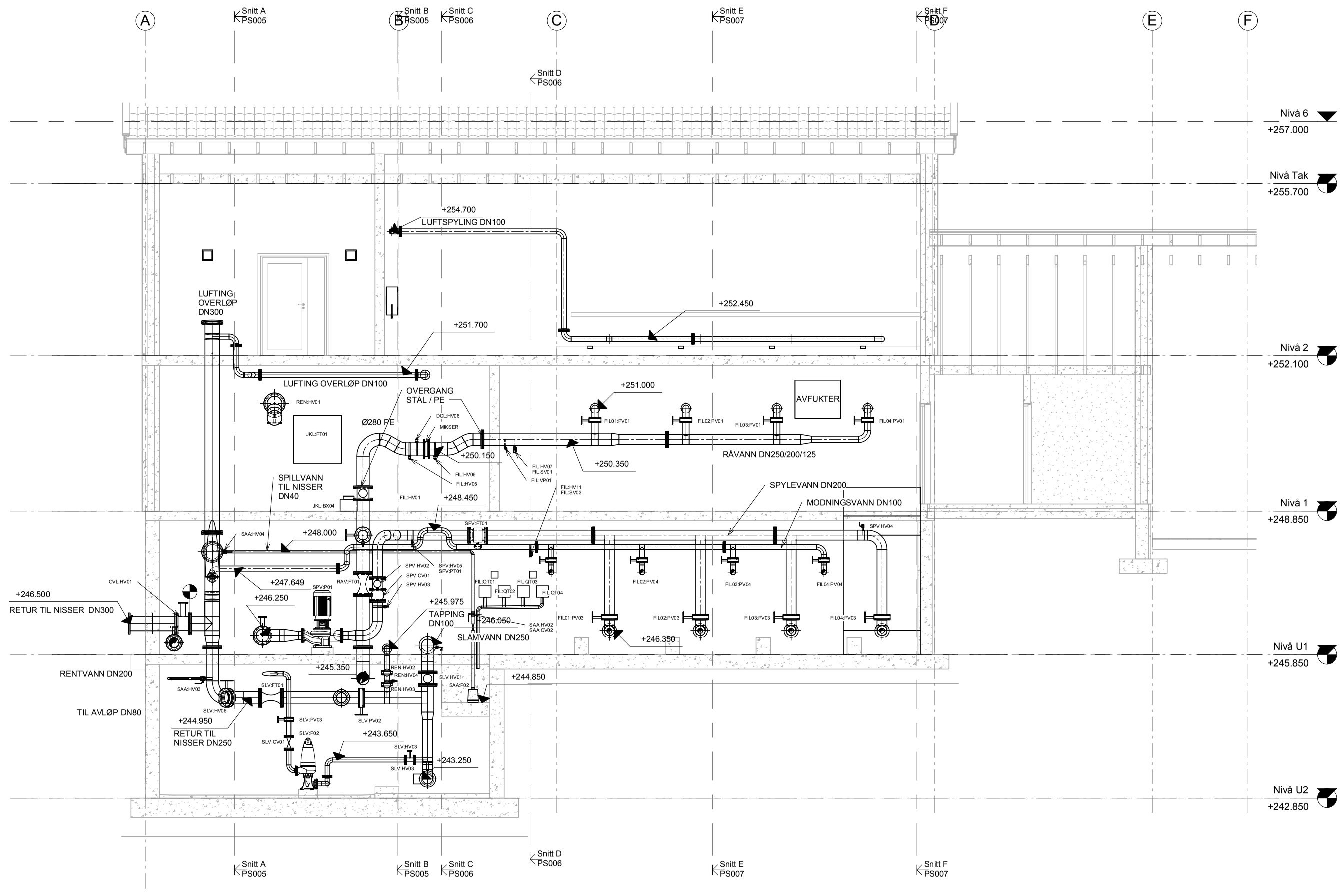
TILBUDSTEGNINGER

asplan viak

Prosjekt: Treungen vv
Oppdragsgiver: Nissedal kommune

Snitt 2
Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PS002**		Rev: **0A**



1 Snitt 3
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Tegningsnummer: PS003	Revisjon: 0A
Rev. 0A	Tekst: TILBUDSTEGNING	Rev dato: 2013-10-21

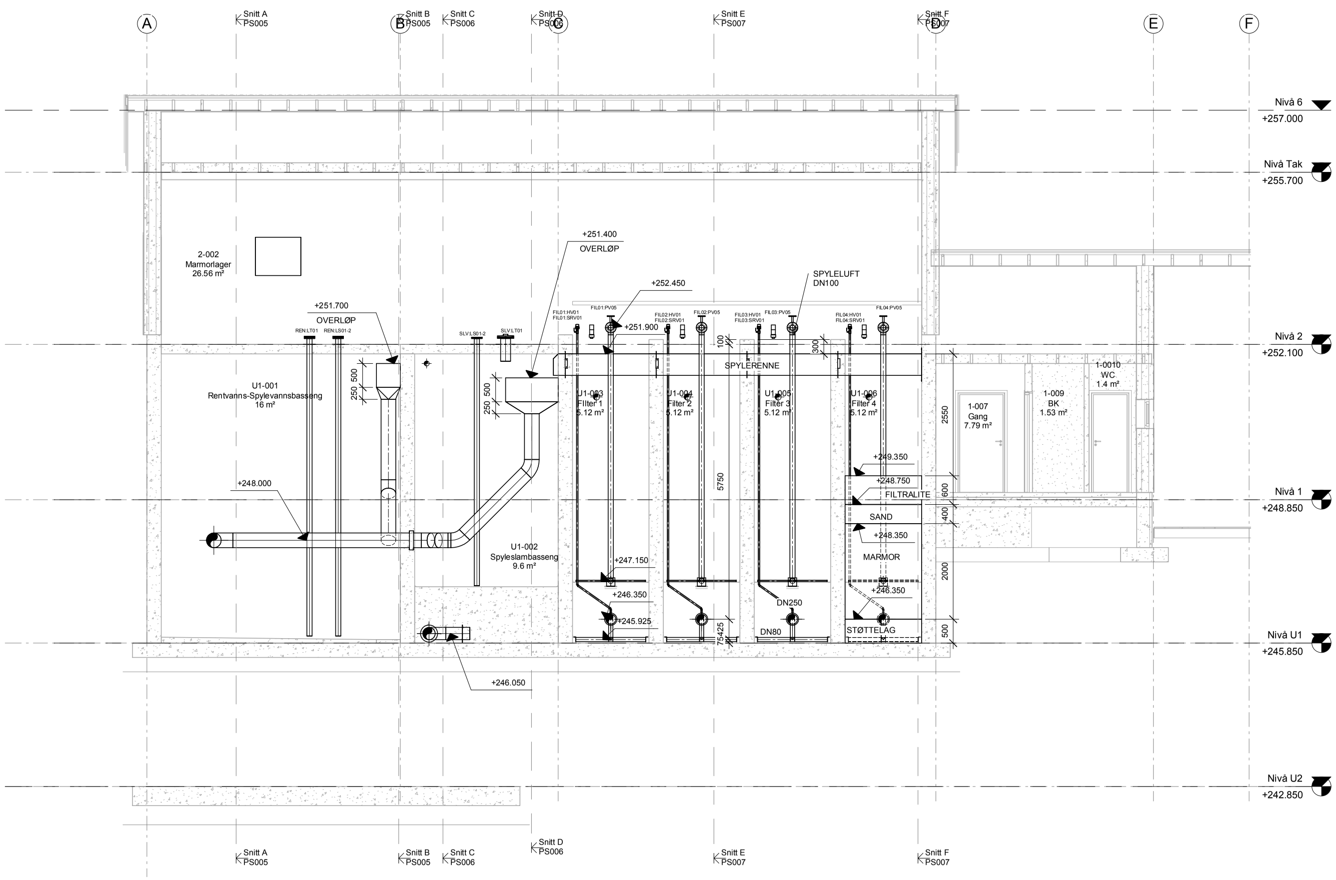
TILBUDSTEGNINGER

asplan viak

Prosjekt: Treungen vv
Oppdragsgiver: Nissedal kommune

Snitt 3
Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PS003**		Rev: **0A**



1 Snitt 4
1 : 50

Tegningsnummer: PS004	Revisjon: 0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		

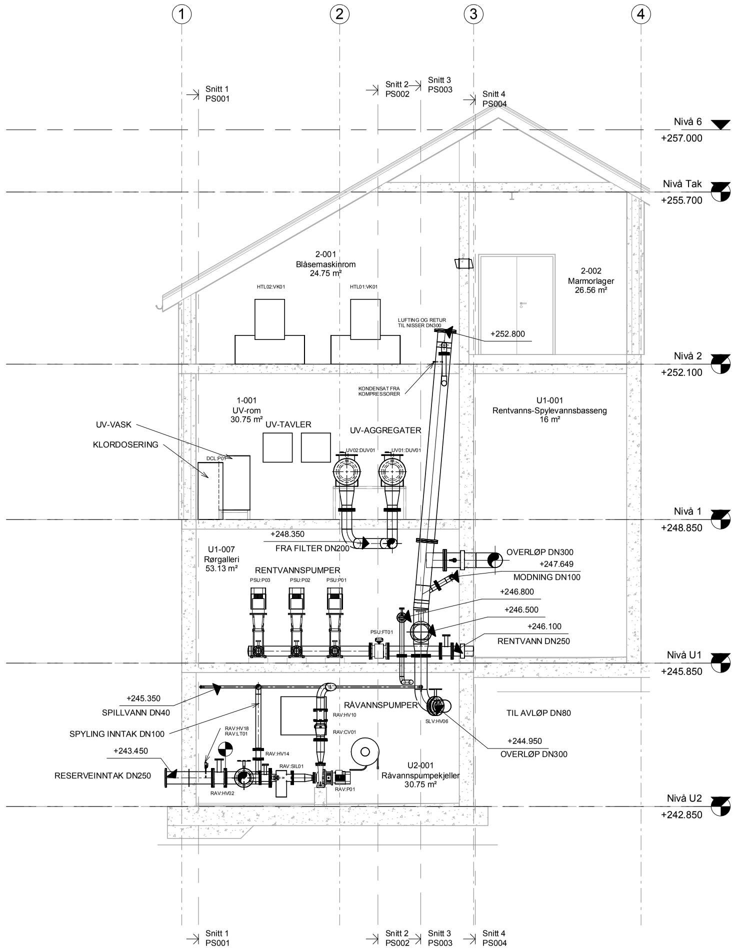
TILBUDSTEGNINGER

asplan viak

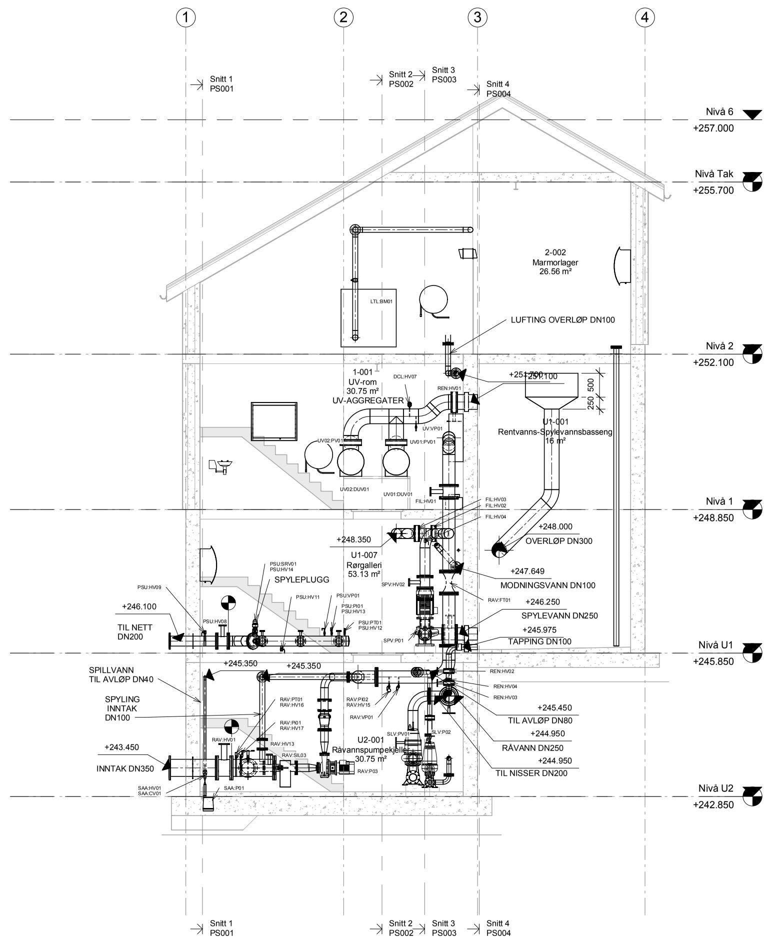
Prosjekt: Treungen vv
Oppdragsgiver: Nissedal kommune

Snitt 4
Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PS004**		Rev: **0A**



1 Snitt A
1 : 50



2 Snitt B
1 : 50

Tegningsnummer: PS005			Revisjon: 0A
Rev.	Tekst:	Rev dato:	Tegn: Kontr:
0A	TILBUDSTEGNING	2013-10-21	

TILBUDSTEGNINGER

asplan viak

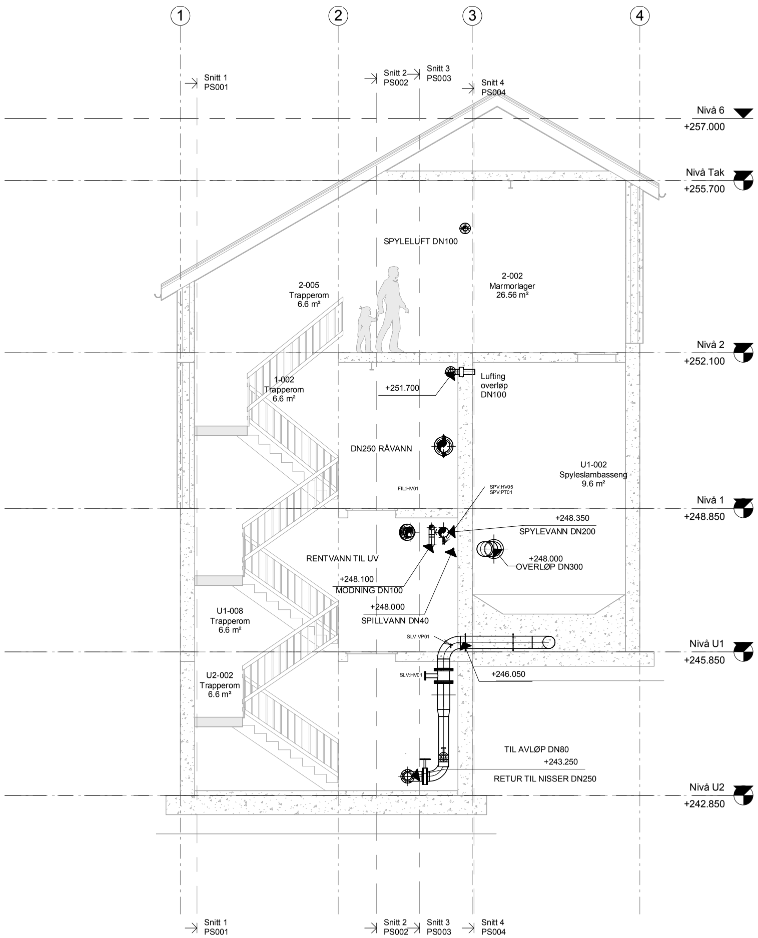
Prosjekt: Treungen vv

Oppdragsgiver: Nissedal kommune

Snitt A og B

Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr.: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PS005**		Rev: **0A**



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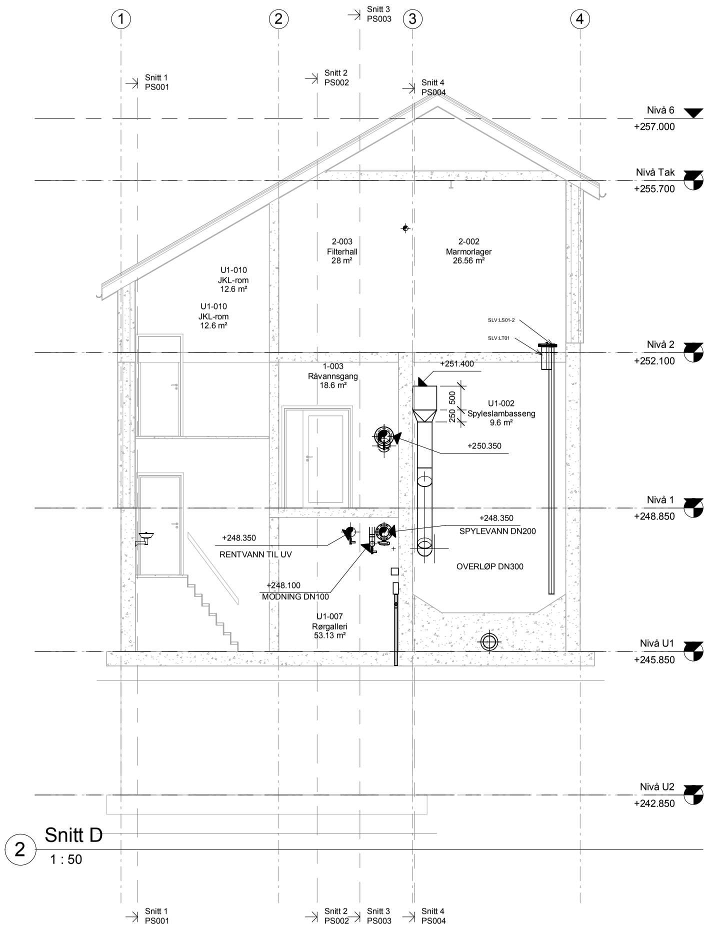
1 : 50



2 Snitt D
1 : 50

Tegningsnummer: **PS006**	Revisjon: **0A**
Rev. 0A Tekst: TILBUDSTEGNING	Rev.dato: 2013-10-21

TILBUDSTEGNINGER

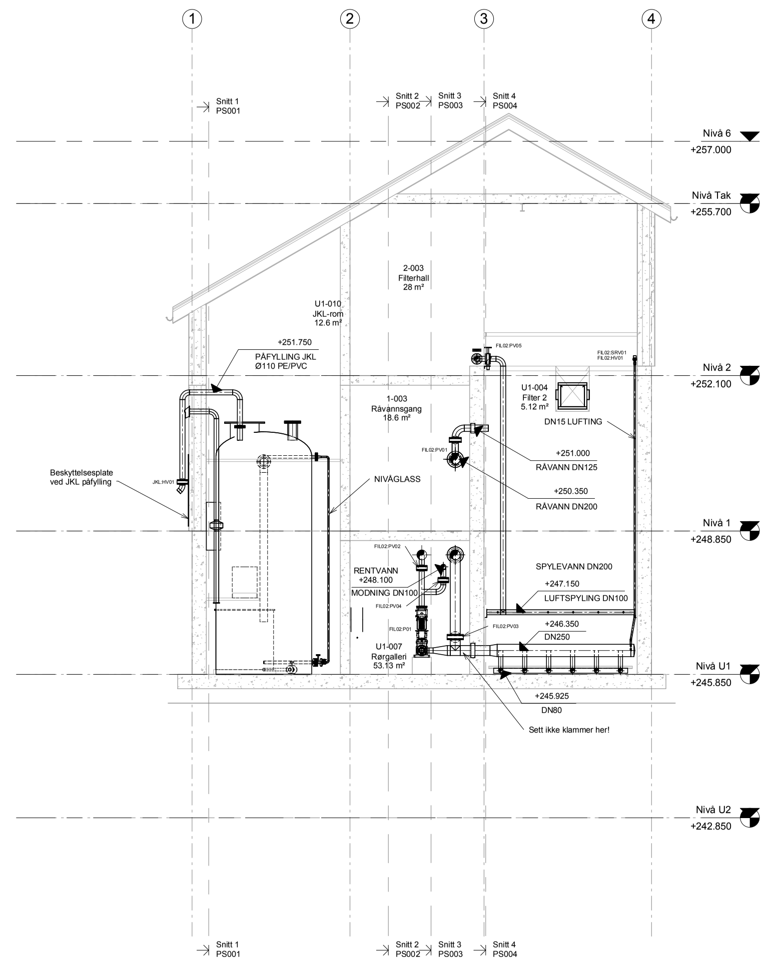
asplan viak

Prosjekt:
Treungen vv
Oppdragsgiver:
Nissedal kommune

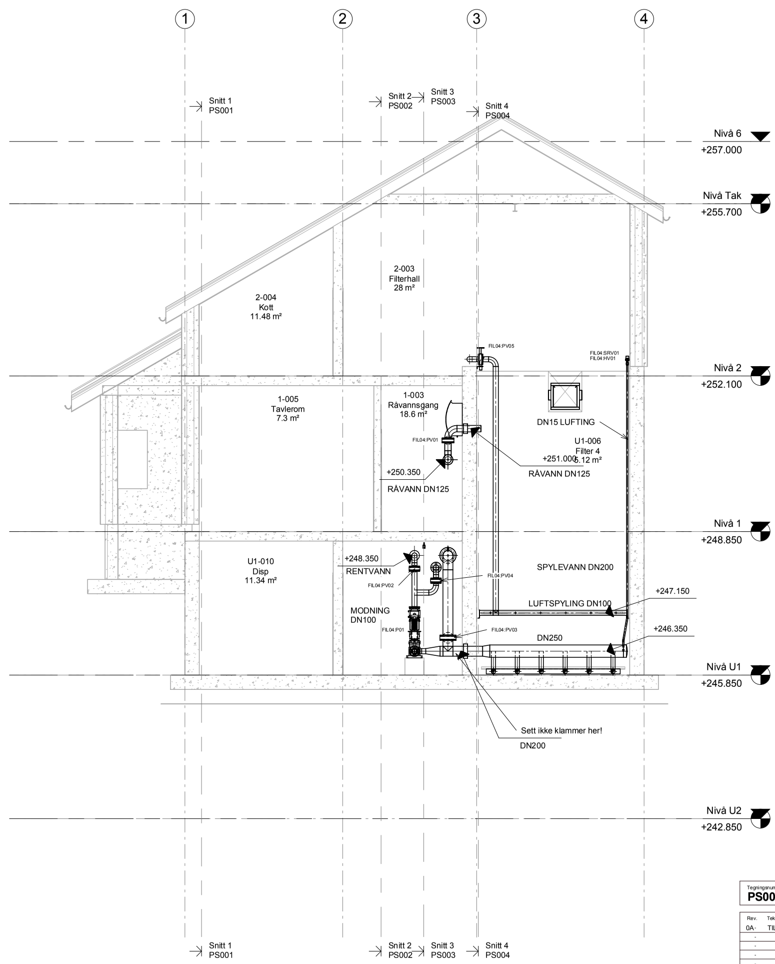
Snitt C og D
Prosessanlegg

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr: 527056	Kontr: PHT	Dato: 2013-10-21

Tegn. nr: **PS006** Rev: **0A**



2 Snitt E
1 : 50



1 Snitt F
1 : 50

Tegningsnummer: PS007	Revisjon: 0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		

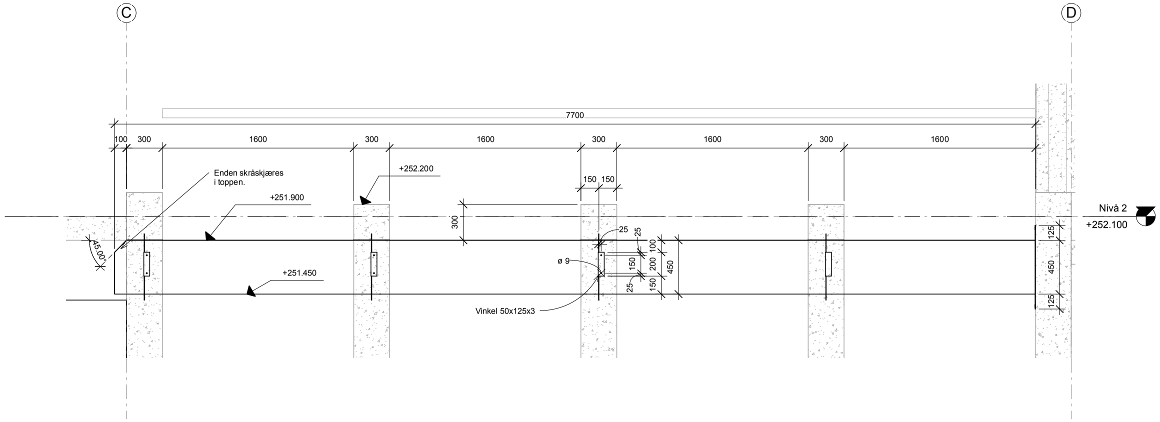
TILBUDSTEGNINGER

asplan viak

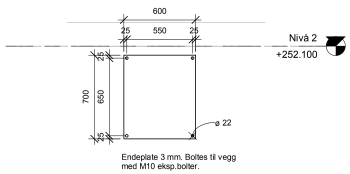
Prosjekt: Treungen vv
Oppdragsgiver: Nissedal kommune

Snitt E og F
Prosessanlegg

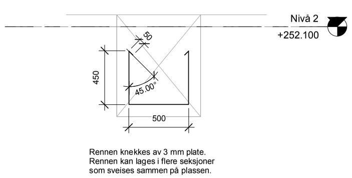
Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 50 (A1)
Oppdragsnr: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PS007**		Rev: **0A**



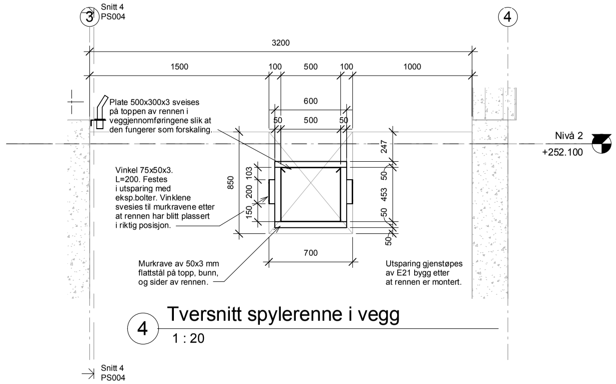
1 Lengdesnitt spylerenne
1 : 20



2 Endeplate spylerenne
1 : 20



3 Tversnitt spylerenne
1 : 20



4 Tversnitt spylerenne i vegg
1 : 20

Materialkvalitet AISI 304/304 L eller bedre.
Skarpe kanter avrundes.

For å hindre at rennen forspennes på grunn av termisk utvidelse skal gjennstøping av rennen om mulig utføres ved en temperatur på mellom 5 og 10 grader celsius.

Tegningsnummer: PJ001	Revisjon: 0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		

TILBUDSTEGNINGER

asplan viak

Prosjekt: Treungen vv
Oppdragsgiver: Nissedal kommune

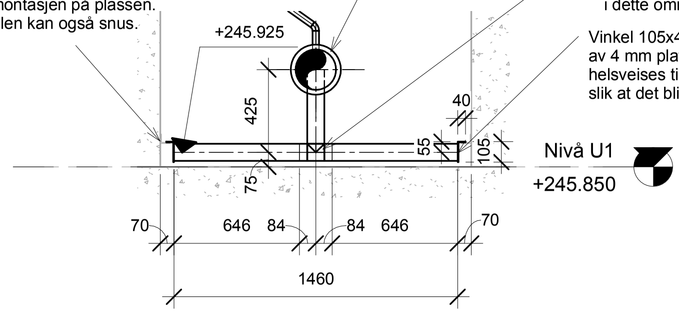
Detalj Spylerenne

Oppdragsleder: PHT	Tegn: MM	Målestokk: 1 : 20 (A1)
Oppdragsnr.: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: PJ001		Rev: 0A

Vinkel 50x50x5. Med hull Ø9 cc 150 mm for bolting til vegg. Delsveises til vinkel på slisserør ved montasjen på plassen. Vinkelen kan også snus.

Ø84x2 T-rør eller påstikk. Det skal ikke være slisser i dette området.

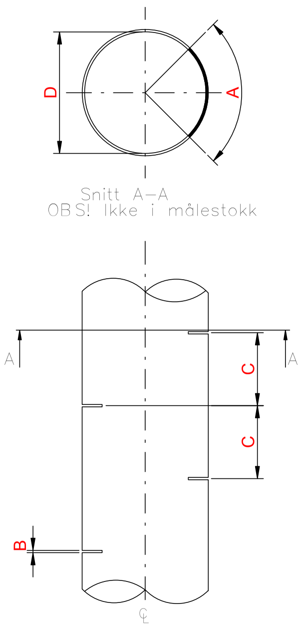
Vinkel 105x40 knekt av 4 mm plate. Slisserør helsveises til vinkelen slik at det blir tett.



2 Snitt fordelingsrør vann
1 : 25

Materialkvalitet AISI 304/304 L eller bedre.
Det lages 4 rør av denne typen.
Alle mengder er spesifisert pr. rør.

Tag.	Spesifikasjon for slisserør Slissene skal LASER skjeres	Mengde:	Enh.:
A	Vinkel på slisse	90	grader
B	Bredde på slisse	1,5	mm
C	Senteravstand slisser OBS! Annnenhver side	28	mm
D	Diameter slisserør	80	mm

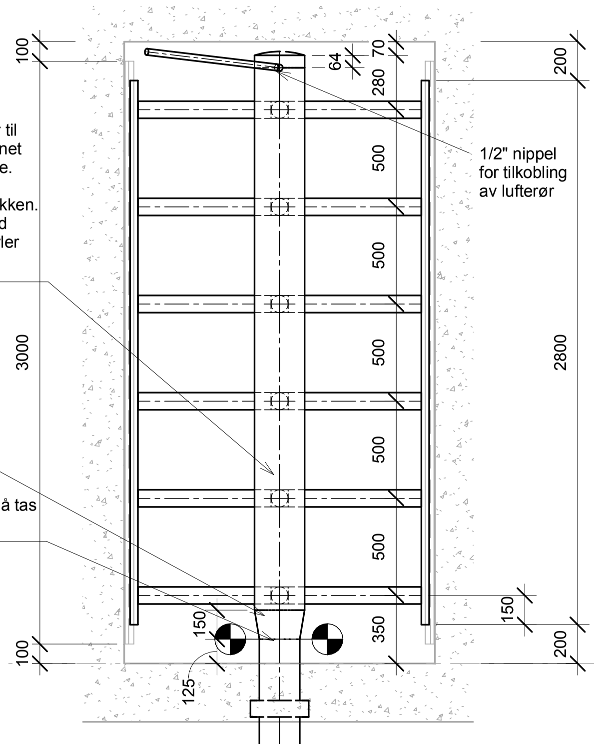


OBS! Klamringen med vinkler til bassengveggen er kun beregnet for å bære/fiksere slisserørene. Slisserørene er for svake til å kunne bære DN250 samlestokken. Denne må derfor klamres med minst 3 stykk klamre med søyler av rør/firkantrør som føres ned til dekket.

1/2" nippel for tilkobling av lufterør

DN250/200 overgang

OBS! Sveis mot DN200 rør må tas på plassen etter at røret er montert i filteret.



1 Plan fordelingsrør vann
1 : 25

Tegningsnummer:	Revisjon:
PJ002	0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		
-				
-				
-				
-				
-				
-				
-				
-				

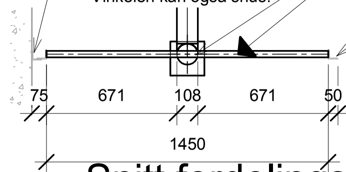
TILBUDSTEGNINGER

asplan viak

Prosjekt:
Treungen vv
Oppdragsgiver:
Nissedal kommune

Detalj Fordelingsrør for vann

Oppdragsleder: PHT	Tegn: MM	Målestokk 1 : 25 (A3)
Oppdragsnr.: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PJ002** (Fag Type Etg. Løpenr.)		Rev. **0A**

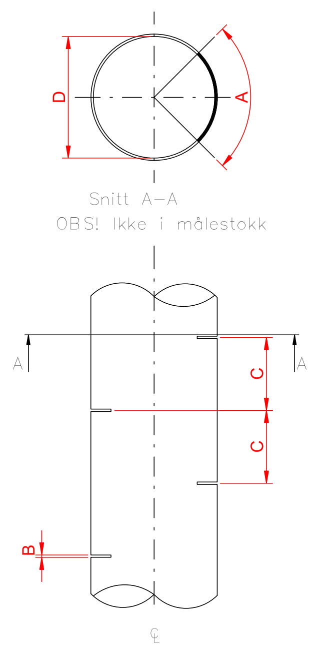


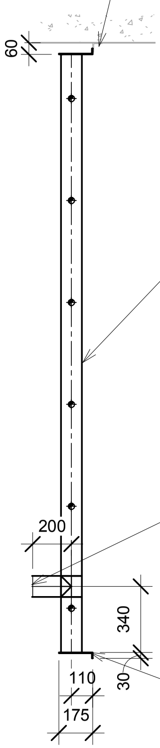
2 Snitt fordelingsrør luft

1 : 25

Materialkvalitet AISI 304/304 L eller bedre.
Det lages 4 rør av denne typen.
Alle mengder er spesifisert pr. rør.

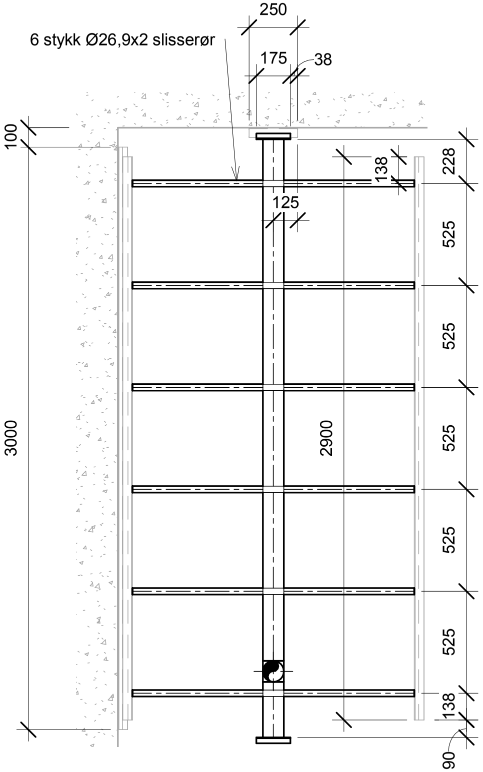
Tag.	Spesifikasjon for slisserør Slissene skal LASER skjeres	Mengde:	Enh.:
A	Vinkel på slisse	60	grader
B	Bredde på slisse	0,2	mm
C	Senteravstand slisser OBS! Annnenhver side	35	mm
D	Diameter slisserør	Ø26,9x2	mm





3 Lengdesnitt fordelingsrør luft

1 : 25



Tegningsnummer: PJ003	Revisjon: 0A

Rev.	Tekst:	Rev.dato:	Tegn:	Kontr:
0A	TILBUDSTEGNING	2013-10-21		
-				
-				
-				
-				
-				
-				
-				
-				

TILBUDSTEGNINGER

asplan viak

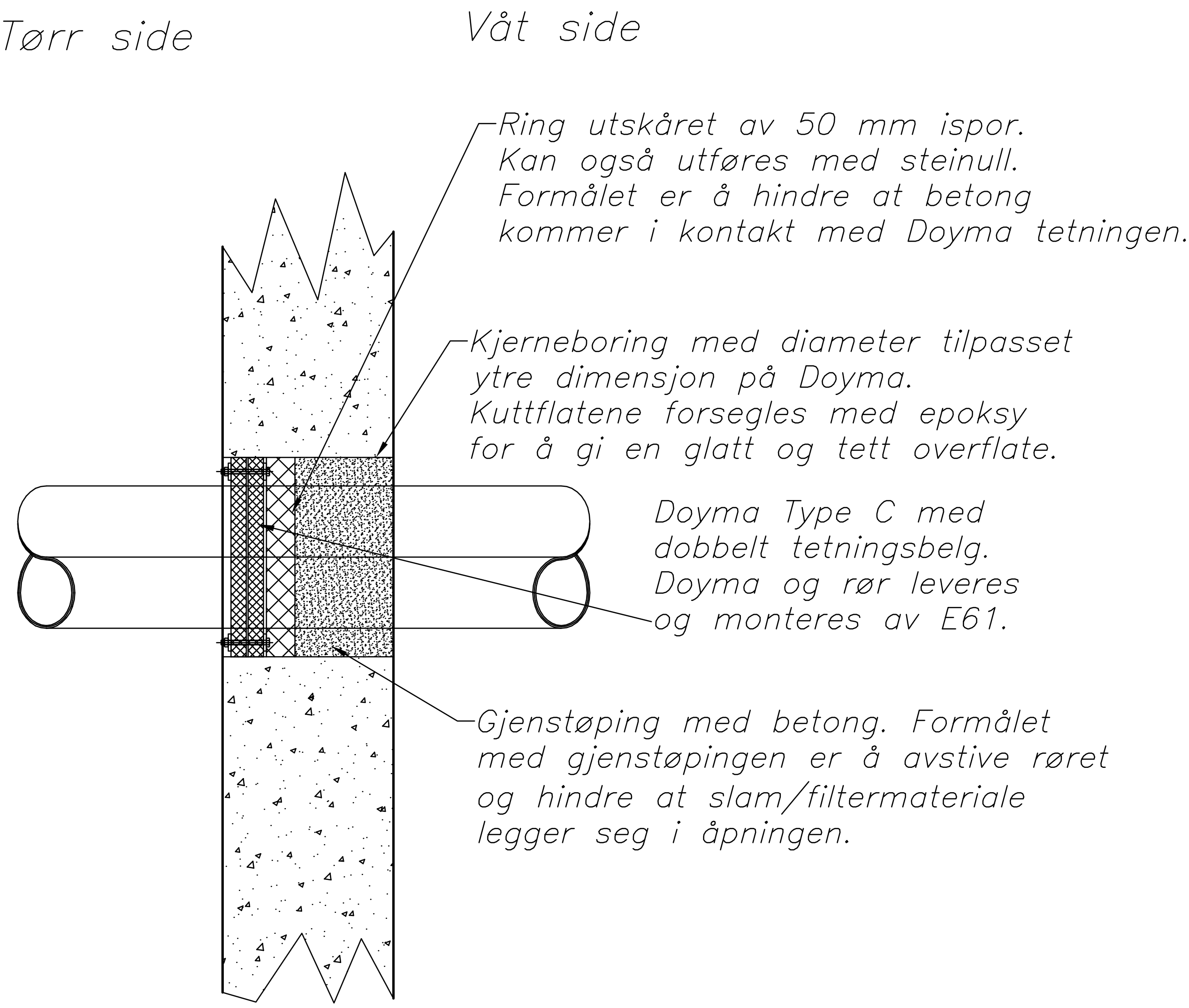
Prosjekt:
Treungen vv

Oppdragsgiver:
Nissedal kommune

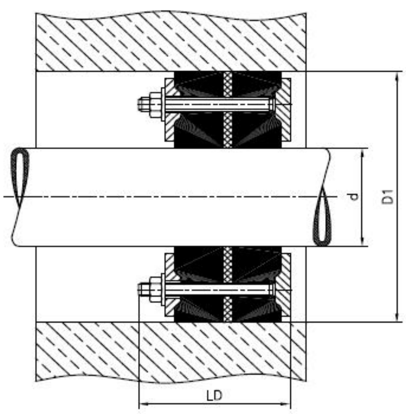
Detalj Fordelingsrør luft

Oppdragsleder: PHT	Tegn: MM	Målestokk 1 : 25 (A3)
Oppdragsnr.: 527056	Kontr: PHT	Dato: 2013-10-21
Tegn. nr: **PJ003**		Rev. **0A**

Fag Type Etg. Løpenr.



Pipe/Cable external diameter d [mm]	Pipe sleeve/ core bore D_1 [NB in mm]
1 - 24	50*
1 - 40	80
41 - 57	100
58 - 77	125
78 - 104	150
105 - 145	200
146 - 190	250
191 - 233	300
234 - 288	350
289 - 339	400
340 - 380	450
381 - 430	500
431 - 530	600
531 - 620	700
L_D (max. overall length) [mm]: 85	



Rev.	Tekst:	Rev.dato:	Kontr:
-			
-	- -		
-			
-			
-			
-			
-			
-			

TILBUDSTEGNING

asplan viak

Prosjekt:
Treungen VBA
Oppdragsgiver:
Nissedal kommune

Detalj av rørgjennomføring
med Doyma tetning

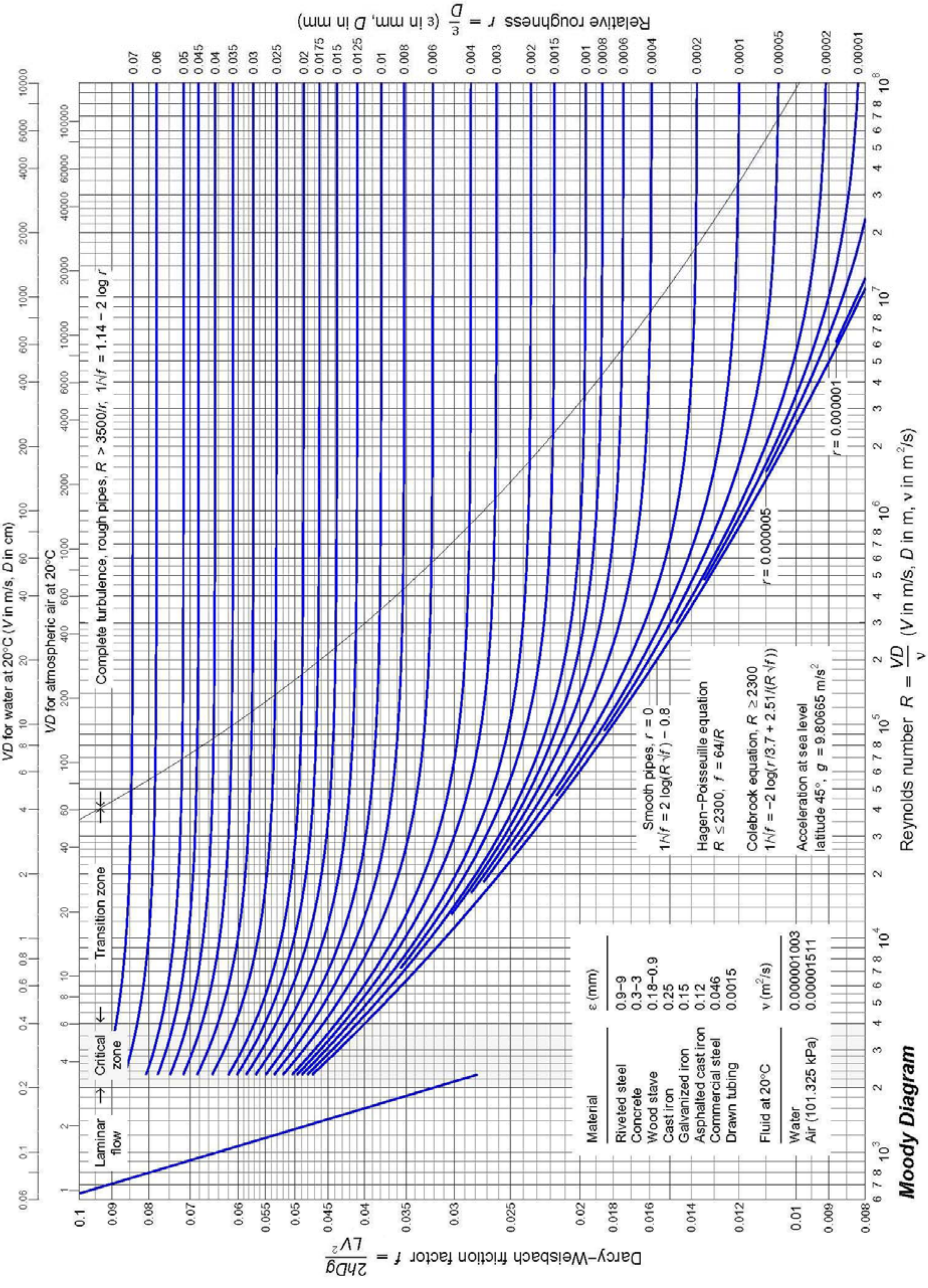
Oppdragsleder:	Tegn:	Målestokk
PHT	MM	-
Oppdragsnr.:	Kontr:	Dato:
527056	MM	2013-10-21

Tegn. nr: **B J 001** (Fag Type Etg. Løpenr.)
Rev.: **01-A**

Appendix B:

Moody Diagram

MOODY DIAGRAM



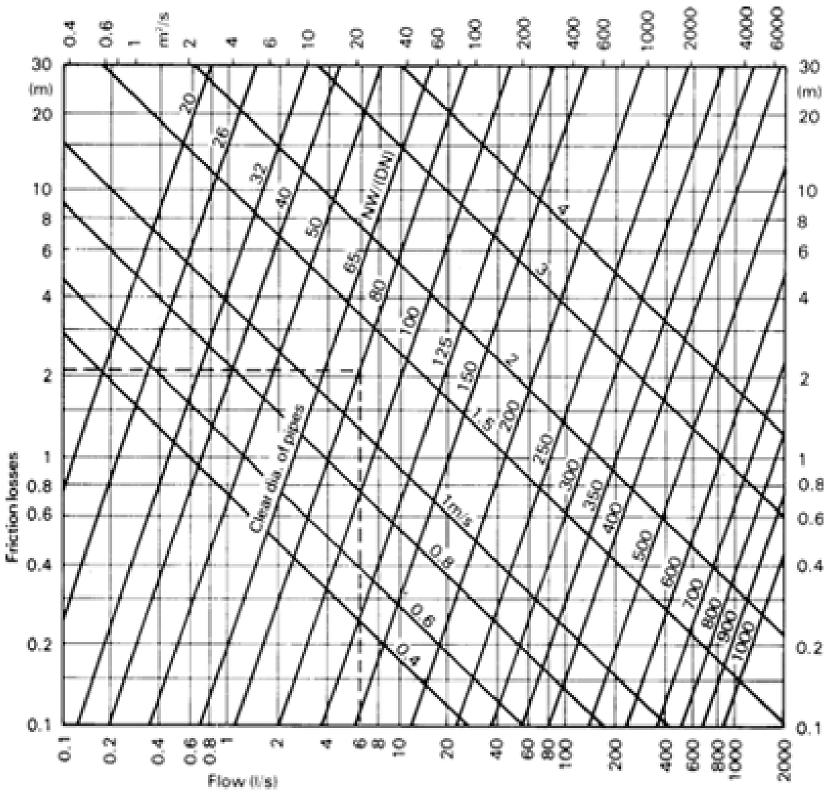
Material	ε (mm)
Riveted steel	0.9–9
Concrete	0.3–3
Wood stave	0.18–0.9
Cast iron	0.25
Galvanized iron	0.15
Asphalted cast iron	0.12
Commercial steel	0.046
Drawn tubing	0.0015

Fluid at 20°C	ν (m²/s)
Water	0.000001003
Air (101.325 kPa)	0.00001511

Friction factors for any type and size of pipe. (From Pipe Friction Manual, 3rd ed., Hydraulic Institute, New York, 1961)

Appendix C:

Colebrook Diagram



Friction losses in metres per 100m for a new pipeline of cast iron

For other types of pipe multiply the friction loss as indicated by the table by the factors given below:

New Rolled steel	–	0.8
New plastic	–	0.8
Old rusty cast iron	–	1.25
Pipes with encrustations	–	1.7

Appendix D:

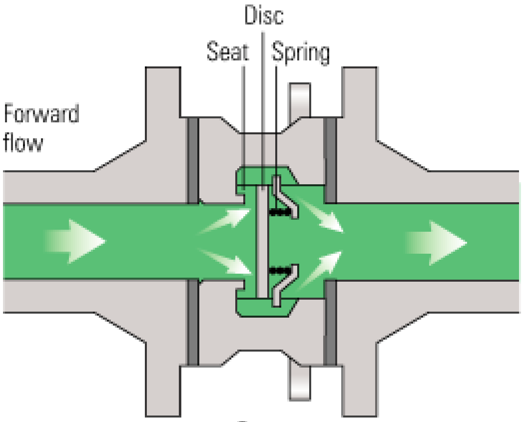
Examples of Singular Loss Coefficients

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

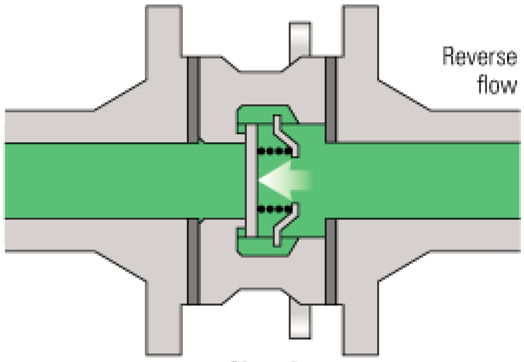
Values from wikiengineer.com, reference: Larock, Jeppson, & Watters, "Hydraulics of Pipeline Systems", 2000	
Globe valve (fully open)	6,4
Globe valve (half open)	9,5
Angle valve (fully open)	5,0
Swing check valve (fully open)	2,5
Butterfly valve (fully open)	0,4
Gate valve (fully open)	0,2
Gate valve (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 (180º)	2,2
Standard tee	1,8
Standard (short radius) elbow (90º)	0,9
Medium radius elbow (90º)	0,7
Long sweep elbow (90º)	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

Appendix E:

Example Check Valve Diagram



Open



Closed

Appendix F:

Pre Intake Pump Filter Diagram

Pipeline Strainer
Cast Construction
Permanent Media

Simplex Basket Strainer

Model 72

- Sizes 3/8" to 8"
- Iron, bronze, carbon steel or stainless steel
- Threaded or flanged

Features

- Quick open cover—no tools needed
- Heavy wall construction
- Large capacity baskets
- Machined basket seat
- Threaded drain
- Mounting feet for stable installation for flanged units 2" and larger
- Perforated or mesh 316 stainless steel basket
- American Bureau of Shipping (ABS) Type Approved for ship designers, builders and owners

Options

- Basket perforations from 1/32" to 1/2"
- Basket mesh from 20 to 400
- MONEL® baskets
- Viton®, PTFE encapsulated or EPDM seals
- Vent valves
- Gauge/vent taps - 1/4" NPT
- Magnetic basket inserts
- Pressure differential gauge and switch
- Flange according to DIN EN

MONEL® is a registered trademark of Special Metals Corporation group of Companies.
Viton® is a registered trademark of E. I. du Pont de Nemours and company.

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The Eaton Model 72 has been the industry standard simplex basket strainer for more than 75 years. It is perfect for industrial and commercial applications in which the line can be temporarily shut down for strainer basket cleaning or changeout.

A reason for its popularity is the unusually large basket capacity. The free straining area with a perforated basket is a minimum of six times the cross sectional pipe area. No tools are needed to open the cover. The quick opening, swinging yoke can be disassembled and the basket removed in seconds. On sizes 4" and larger, a special cover clamp is provided to distribute the seating pressure and to ensure positive seating of the cover.

Another feature is a threaded drain on every size strainer (fitted with a yoke quick-closer). Sizes 2" and larger are equipped with legs that bolt to the floor for rock solid installation.

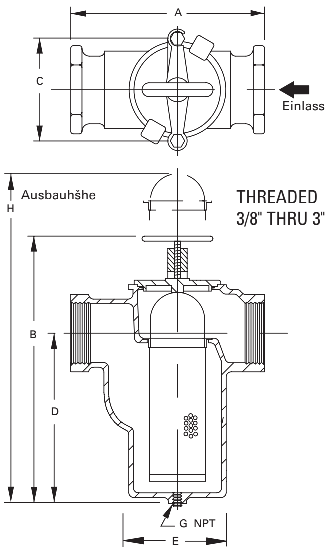
Wall thicknesses are exceptionally heavy. The basket seats are precision machined to give a tight seal and prevent any material from bypassing the basket. The Eaton Model 72 simplex basket strainer is a top quality, heavy-duty unit designed to stand up to the most demanding of applications.

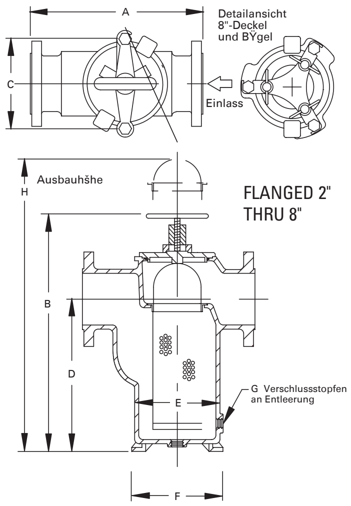
Model 72 simplex

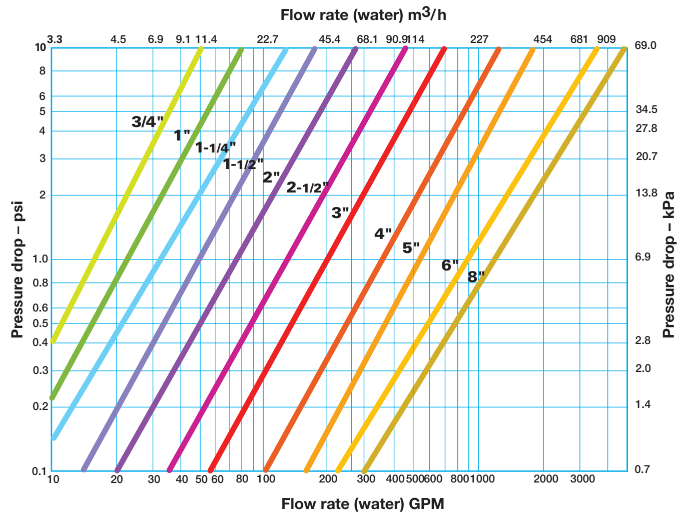
Size	Material	End connection	Seals	Pressure rating*
3/8" to 3"	Iron and bronze	Threaded	Buna-N®	200 psi (13.8 bar)
1" To 3"	Carbon steel	Threaded	Buna-N	200 psi (13.8 bar)
1" To 3"	Stainless steel	Threaded	Viton	200 psi (13.8 bar)
1" To 8"	Iron	Flanged 125#	Buna-N	200 psi (13.8 bar)
1" To 8"	Bronze	Flanged 150#	Buna-N	200 psi (13.8 bar)
1" To 8"	Carbon steel	Flanged 150#	Buna-N	200 psi (13.8 bar)
1" To 8"	Stainless steel	Flanged 150#	Viton	200 psi (13.8 bar)

* @ 100 ˚ F (38 ˚C)

Model 72 Simplex Basket Strainer







Threaded Model 72 dimensions (in/mm)

Dimensions and weights are for reference only. Contact Eaton for certified drawings.

Size	A	B	C	D	E	F	G	H	Net Wt (lb / kg) Bronze	Carbon Steel	Iron	Stainless Steel
⅜	4.00 / 102	6.63 / 168	2.88 / 73	4.00 / 102	2.38 / 60	–	⅜	11 / 279	4 / 1.8	–	4 / 1.8	–
½	4.00 / 102	6.63 / 168	2.88 / 73	4.00 / 102	2.38 / 60	–	⅜	11 / 279	4 / 1.8	–	4 / 1.8	–
¾	5.38 / 137	8.38 / 213	4.00 / 102	5.00 / 127	3.06 / 78	–	½	13 / 330	8 / 3.6	–	7 / 3.2	–
1	5.38 / 137	8.38 / 213	4.00 / 102	5.00 / 127	3.06 / 78	–	½	13 / 330	8 / 3.6	7 / 3.2	7 / 3.2	7 / 3.2
1-¼	6.75 / 172	9.88 / 251	4.88 / 124	5.88 / 149	3.88 / 99	–	½	14 / 356	13 / 6	–	12 / 6	–
1-½	7.25 / 184	11.00 / 279	4.88 / 124	7.00 / 178	4.00 / 102	–	¾	16 / 406	16 / 7	15 / 7	15 / 7	16 / 7.3
2	8.75 / 222	13.38 / 340	6.75 / 172	7.63 / 194	5.13 / 130	–	1-¼	21 / 533	32 / 15	36 / 16	28 / 13	31 / 14
2-½	10.38 / 264	14.88 / 378	8.00 / 203	8.63 / 219	6.38 / 162	–	1-½	26 / 660	49 / 22	52 / 24	42 / 19	51 / 23
3	11.50 / 292	17.75 / 468	8.00 / 203	11.38 / 298	6.63 / 168	–	1-½	28 / 711	60 / 27	60 / 27	52 / 23	60 / 27

Mod. 72 C_V factors*

Size	Value	Size	Value
⅜"	15.0	2"	73
½"	15.0	2-½"	125
¾"	15.0	3"	180
1"	22.5	4"	350
1-¼"	31.5	6"	900
1-½"	46.0	8"	1400

* For water with clean, perforated basket

Flanged Model 72 dimensions (in/mm)

Dimensions and weights are for reference only. Contact Eaton for certified drawings.

Size	A	B	C	D	E	F	G	H	Net Wt (lb / kg) Carbon Bronze	Steel	Stainless Iron	Steel
1	7.63 / 194	8.38 / 213	4.00 / 102	5.00 / 127	–	–	1⁄2	13.00 / 330	16 / 7	9 / 4	9 / 4	9 / 4
1 1⁄2	10.25 / 260	11.00 / 279	4.88 / 124	7.00 / 178	–	–	3⁄4	16.00 / 406	30 / 14	17 / 7.7	17 / 7.7	17 / 7.7
2	10.50 / 268	13.75 / 349	6.75 / 172	7.63 / 194	5.13 / 130	6.25 / 159	3⁄8	20.00 / 508	49 / 22.3	36 / 16	36.5 / 17	36 / 16
2 1⁄2	11.63 / 295	15.63 / 397	8.00 / 203	8.88 / 226	6.38 / 162	7.63 / 194	3⁄8	23.00 / 584	64 / 29.1	63 / 27	54 / 25	63 / 29
3	13.13 / 334	18.00 / 457	8.00 / 203	10.63 / 270	6.50 / 165	8.00 / 203	3⁄8	27.00 / 686	85 / 38.6	–	76 / 35	–
3	13.13 / 334	18.75 / 476	7.94 / 202	12.00 / 305	6.50 / 165	8.00 / 203	1⁄2	27.00 / 686	–	86 / 39	–	86 / 39
4	16.75 / 425	19.88 / 505	10.75 / 273	10.75 / 273	9.63 / 245	11.38 / 289	1⁄2	30.00 / 762	140 / 63.6	–	125 / 55	–
4	17.25 / 438	19.88 / 505	10.69 / 272	10.69 / 272	9.25 / 235	11.38 / 289	1⁄2	30.00 / 762	–	130 / 59	–	130 / 59
5	18.13 / 461	25.13 / 638	10.75 / 273	15.25 / 387	10.00 / 254	11.38 / 289	1⁄2	41.00 / 1,041	182 / 82.7	–	170 / 775	–
6	19.63 / 499	28.50 / 724	10.69 / 272	18.38 / 467	10.00 / 254	11.38 / 289	1⁄2	46.00 / 1,168	270 / 122.7	235 / 107	200 / 91	235 / 107
8	27.00 / 686	40.50 / 1,029	–	27.00 / 686	13.75 / 349	17.50 / 445	1⁄2	60.00 / 1,524	600 / 272.7	550 / 250	500 / 227	550 / 250

North America
44 Apple Street
Tinton Falls, NJ 07724
Toll Free: 800 656-3344
(North America only)
Tel: +1 732 212-4700

Europe/Africa/Middle East
Auf der Heide 2
53947 Nettersheim, Germany
Tel: +49 2486 809-0

Internormen Product Line
Friedensstraße 41
68804 Altlußheim, Germany
Tel: +49 6205 2094-0

Begerow Product Line
An den Nahewiesen 24
55450 Langenlonsheim, Germany
Tel: +49 6704 204-0

China
No. 3, Lane 280,
Linhong Road
Changning District, 200335
Shanghai, P.R. China
Tel: +86 21 5200-0099

Singapore
4 Loyang Lane #04-01/02
Singapore 508914
Tel: +65 6825-1668

Brazil
Av. Julia Gaioli, 474 – Bonsucesso
07251-500 – Guarulhos, Brazil
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7-2015

Appendix G:

Measured Pressure Loss Through Filter, Pre/Under/Post Ripening

Test	Time	Operation duration	Volume Cleaned	Flow (l/s)	Flow (m3/s)	Velocity (m/s)	Test	Velocity (m/h)	Hz	Power (kW)
Before Backwash	June 27th						Before Backwash			
Test #1	12:57	72,3		2,98	0,00298	0,000582031	Test #1	2,0953125	17,4	0,19406
Test #2	13:08	72,5	194	5,99	0,00599	0,001169922	Test #2	4,21171875	24,1	0,41046
Ripening	14:18						Ripening			
Test #1	14:26			6,05	0,00605	0,001181641	Test #1	4,25390625	11,8	0,23664
Test #2	14:46			5,97	0,00597	0,001166016	Test #2	4,19765625	11,9	0,23351
Test #3	15:05			5,98	0,00598	0,001167969	Test #3	4,2046875	12	0,2339
After Ripening							After Ripening			
Test #1	15:29	0,1		2,88	0,00288	0,0005625	Test #1	2,025	13,8	0,18323
Test #2	15:48			5,93	0,00593	0,001158203	Test #2	4,16953125	21,3	0,40694

Filter Parameters

	Elev
Overflow at	251,9
Empty	248,18

	Height at Overflow
Filter 4	3,72

P1 (bar)	P2 (bar)	P1 (m)	P2 (m)	Test	Filter water surface height (m)	Storage Tank surface elevatin	Pressure Gauge Elev.	P1 Elev	P2 Elev
				Before Backwash					
0,438	0,651	4,4663736	6,6383772	Test #1	3,3	4,71	245,95	250,41637	252,5883772
0,355	0,685	3,620006	6,985082	Test #2	3,16	5,13	245,95	249,57001	252,935082
				Ripening					
0,494	0,391	5,0374168	3,9871052	Test #1	3,4		245,95	250,98742	249,9371052
0,485	0,391	4,945642	3,9871052	Test #2	3,35		245,95	250,89564	249,9371052
0,482	0,391	4,9150504	3,9871052	Test #3	3,34		245,95	250,86505	249,9371052
				After Ripening					
0,518	0,636	5,2821496	6,4854192	Test #1	3,38	4,74	245,95	251,23215	252,4354192
0,466	0,686	4,7518952	6,9952792	Test #2	3,21	5,23	245,95	250,7019	252,9452792

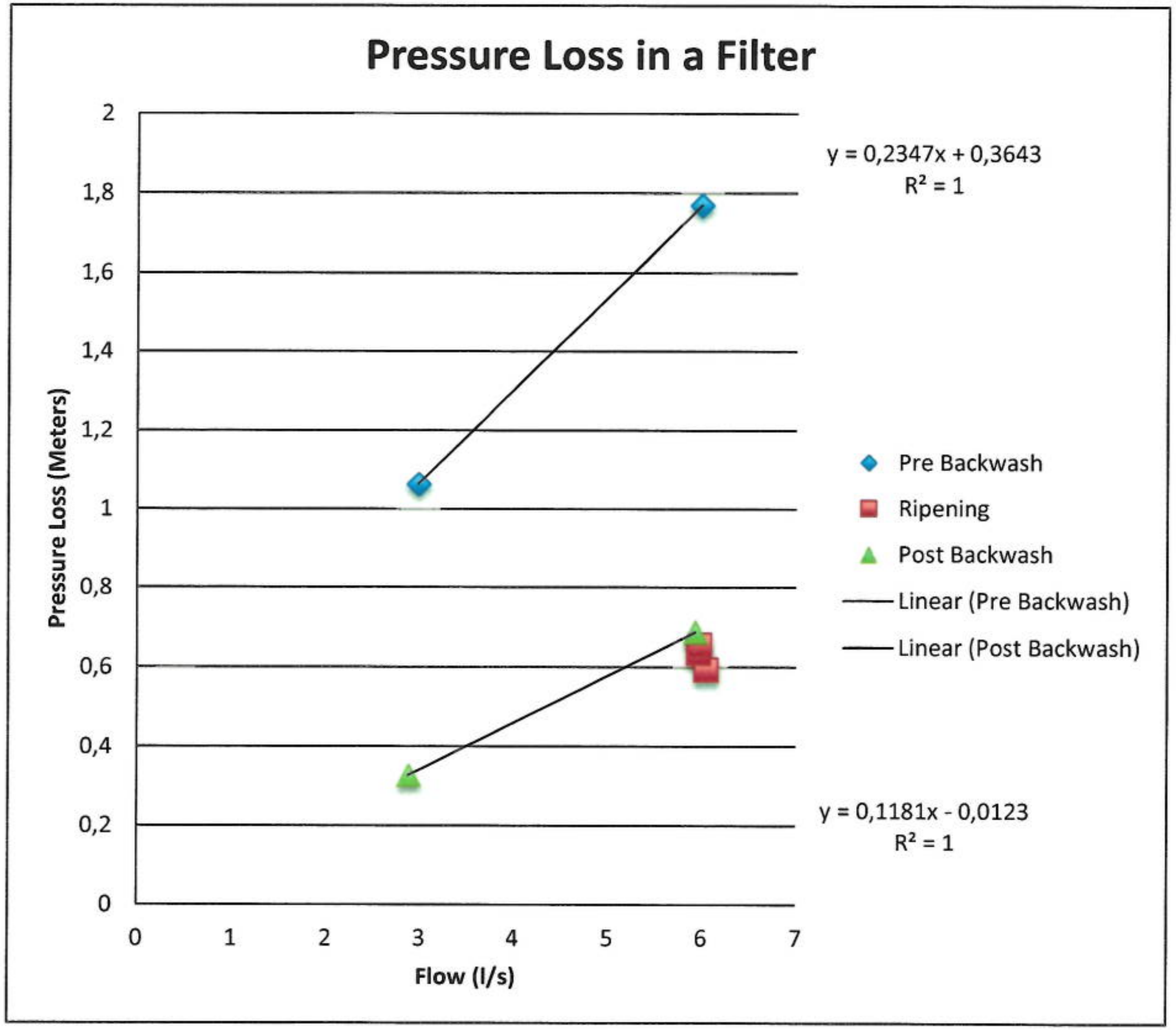
Test	Filter Water Elev	Loss in Filter	Storage water Elev.	Loss Pump to Storage
Before Backwash				
Test #1	251,48	1,0636264	250,68	1,9083772
Test #2	251,34	1,769994	251,1	1,835082
Ripening				
Test #1	251,58	0,5925832	**No water transported to storage tank under the ripening phase.**	
Test #2	251,53	0,634358		
Test #3	251,52	0,6549496		
After Ripening				
Test #1	251,56	0,3278504	250,71	1,7254192
Test #2	251,39	0,6881048	251,2	1,7452792

Storage Tank Parameters				
	Elev			Height at Overlow
Overflow at	251,7		Storage	5,73
Empty	245,97			

Calibration of 0 flow: Filter surface vs Pressure before valve, should be equal						
P (bar)	P (m)	Filter height	Filter surface elev.	Gauge/flo or Elev.	Water surface at gauge	Head loss
0,557	5,68127	3,48	251,66	245,95	251,631272	0,02872811

Pressure info	
P1	Post filter, pre pump
P2	Post pump

Pressure Change pre/post Backwashing Process			
Flow (l/s)	Pre (m)	Post (m)	Percent Change
3	1,0636264	0,3278504	69,17616938
6	1,769994	0,6881048	61,12389082


Pressure Loss in a Filter
y = 0,2347x + 0,3643
R² = 1
y = 0,1181x - 0,0123
R² = 1
Pre Backwash
Ripening
Post Backwash
Linear (Pre Backwash)
Linear (Post Backwash)
Pressure Loss (Meters)
Flow (l/s)
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
0
1
2
3
4
5
6
7

Appendix H:

Diaphragm Valve Spec Sheet

DN 40 - 400
PN 6*/10/16
Pmax = 16 bar

*on agreement

FA6530 FAGSTOP

DIAPHRAGM NON-RETURN VALVE

- Flanged centric non return valve with soft sealing for complete, quick and silent closing of the return flow
- Ensured integrity in food - processing industry
- Wide range of application
- Excellent flow characteristics
- Technical delivery conditions to EN 12266 - 1,2
- EN 19 Specification
- Face to face EN 558-1, basic series 48 (DIN 3202, F6)
- Strength test / Pressure testing to EN 12266 - P10, P11
- Flanged connections EN 1092-2 PN 10/16

Adresse/Address
Fagerberg Norge AS
Årvollskogen 33
1529 Moss

Telefon/Telephone
+ 47 69 35 55 30
Telefax/Telecopy
+ 47 69 35 55 31

E-post/E-mail
post@fagerberg.no
Hjemmeside/Web-site
www.fagerberg.no

Bankonto/Bank account
5183.05.40869
Foretaksnr./Reg. No.
NO 856 326 942 MVA

ORDER CODE

Body
EN-GJS-400-15U (JS1030), GGG 40 **02**
EN-GJL-250 (JL 1040), GG 25 **01**

Seal material
EPDM (Nordel) -30°C ... 90°C **E**
NBR (Perbunan) -20°C ... 50°C **P**

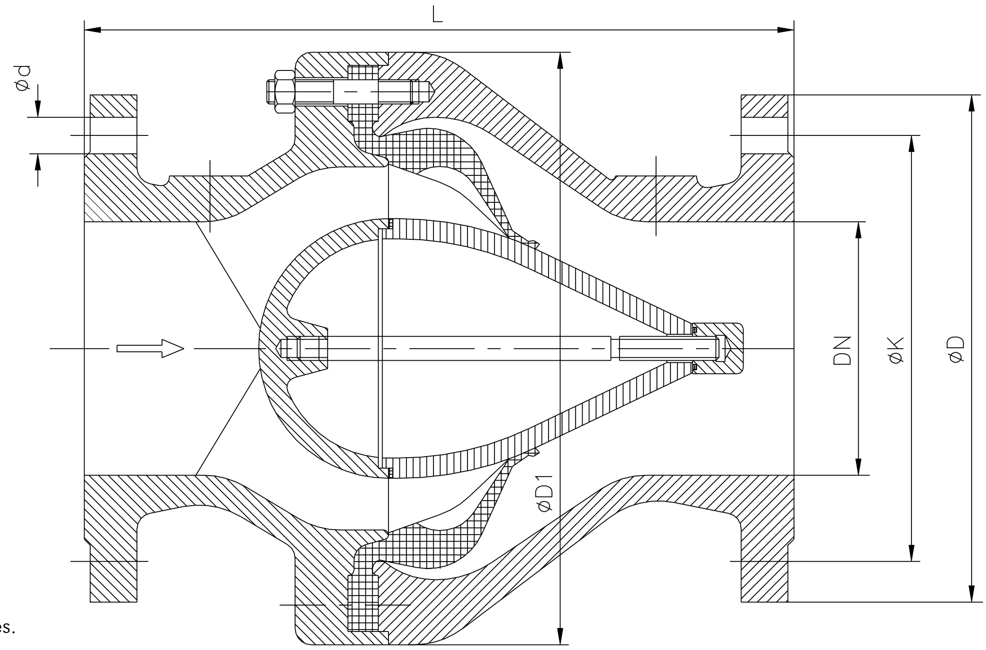
Guide material
EN-GJS-40015-U (JS1030), GGG 40 **02**
EN-GJL-250 (JL 1040), GG 25 **01**

Pressure rating
PN 10 **10**
PN 16 **16**

Nominal size
DN 40 - 400

Other materials for body, guide and seal are also available on agreement and on placing the order.

TECHNICAL DRAWING



We have the right to technical changes.

TECHNICAL INFORMATION

MEVA VALVE DIMENSIONS													
			Flange PN10				Flange PN16				Flow characteristic		Weight
DN	L	D1	D	Dk	n	ϕd	D	Dk	n	ϕd	Kv (m3/h)	ζ (-)	kg
40	180	150	150	110	4	18	150	110	4	18	25.28	6.41	9.50
50	200	175	165	125	4	18	165	125	4	18	38.05	6.91	14.10
65	240	220	185	145	4	18	185	145	4	18	65.40	6.68	16.00
80	260	220	200	160	8	18	200	160	8	18	99.78	6.58	24.00
100	300	292	220	180	8	18	220	180	8	18	157.65	6.44	49.00
125	350	292	250	210	8	18	250	210	8	18	236.62	6.98	50.50
150	400	292	285	240	8	22	285	240	8	22	351.76	6.55	55.00
200	500	380	340	295	8	22	340	295	12	22	646.08	6.13	101.00
250	600	446	405	350	12	22	405	355	12	26	972.03	6.61	146.00
300	700	550	460	400	12	22	460	410	12	26	1407.05	6.55	251.00
350	800	645	505	460	16	22	-	-	-	-	1915.33	6.54	352.00
400	900	720	565	515	16	26	-	-	-	-	2526.89	6.41	423.00

All dimensions are in mm.

MEVA TEST			
	TEST PRESSURE (bar)		Max. operating pressure at
Pressure rating (bar)	Body	Sealing	80° C (bar)
10	16	10	10
16	24	16	16

Adresse/Address
Fagerberg Norge AS
Årvollskogen 33
1529 Moss

Telefon/Telephone
+ 47 69 35 55 30
Telefax/Telecopy
+ 47 69 35 55 31

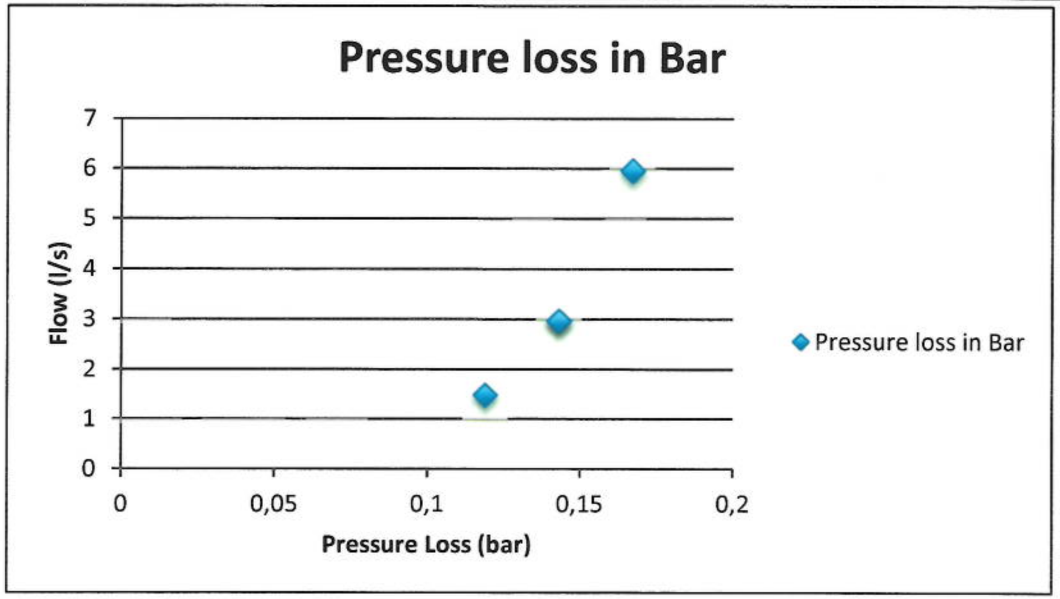
E-post/E-mail
post@fagerberg.no
Hjemmeside/Web-site
www.fagerberg.no

Bankonto/Bank account
5183.05.40869
Foretaksnr./Reg. No.
NO 856 326 942 MVA

Appendix I:

Measured Values For Post Filter Check Valve

Test	Time	Flow	Hz	P1 (bar)	P2 (bar)	Head loss (bar)	P1 (m)	P2 (m)	Check Valve Loss (m)
Check Valve									
Test #1	17:04	1,48	8,8	0,608	0,489	0,119	6,1998976	4,9864308	1,2134668
Test #2	17:14	2,97	13,7	0,643	0,5	0,143	6,5567996	5,0986	1,4581996
Test #3	17:16	2,97	13,8	0,641	0,498	0,143	6,5364052	5,0782056	1,4581996
Test #4	17:26	5,96	21,2	0,678	0,511	0,167	6,9137016	5,2107692	1,7029324



Pressure info	
P1	Post Pump, pre check valve
P2	Post Check valve and elbow bend

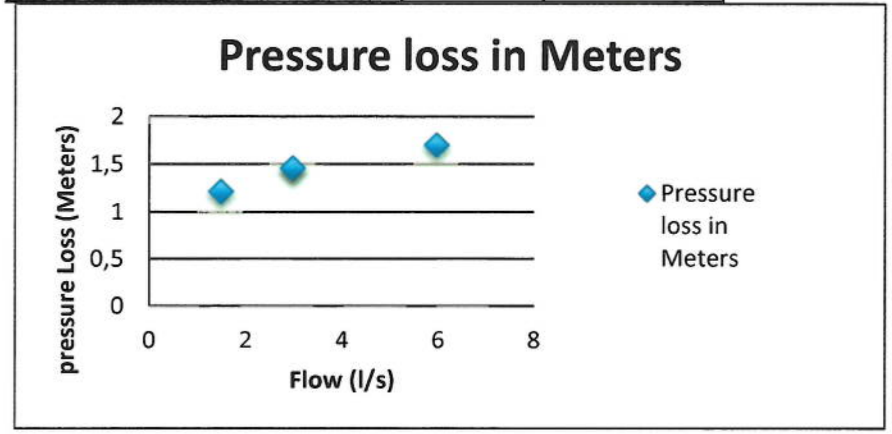
Storage Tank Level (m)	Storage Tank WSE	P2 WSE	Loss P2 to Storage
4,68	250,65	250,9364	0,2864308
4,77	250,74	251,0486	0,3086
4,8	250,77	251,0282	0,2582056
5,25	251,22	251,1608	-0,0592308

Storage Tank Info

	Elev
Overflow at	251,7
Empty	245,97

Gauge Elevatoin	
Concrete	245,85
Added Slope	0,1
=	245,95

	Height at Overlow
Storage	5,73
Vavle	57,7208
Bend	0,3
q=va	
k sum	58,0208
d	0,1
g	9,81
v	
hl	



Test	Area	Flow	Velocity	Hl singular
1	0,00785398	0,00148	0,18843945	0,10500945
2	0,00785398	0,00297	0,37815214	0,42288068
3	0,00785398	0,00297	0,37815214	0,42288068
4	0,00785398	0,00596	0,75885077	1,70293263

Appendix J:

Measured Values for Post Filter Pipe Collection

Test	Time	Flow per filter	Flow Total	Pressure (bar)	Water storage level	Pressure (m)		Ground floor Elevation
Post filter								
Test #1	17:35	5,95	23,8	0,534	5,7	5,4453048		250
Test #2	17:40	3,02	12,08	0,56	5,7	5,710432		250
Test #3	17:51	1,55	6,2	0,554	5,61	5,6492488		250

Pump Info	
P	Post Filter Pumps

Note, unlike the other tests, these tests were preformed as the flow rate decrease, opposite of the other tests.

Elevation tank water surface	Elevation of pre UV	Pressure loss	
251,67	255,445305	3,7753048	
251,67	255,710432	4,040432	
251,58	255,649249	4,0692488	

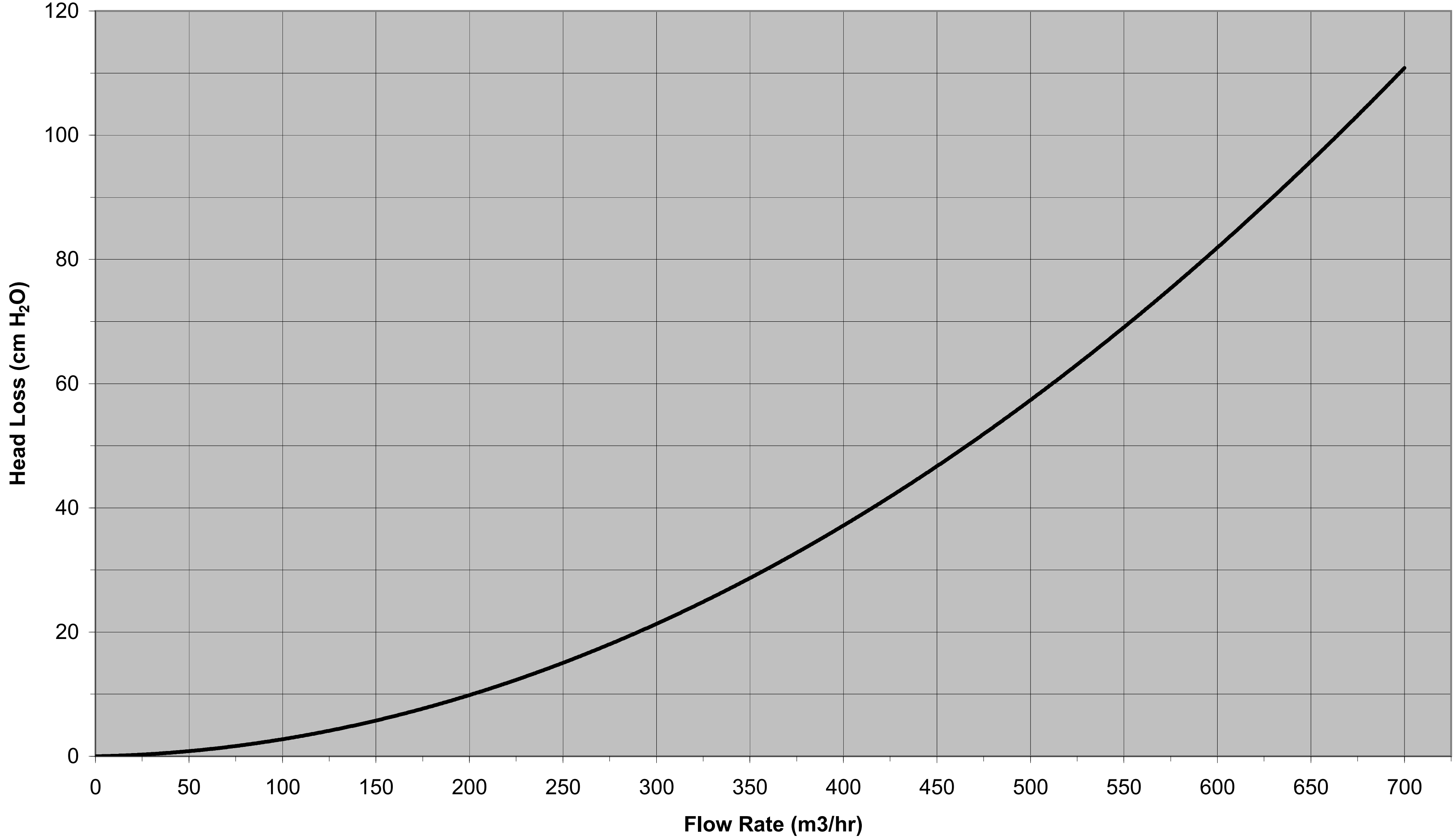
overflow	251,7	
over-5.73	245,97	Filter #4
Concrete	245,85	
Added Slope	0,1	
	245,95	

Appendix K:

Pressure Loss Curve For UV Disinfection Process

TROJANUVSWIFT™SC

D12 Headloss Curve



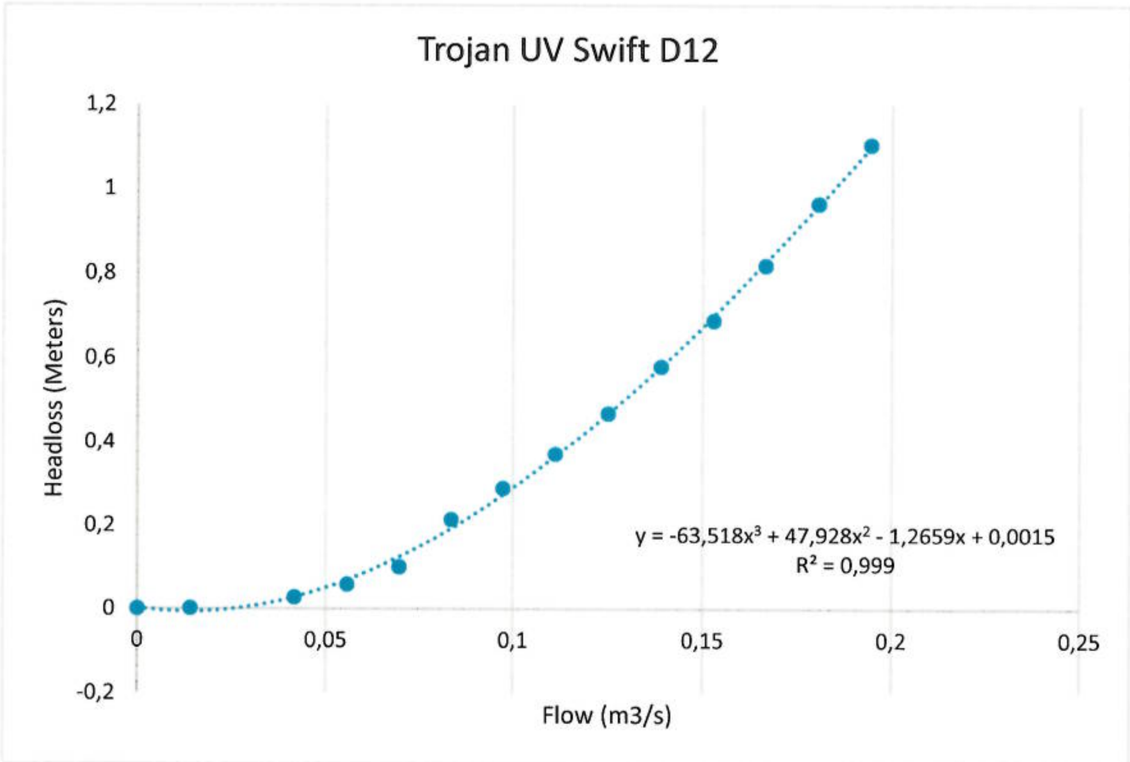
UV Disinfection

Headloss		Flow	
cm	m	m3/hr	m3/s
0	0	0	0
0,08	0,0008	50	0,01388889
2,66666667	0,0266667	150	0,04166667
5,73333333	0,0573333	200	0,05555556
9,86666667	0,0986667	250	0,06944444
21,3333333	0,2133333	300	0,08333333
28,8	0,288	350	0,09722222
37,0666667	0,3706667	400	0,11111111
46,8	0,468	450	0,125
58	0,58	500	0,13888889
68,9333333	0,6893333	550	0,15277778
81,8666667	0,8186667	600	0,16666667
96,5333333	0,9653333	650	0,18055556
110,533333	1,1053333	700	0,19444444

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

Q	Length	hl	mm	Q
100	7,5	0,08	0,006	50
		2,66666667	0,2	150
13,3333333	Ratio	5,73333333	0,43	200
		9,86666667	0,74	250
		21,3333333	1,6	300
		28,8	2,16	350
		37,0666667	2,78	400
		46,8	3,51	450
		58	4,35	500
		68,9333333	5,17	550
		81,8666667	6,14	600
		96,5333333	7,24	650
		110,533333	8,29	700

Equation for Loss Through UV
Y=-63,518x^3+47,928x^2-1,2659x+0,0015



Appendix L:

Measured Values Post Intake Pump

Test	Time	Flow	Hz	Amps	P1 (bar)	P2 (bar)	P1 (m)	P2 (m)
Intake Pump, 100% Open Valve								
Test #1	08:38	22	40,1	6,975	0,211	1,04	2,1516092	10,605088
Test #2	03:46	37	50	10,575	0,085	0,885	0,866762	9,024522
Valve Cloed by 10 revolutions, ~66%								
Test 1	08:56	37	50	10,575	0,095	0,882	0,968734	8,9939304
Pump turned off								
Test 1	09:05	0	0	0	0,283	0,281	2,8858076	2,8654132

Pressure info	
P1	Post pump filter, pre pump
P2	Post pump

Filter info

	Elev
Overflow at	251,92
Empty	248,22

	Height at Overflow
Filter 4	3,7

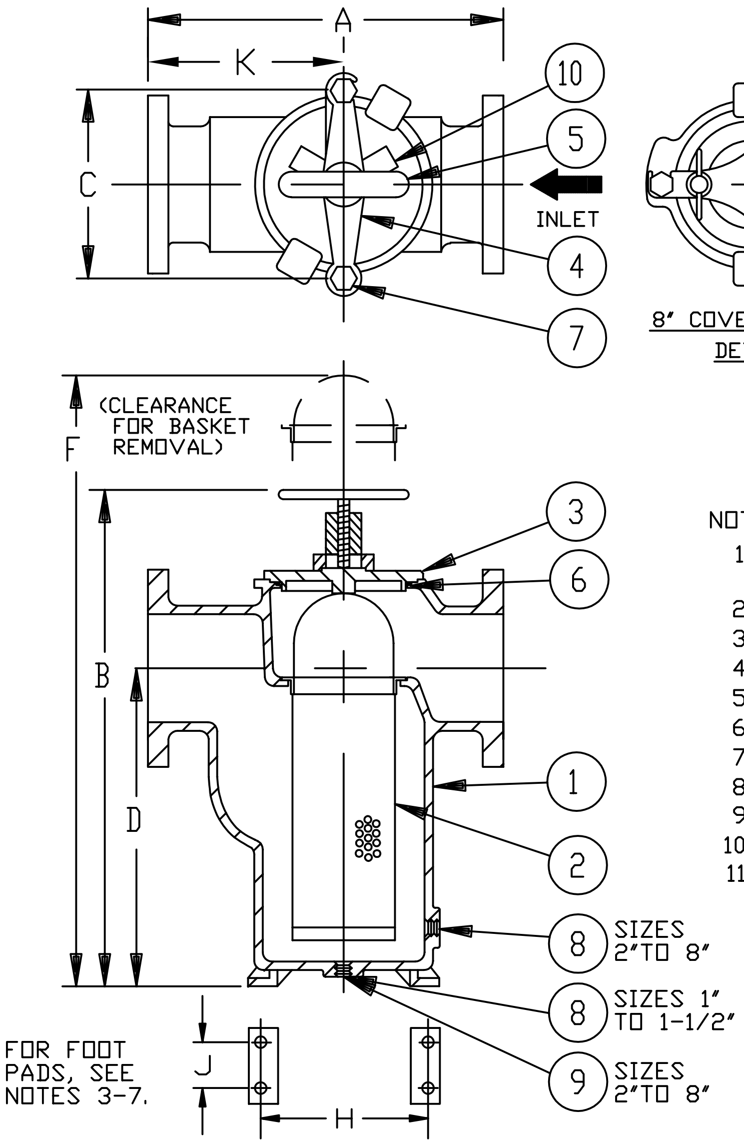
Overflow of Filter	Filter #1 Level	Real filter height	Filter WSE	Gauge Elevation	Nisser Ref Elev	Nisser Level	Nisser WSE	P1 WSE	P2 WSE
0,004	3,7	3,704	251,92	242,92	243,815	2,5	246,315	245,0716092	253,525088
0,009	3,7	3,709	251,92	242,92	243,815	2,5	246,315	243,786762	251,944522
	3,7		251,92	242,92	243,815	2,5	246,315	243,888734	251,91393
	3,7		251,92	242,92	243,815	2,5	246,315	245,8058076	245,785413

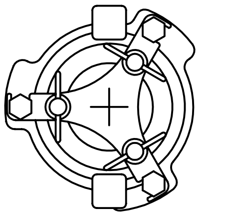
Real Filter WSE with Overflow Calc	Pressure Loss to filter	Real Pressure Loss	Pressure loss from intake
251,924	1,605088	1,601088	1,2433908
251,929	0,024522	0,015522	2,528238
	-0,0060696		2,426266
	-6,1345868		0,5091924

Pressure at P1 is controlled by check valve not allowing full pressure from the pressure side of the pump.

Appendix M:

Pre Pump Filter Specifications





8" COVER & YOKE DETAIL

NO.	PART NAME	MATERIAL
1	BODY	CAST IRON ASTM A126 CL.B
2	SCREEN	
	PERF. DIA.	
	MESH	
3	COVER	CAST IRON ASTM A126 CL.B
4	YOKE	DUCTILE IRON
5	YOKE SCREW	STEEL
6	O-RING	BUNA-N
7	STUD	STEEL
8	DRAIN PLUG	CARBON STEEL
9	BODY PLUG	CAST IRON
10	COVER CLAMP	DUCTILE IRON

NOTES:

1. INLET/OUTLET FLANGED CONNECTIONS DRILLED IN ACCORDANCE WITH DIN 2632 / DIN 2633 - FLAT FACED.
2. COVER CLAMP (ITEM 10) FOR 4", 5", 6" SIZES.
3. NO FOOT PADS FOR SIZES 1", 1-1/4", 1-1/2".
4. 7/16"ø SLOTTED FOOT PADS FOR SIZE 2".
5. 1/2"ø SLOTTED FOOT PADS FOR SIZES 2-1/2",3".
6. 9/16"ø HOLED FOOT PADS FOR SIZES 4",5",6".
7. 5/8"ø SLOTTED FOOT PADS FOR SIZE 8".
8. DIMENSIONS B,D,F ARE FROM BOTTOM OF STRAINER.
9. DIMENSION "G" (NPT) IS FOR DRAIN PLUG, ITEM 8.
10. ITEM 9, BODY PLUG IS NOT TO BE USED AS DRAIN.
11. MAX. WORKING PRESSURE : 200 PSI @ 100° F (13.8 BAR @ 37.8° C)

CERTIFIED FOR:

P. O. NO.:

REG. NO.:

QUOTE NO.:

TAG NO.:

PIPE SIZE (NOMINAL)	DIMENSIONS A IN. MM.	B IN. MM.	C IN. MM.	D IN. MM.	F IN. MM.	G (NOM.) IN. MM.	H IN. MM.	J IN. MM.	K IN. MM.	WEIGHT (DRY) LBS	KGS	PART NO.
1" (25mm)	7.63/ 194	8.38/ 213	4.00/ 102	5.00/ 127	13/ 330	1/2 (15)	----	----	4.31/ 109	9/	4	ST072010AD40
1-1/4" (32mm)	10.25/ 260	11.00/ 279	4.88/ 124	7.00/ 178	16/ 406	3/4 (20)	----	----	5.63/ 143	13/	6	ST072012AD40
1-1/2" (40mm)	10.25/ 260	11.00/ 279	4.88/ 124	7.00/ 178	16/ 406	3/4 (20)	----	----	5.63/ 143	17/	8	ST072015AD40
2" (50mm)	10.50/ 268	13.75/ 349	6.75/ 172	7.63/ 194	20/ 508	1/2 (15)	5.50/140	2.50/ 64	5.75/ 146	37/	17	ST072020AD40
2-1/2" (65mm)	11.63/ 295	15.63/ 397	7.94/ 202	8.88/ 226	23/ 584	3/8 (10)	6.50/165	2.88/ 73	6.63/ 168	54/	24	ST072025AD40
3" (80mm)	13.13/ 334	18.00/ 457	8.00/ 203	11.00/ 279	27/ 686	3/8 (10)	7.00/178	3.13/ 80	7.25/ 184	76/	34	ST072030AD40
4" (100mm)	16.75/ 425	19.88/ 505	10.69/ 272	10.69/ 272	29/ 737	1/2 (15)	10.00/254	3.88/ 99	9.38/ 238	125/	57	ST072040AD40
5" (125mm)	18.13/ 460	25.13/ 628	10.69/ 272	15.19/ 386	38/ 965	1/2 (15)	10.00/254	4.63/118	10.13/ 257	170/	77	ST072050AD40
6" (150mm)	19.63/ 499	28.50/ 724	10.69/ 272	18.31/ 465	46/1168	1/2 (15)	10.00/254	5.00/127	10.81/ 275	200/	91	ST072060AD40
8" (200mm)	27.00/ 686	40.00/1016	----	27.00/ 686	60/1524	1-1/2(40)	15.75/400	8.63/219	15.50/ 394	500/	227	ST072080AD40

ELECTRONIC FILE NAME: A4-1234B.DWG

REF. ECR	DATE

EATON

EATON FILTRATION, LLC

900 FAIRMOUNT AVENUE, ELIZABETH, NEW JERSEY 07207

NAME: MODEL 72 SIMPLEX STRAINER DIN PN16 FLAT FACE FLANGE SIZES 1" THRU 8" CAST IRON

DRAWN	DATE	CERT.	DATE
CJL	29/06/00	CJL	29/06/00

SIZE	DWG NO	REV
A4	A4-1234	B

Appendix N:

Measured Values For Pre Pump Filter Loss

Test	Time	Flow	P1 (bar)	P2 (bar)	P1 (m)	P2 (m)	Pressure Loss
Pre Pump Filter							
Test #1	09:19	0	0,282	0,282	2,8756	2,8756	0
Test #2	09:27	22	0,248	0,215	2,5289	2,1924	0,3365076
Test #3	09:31	37	0,188	0,1	1,9171	1,0197	0,8973536

Elevation is not needed in this calculatoin as both points are meassured from the same point, and the pressure loss through the filter is the focus

As long as nothing is clogging the pump, the loss should be relatively small

Pressure info	
P1	Pre Pump Filter
P2	Post Pump Filter

Appendix O:

Measured Values For Post Intake Pump Combination Pipe

Test	Time	Flow	Hz	Amps	P intake (bar)	P1 (bar)	P2 (bar)	P1 (m)
Post pumps, pre filter								
Test #1	09:57	0	0	0	0,181	0,264	0,88	2,6920608
Test #2	10:04	22,25	40,1	6,975	0,181	0,207	0,891	2,1108204
Test #3	10:14	37,13	50	10,5	0,156	0,088	0,905	0,8973536

Pressure Info	
P1	Pre pumps, post pre pump filter
P2	Post Parallel Pumps

a	0,19634954
v	0,18910154
z1	245,35
hl	245,351823

z2	251,9

Filter Info	
Filter	251,9
Empty	248,18

Gauge Info	
Elevation	242,92

P2 (m)	Lake Water Level	Reference Elevation	Filter Level	Gauge Elevatoin	WSE Post Pump	Filter Surface Elev	Loss to Filter	Loss to intake pump
8,973536	2,25	243,815	3,7	242,92	251,893536	251,88	0,013536	0,4529392
9,0857052	2,25	243,815	3,7	242,92	252,0057052	251,88	0,1257052	1,0341796
9,228466	2,25	243,815	3,7	242,92	252,148466	251,88	0,268466	2,2476464

Appendix P:

Measured Losses From Static Mixer

Test	Time	Flow	Hz	Amps	P intake (bar)	P1 (bar)
1 Pump						
Test #1	10:50	0	0	0	0,147	0,289
Test #2	10:53	22	40,1	6,975	0,181	0,3
Test #3	10:58	37	50	10,5	0,156	0,32
2 Pumps						
Test #1	11:02	68,07	50	10,2	0,079	0,37
			50	10,2	0,079	

Pressure info		Filter Info	
P1	Post filter, pre pump	Filter	251,9
P2	Post pump	Empty	248,18

Pump 2 had valve slightly closed, 50%			
Test No Flow, P1=P2			
P1	0,294	P2	0,292
		Difference:	0,002

P2 (bar)	P1 (m)	P2 (m)	Filter Level	Gauge Elevatoin	Pre Static Mixer WSE	Post Static Mixer WSE	Pressure Loss
0,283	2,94699	2,88581	3,7	248,97	251,9169908	251,8558076	0,0611832
0,288	3,05916	2,93679	3,7	248,97	252,02916	251,9067936	0,1223664
0,301	3,2631	3,06936	3,7	248,97	252,233104	252,0393572	0,1937468
0,33	3,77296	3,36508	3,7	248,97	252,742964	252,335076	0,407888

Appendix Q:

Compilation Of Measured Values For Raw Water

Test	Time	Flow l/s	P measured (bar)	Storage Level (m)	Overflow Depth (m)	Elevatoin P1	Filter Elevation	Pressure Loss
Post Intake Pump, Gate Valve Fully Open	08:38	22	1,004	3,7	0,004	253,158	251,9	1,257989
	08:46	37	0,885	3,7	0,009	251,945	251,9	0,044522
Gate Valve Half Closed	08:56	37	0,882	3,7		251,914	251,9	0,01393
Post Pipe Combination	09:57	0	0,88	3,7		251,894	251,9	-0,00646
	10:04	22	0,891	3,7		252,006	251,9	0,105705
	10:14	37	0,905	3,7		252,148	251,9	0,248466
Post Pipe Combination, Pre Static Mixer	10:50	0	0,289	3,7		251,917	251,9	0,016991
	10:53	22	0,3	3,7		252,029	251,9	0,12916
	10:58	37	0,32	3,7		252,233	251,9	0,333104
2 Pumps Post Combination	11:02	68,07	0,37	3,7	0,018	252,743	251,9	0,842964

The test occuring at 8:38 has an unusually high pressure loss. A possible, and most likely probable explanation is that the check valve did not fully open. This is a likely explenation as the pump had not been in use for a period of time before testing was conducted. The check valve was most likey only opening part way, and did not completely open until a higher flow was tested.

Filter info				
	Elev			Height at Overflow
Overflow at	251,9		Filter	3,7
	Empty	248,2		
	Pressure Reference Point		Pressure Reference Point 2	
		Elevatoin		Elevatoin
	Gauge	242,92	Gauge	248,97

Test Point	Section	Flow (l/s)	Average Loss (m)	
A	Post Intake Pump	22	1,2579888	Test on the pressure side of the pump were all preformed at different locatoins for the same flow, thus it is there is no average of loss from point A to B based on multiple tests. But rather a singe example and result. However, it is possible to calculate the loss between test points by viewing the observed pressures
		37	0,044522	
A	Gate Valve Half Closed	37	0,0139304	
B	Post Pipe Combination	0	-0,006464	
		22	0,1057052	
		37	0,248466	
C	Post Pipe Combination /Pre Static Mixer	0	0,0169908	
		22	0,12916	
		37	0,333104	
C	2 Pumps	68,07	0,842964	

Pressure Loss between measuting points		
Section	Flow (l/s)	Loss (m)
A-B	22	1,1522836
A-B	37	-0,203944
B-C	0	-0,0234548
B-C	22	-0,0234548
B-C	37	-0,084638

Reason for negative values:
The most logical and probably correct reason for these pressure isses are that the elevatoin of the gauge could have been incorrectly recorded

Appendix R:

Compilation Of Measured Values For Clean Water

Test	Time	Flow per filter pump	Total Flow	P measured	Storage Level	Elevatoin P1	Elevatoin Storage	Pressure Loss
Pre Filter Cleaning	12:57	2,98		0,651	4,71	252,588	250,68	1,908377
	13:08	5,99		0,685	5,13	252,935	251,1	1,835082
Post Filter Ripening	15:29	2,88		0,636	4,74	252,435	250,71	1,725419
	15:48	5,93		0,686	5,23	252,945	251,2	1,745279
Check Valve Test	17:04	1,48		0,608	4,68	252,15	250,65	1,499898
	17:14	2,97		0,643	4,77	252,507	250,74	1,7668
	17:16	2,97		0,641	4,8	252,486	250,77	1,716405
	17:26	5,96		0,678	5,25	252,864	251,22	1,643702
Post pipe filter pipe combination	17:35	5,95	23,8	0,534	5,7	251,395	251,67	-0,2747
	17:40	3,02	12,08	0,56	5,7	251,66	251,67	-0,00957
	17:51	1,55	6,2	0,554	5,61	251,599	251,58	0,019249

Storage Tank Info				
	Elev			Height at Overlow
Overflow at	251,7		Storage	5,73
Empty	245,97			

Pressure Reference point	
	Elevatoin
Gauge	245,95

Post Filter Pump(s)		
Section	Flow (l/s)	Avg. Loss (m)
Filter Pump to Storage	1,5	1,4998976
	3	1,7792503
	6	1,741354267
Filter Pump Collection to Storage	1,5	0,0192488
	3	-0,009568
	6	-0,2746952

Appendix S:

Blank/Zeroed Workbook Ready For A New Project

Treatment Plant:				
Treungen			Flow	0,03
Date	July 1, 2016		Viscosity	1,31E-06
			K	1,50E-05
Section		Total Loss Per Section		Units
Raw Water		0,834058034		Meters
Filter		#DIV/0!		Meters
Clean Water		0,02002113		Meters
Total Loss Experienced		#DIV/0!		Meters

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

Major Losses Due to Friction	
Flow	0,03
Viscosity	1,31E-06
k steel	0,000015
k PE	

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

Reference	Section	Diameter	Pipe Length/Section	Split Flow? Yes/No	Splint into	Split Flow	Reduced flow? Yes/No	% of Total flow (0-100)
Raw Water		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
			1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	no	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100
		1	1,000	No	1	0,03	no	100

Reduced Flow	Area	Velocity	D(h)	Re	K	K/D(h)	1	f	Repatitions	Major Loss Per Split	Total Major loss	k-total for Minor Loss
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	1,000101	0,023685	1	1,7613E-06	1,7613E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999893	0,023676	1	1,7607E-06	1,7607E-06	
0,03	0	0	0	0	0,000015	0		0,023649	1	0	0	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999714	0,023669	1	1,7601E-06	1,7601E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999628	0,023665	1	1,7598E-06	1,7598E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999628	0,023665	1	1,7598E-06	1,7598E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999714	0,023669	1	1,7601E-06	1,7601E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999628	0,023665	1	1,7598E-06	1,7598E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999628	0,023665	1	1,7598E-06	1,7598E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999504	0,02366	1	1,7595E-06	1,7595E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999912	0,023677	1	1,7607E-06	1,7607E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999828	0,023674	1	1,7605E-06	1,7605E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999965	0,023679	1	1,7609E-06	1,7609E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999816	0,023673	1	1,7604E-06	0,000002	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999504	0,02366	1	1,7595E-06	1,7595E-06	

Minor Loss for Diameter transition flow	Minor Loss per Split	Total Minor loss	Unit preocess	Total Major+Minor Loss
0	0	0	0	1,76132E-06
0	0	0	0	1,76067E-06
0	0	0	0	0
0	0	0	0	1,76012E-06
0	0	0	0	1,75985E-06
0	0	0	0	1,75985E-06
0	0	0	0,8340334	0,834035151
0	0	0	0	1,75985E-06
0	0	0	0	1,75985E-06
0	0	0	0	1,75946E-06
0,02	0	0	0	1,76073E-06
#REF!	0	0	0	1,76047E-06
0	0	0	0	1,7609E-06
0,02	0	0	0	1,76043E-06
#REF!	0	0	0	1,75946E-06

Major Losses Due to Friction

Flow	0,03
Viscosity	1,31E-06
K	0,000015

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

Reference	Section	Diameter	Pipe Length/Section	Split Flow? Yes/No	Splint into	Split Flow	Reduced flow? Yes/No	% of Total flow (0-100)
Clean Water		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100
		1	1,000	No	1	0,03	No	100

Reduced Flow	Area	Velocity	D(h)	Re	K	K/D(h)	1	f	Repatitions	Major Loss Per Split	Total Major loss	k-total for Minor Loss
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	1,000279	0,023692	1	1,7619E-06	1,7619E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999979	0,02368	1	1,7609E-06	1,7609E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999979	0,02368	1	1,7609E-06	1,7609E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,99982	0,023673	1	1,7604E-06	1,7604E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999966	0,023679	1	1,7609E-06	1,7609E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999828	0,023674	1	1,7605E-06	1,7605E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999984	0,02368	1	1,761E-06	1,761E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999984	0,02368	1	1,761E-06	1,761E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999866	0,023675	1	1,7606E-06	1,7606E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999789	0,023672	1	1,7603E-06	1,7603E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999984	0,02368	1	1,761E-06	1,761E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999866	0,023675	1	1,7606E-06	1,7606E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999714	0,023669	1	1,7601E-06	1,7601E-06	
0,03	0,785398	0,038197	1	29158,16	0,000015	0,000015	0,999866	0,023675	1	1,7606E-06	1,7606E-06	

Minor Loss for Diameter Transition flow	Minor Loss per Split	Total Minor loss	Unit Process	Total Major+Minor Loss
0	0	0	0	1,76187E-06
0	0	0	0	1,76094E-06
0	0	0	0	1,76094E-06
0	0	0	0	1,76044E-06
0	0	0	0	1,7609E-06
0	0	0	0	1,76047E-06
0	0	0	0	1,76095E-06
0	0	0	0	1,76095E-06
	0	0	0	1,76059E-06
0	0	0	0	0,01
0	0	0	0	1,76095E-06
0	0	0	0	1,76059E-06
0	0	0	0	0,01
0	0	0	0	1,76059E-06

Filter						
Variables						
hl	Head Loss	ρw	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
L	Depth					
Re	Reynolds Number					

Reynolds Number		
ρw	999,7	kg/m
v	5,273438	m/h
d	2	m
µ	0,001307	kg/m*s

Re	

Filtralite			Sand			Marble		
hl	#DIV/0!	m	hl	#DIV/0!	m	hl	#DIV/0!	m
Kv			Kv			Kv		
K|			K|			K|		
ρw		kg/m	ρw		kg/m	ρw		kg/m
d		m	d		m	d		m
ε			ε			ε		
µ		kg/m*s	µ		kg/m*s	µ		kg/m*s
v		m/h	v		m/h	v		m/h
g		m/s^2	g		m/s^2	g		m/s^2
L		m	L		m	L		m

Velovity for given area				
Area per filter	5,12	m2	# of filters	4
Flow	0,0075	m3/s		
Velovity	5,273438	m/h		

Head Loss (Meters)	
Filtrite	#DIV/0!
Sand	#DIV/0!
Marble	#DIV/0!
Total Loss	#DIV/0!

Appendix T:

Visual Basic Editor Code

```
Private Sub Worksheet_Calculate()

    Application.EnableEvents = False

    Range("U9").GoalSeek Goal:=1, ChangingCell:=Range("V9")
    Range("U10").GoalSeek Goal:=1, ChangingCell:=Range("V10")
    Range("U11").GoalSeek Goal:=1, ChangingCell:=Range("V11")
    Range("U13").GoalSeek Goal:=1, ChangingCell:=Range("V13")
    Range("U14").GoalSeek Goal:=1, ChangingCell:=Range("V14")
    Range("U16").GoalSeek Goal:=1, ChangingCell:=Range("V16")
    Range("U17").GoalSeek Goal:=1, ChangingCell:=Range("V17")
    Range("U18").GoalSeek Goal:=1, ChangingCell:=Range("V18")
    Range("U19").GoalSeek Goal:=1, ChangingCell:=Range("V19")
    Range("U20").GoalSeek Goal:=1, ChangingCell:=Range("V20")
    Range("U21").GoalSeek Goal:=1, ChangingCell:=Range("V21")
    Range("U22").GoalSeek Goal:=1, ChangingCell:=Range("V22")
    Range("U23").GoalSeek Goal:=1, ChangingCell:=Range("V23")
    Range("U93").GoalSeek Goal:=1, ChangingCell:=Range("V93")
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    Range("U95").GoalSeek Goal:=1, ChangingCell:=Range("V95")
    Range("U96").GoalSeek Goal:=1, ChangingCell:=Range("V96")
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    Range("U98").GoalSeek Goal:=1, ChangingCell:=Range("V98")
    Range("U99").GoalSeek Goal:=1, ChangingCell:=Range("V99")
    Range("U100").GoalSeek Goal:=1, ChangingCell:=Range("V100")
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    Range("U103").GoalSeek Goal:=1, ChangingCell:=Range("V103")
    Range("U104").GoalSeek Goal:=1, ChangingCell:=Range("V104")
    Range("U106").GoalSeek Goal:=1, ChangingCell:=Range("V106")

    Application.EnableEvents = True

End Sub
```

Appendix U:

Theoretical Results and Graphs For Raw Water

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

Major Losses Due to Friction

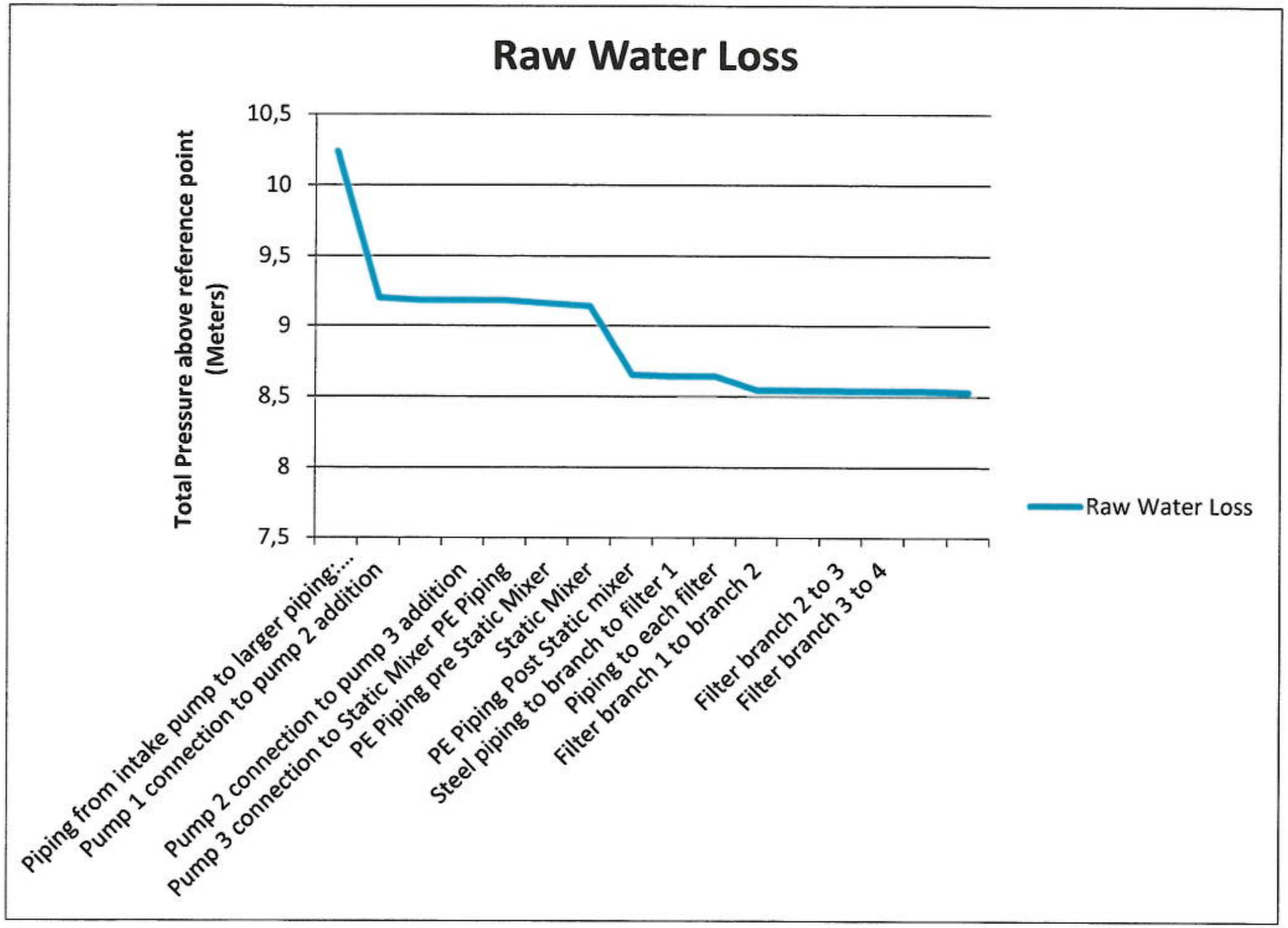
Flow	0,023
Viscosity	1,31E-06
k steel	0,000015
k PE	0,0000015

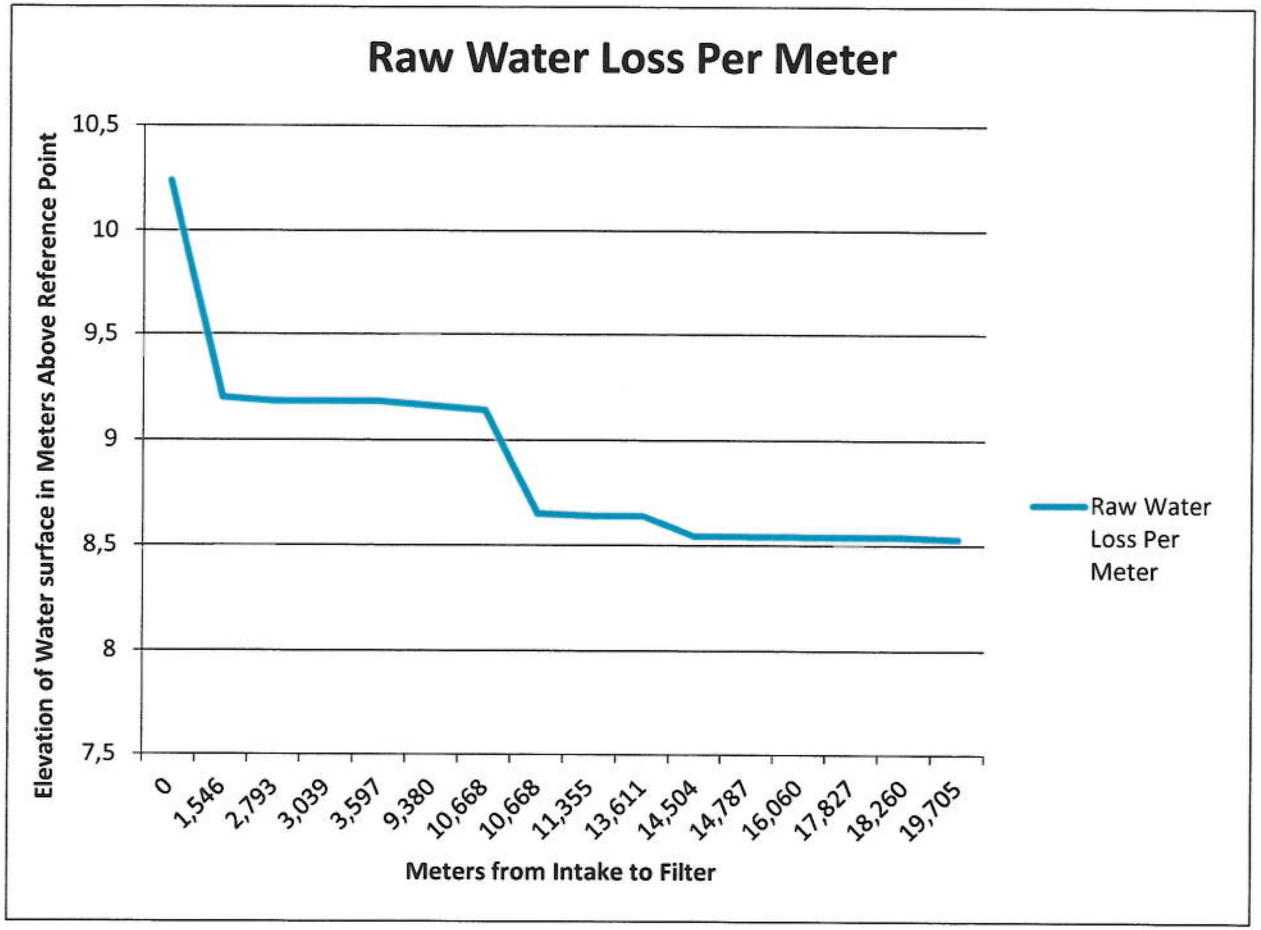
Plant Altercatioins	#
Intake Pumps: 1 or 2	1
Filters in operation: 3 or 4	4
UV in operation: 1 or 2	1

Reference	Section	Diameter (m)	Pipe Length/Section (m)	Split Flow? Yes/No	Splint 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
		0,25	0,246	No	1	0,023	yes
	Pump 2 connection to pump 3 addition	0,25	0,558	No	1	0,023	yes
	Pump 3 connection to Static Mixer PE Piping	0,25	5,783	No	1	0,023	No
	PE Piping pre Static Mixer	0,25	1,289	No	1	0,023	No
	Static Mixer	0	0,000	No	1	0,023	No
	PE Piping Post Static mixer	0,25	0,686	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
		0,2	1,273	No	1	0,023	yes
	Filter branch 2 to 3	0,2	1,767	No	1	0,023	yes
	Filter branch 3 to 4	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	Repati-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 preocess	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
Total Pressure above reference point (Meters)
10,5
10
9,5
9
8,5
8
7,5
Piping from intake pump to larger piping:...
Pump 1 connection to pump 2 addition
Pump 2 connection to pump 3 addition
Pump 3 connection to Static Mixer PE Piping
PE Piping pre Static Mixer
Static Mixer
PE Piping Post Static mixer
Steel piping to branch to filter 1
Piping to each filter
Filter branch 1 to branch 2
Filter branch 2 to 3
Filter branch 3 to 4
Raw Water Loss


Raw Water Loss Per Meter
Elevation of Water surface in Meters Above Reference Point
10,5
10
9,5
9
8,5
8
7,5
0
1,546
2,793
3,039
3,597
9,380
10,668
10,668
11,355
13,611
14,504
14,787
16,060
17,827
18,260
19,705
Meters from Intake to Filter
Raw Water Loss Per Meter

Appendix V:

Theoretical Results and Graphs For The Filter

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

Reynolds Number			Re	1546,196
ρw	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	
ρw	999,7	kg/m	ρw	999,7	kg/m	ρw	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	
Velovity for given area		
Area	5,12	m2
Flow	0,00575	m3/s
Velovity	4,042969	m/h


Loss in Filter at 23 l/s
3,5
3
2,5
2
1,5
1
0,5
0
Total Depth of Filter (m)
0
0,034227448
0,142557279
0,667718756
Pressure Loss (m)
Loss in Filter at 23 l/s

Appendix W:

Theoretical Results and Graphs For Clean Water

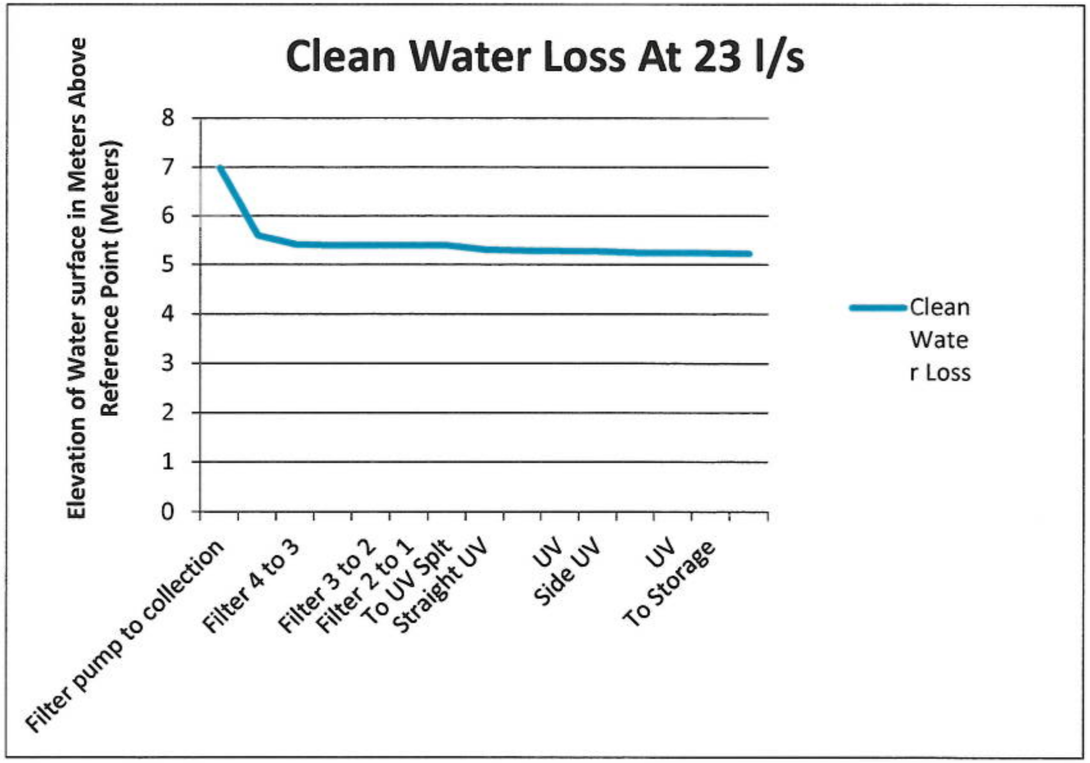
Major Losses Due to Friction	
Flow	0,023
Viscosity	1,31E-06
K	0,000015

Plant Altercatioins	#
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	Splint 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 Splt	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	Repatitions	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
Elevation of Water surface in Meters Above Reference Point (Meters)
8
7
6
5
4
3
2
1
0
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
Clean Water Loss

Appendix X:

Data For Filtralite MC Filter Media

Instructions and recommendations for Filtralite® MC 0.8-1.6 mm

1 General

Filtralite® MC 0.8-1.6 mm is a filter media for purification of water and residual and industrial effluents. It is made of expanded clay granules that are crushed and sieved. The porous sharp edged grains have strong resistance against mechanical abrasion and a low acid solubility.
Filtralite® MC 0.8-1.6 mm is an inert ceramic material and complies with requirements of EN 12905.

2 Application of Filtralite® MC 0.8-1.6 mm

Filtralite® MC 0.8-1.6 mm can be used as filter media both in conventional deep bed filters for particle removal and in biological filters. It can be utilized in single media filters as well as top layer in multi media filters.
Filtralite® MC 0.8-1.6 mm can be applied in both open and closed filters for treatment of ground water, surface water, seawater and effluents.

3 Recommendations for filter design

3.1 Biofilters

Due to its porous structure and large specific surface area Filtralite® MC 0.8-1.6 mm is ideal as support media for biofilms in fixed bed biofilters. Biofilters are normally single media filters. To obtain biological degradation of substances in the water, it is important that the contact time (the time the water takes to pass through the filter) is long enough. The needed Empty Bed Contact Time (EBCT) is dependent of which matter to be removed, concentration, temperature etc. Experiences from different plants and tests show that the EBCT should not be any shorter than 15-20 minutes. It is recommended to run a pilot test to define the correct EBCT for that specific water.

3.2 Multi media filters

Down flow multi media filters have the advantage compared to single media filters that the total head loss is lower and the storage capacity of the filter is higher. The result of this is that the filter can be operated longer before backwash is needed.

The most normal multi media filter, dual media filter, has a coarse upper layer and a finer lower layer. When designing a dual media filter it is important that the filter materials have different settling velocities, so that the materials will separate after backwash. The lower layer filter media must be heavier and have smaller grains than the upper layer media.

Recommended dual media filter design using Filtralite® MC 0.8-1.6 mm is:

Filter media	Grain size [mm]	Layer depth [mm]
Filtralite® MC 0.8-1.6 mm	0.8-1.6	500-900
Quartz sand	0.5-0.8	400-800

Filtration rate for potable water dual media filters designed according to the table above is normally 5-15 m/h.
For other applications filtration rate can be lower or higher.

4 Installation and start up

4.1 Installation

Filtralite® MC 0.8-1.6 mm can be delivered either in big bags or bulk. When delivered in big bags the installation of the material can be done by lifting the big bag over the filter cell by a crane or fork lift and then cut the bottom of the big bag so that the filter media falls into the filter. To avoid any dispersion of dust attached to the filter media, water should be filled into the filter cell before the Filtralite® MC 0.8-1.6 mm is filled in. Most of the dust will then be kept in the water.

If the material delivered in big bags is stored after it is supplied to the plant, make sure to store the big bags on pallets to avoid degradation of the bottom of the big bags and for reducing the risk for contamination of the filter media. The big bags should not be stored outdoors for a longer period than 3 months without being covered by tarpaulin or similar to avoid degradation of the big bags. The big bags should also be kept out of direct sunlight.

For delivery in bulk the Filtralite® MC 0.8-1.6 mm media can be installed by pneumatically blowing it into the filters. To avoid too much abrasion to the media through the hose/pipe, the diameter of the hose should not be smaller than 4''. It is also important to avoid bends. If bends are necessary they should have as large radius as possible. To avoid dust in the area where the filters are located, water should be added to the hose (1/2'' hose with water pressure about 6 bar). The water should be connected to the hose around 5-10 m before the end of the hose, to allow all dust to be wetted. The total blowing distance (length of hose) should not exceed 60 meters.

4.2 Start up

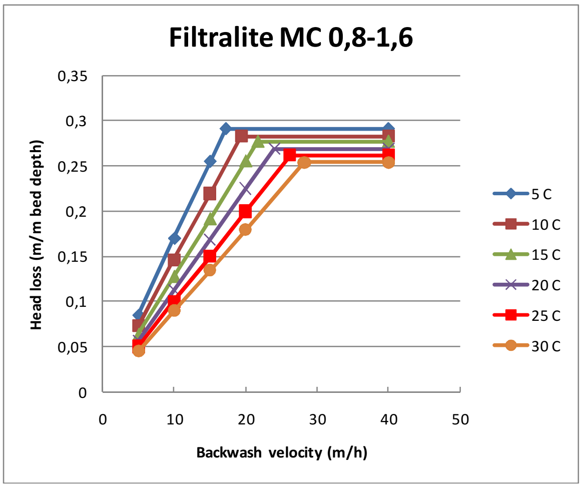
After the Filtralite® MC 0.8-1.6 mm has been installed in the filter, the filter should be filled with water to above the top of the filter media. The filter media should be wetted for about 24 hours before washing of the filter media starts. This period for soaking the material can be combined with disinfecting the filter media by adding to the water a disinfectant.

After the media is soaked it should be backwashed properly to get rid of dust etc. If the backwash can be operated manually, the first backwash can be carried out by only water that flushes through the filter until the outlet wash water is clean. If the backwash system can only operate at a fixed procedure, this backwash procedure should be repeated until the water is clean. After the filter media has been cleaned, the filter can be put into operation.

5 Operation

5.1 Filtration

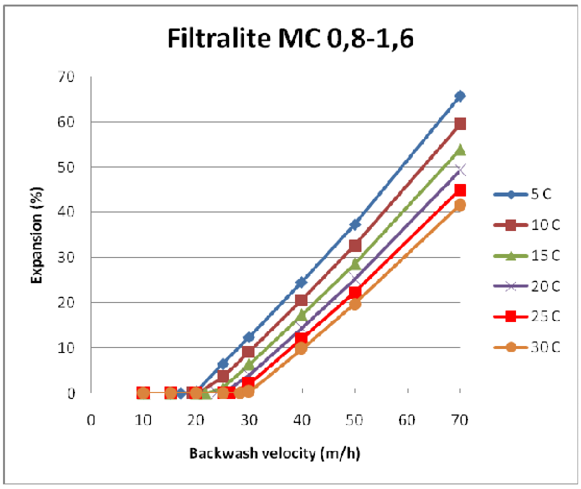
In filtration mode Filtralite® MC 0.8-1.6 mm provides low head loss and high storage capacity for sludge, resulting in long filter runs between each backwash. The following diagram shows the correlation between head loss and backwash velocities for different water temperatures.



5.2 Backwash

During operation sludge will attach to the filter and the head loss through the filter will increase. The filter has to be backwashed to clean the filter media, when the head loss reaches the maximum level allowed in the filter, or the filtrate reaches a break through of particles.

For dimensioning of the backwash system it is important to know the water velocity needed for fluidizing the filter media. The following diagram shows the expansion of Filtralite® MC 0,8-1,6 during backwash for different water velocities and temperatures.



Backwashing of dual media filters has to be carried out in a way that secures that the layers will be separated after the backwash. This is usually obtained by using only water above fluidization velocity for the final stap of the backwash procedure. The most recommendable way of backwashing a dual media filter with Filtralite® MC 0.8-1.6 mm as top layer is collapsed pulse backwashing, carried out as follows:

1. Lower the water level to approx. 10 cm above the top of the filter media.
2. Flush with approx. 9 m/h water in combination with 25-35 m/h air till the water level is approx. 30 cm below overflow.
3. Pause for 120 seconds.
4. Flush with water with velocity which gives the material an expansion of 15-30% in 600 seconds, or till the backwash water is clean.

If this procedure does not provide sufficient cleaning, step 2 and 3 can be repeated before the final step 4.

5.3 Putting out of operation

If the filter should be put out of operation it is important to wash the filter intensively before it is stopped. The filter can then stay water filled for around a couple of weeks. If the filter is to be taken out of operation for a longer period the water should be drained off.

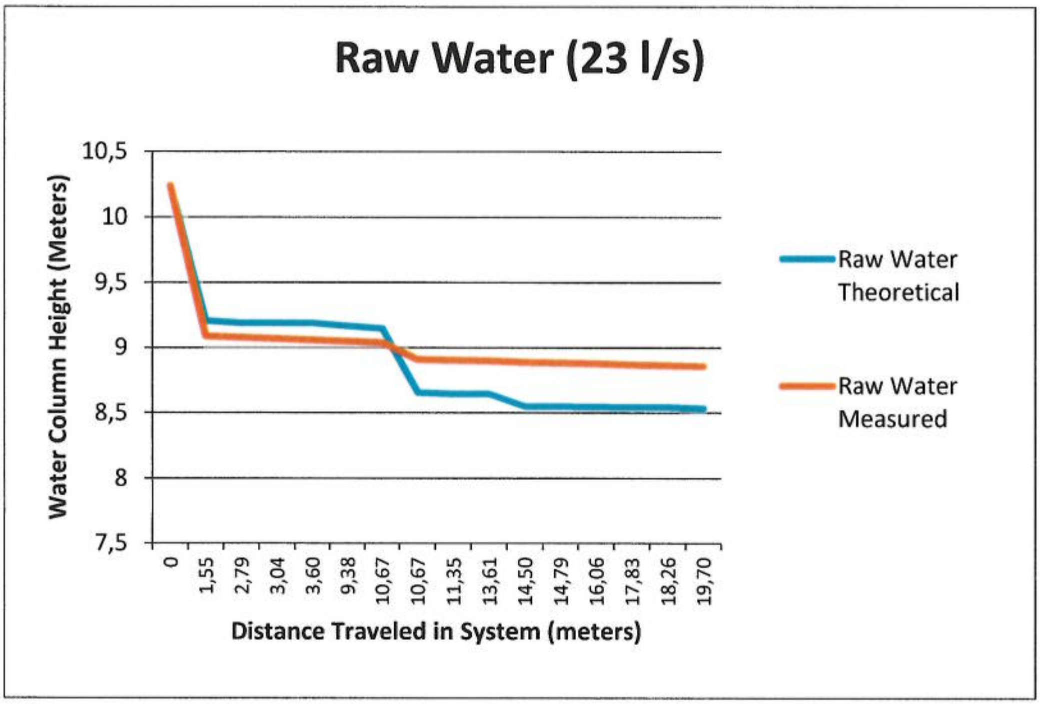
5.4 Restart of filter after standstill or re-fill of filter media

When restarting a filter after it has been out of operation for a period, the filter has to be backwashed intensively several times. If the filter has been stopped for re-fill of filter media the procedure for start-up of a new filter (section 4.2) should be followed.

Appendix Y:

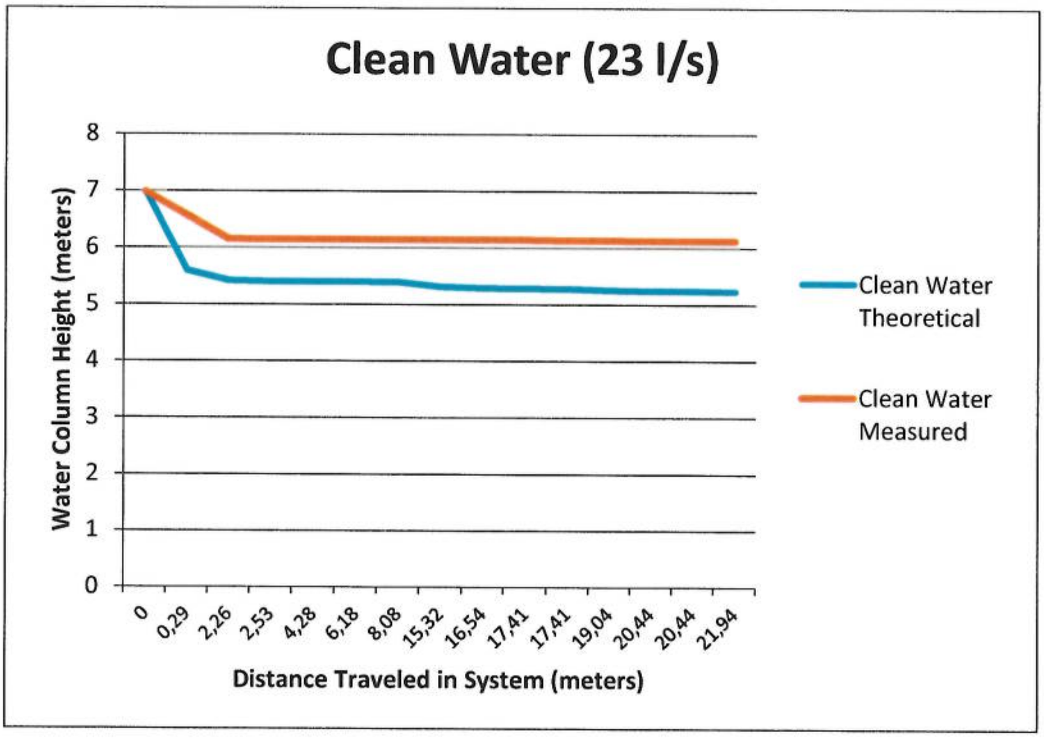
Enlarged Theoretical Vs. Measured Pressure Loss Graphs

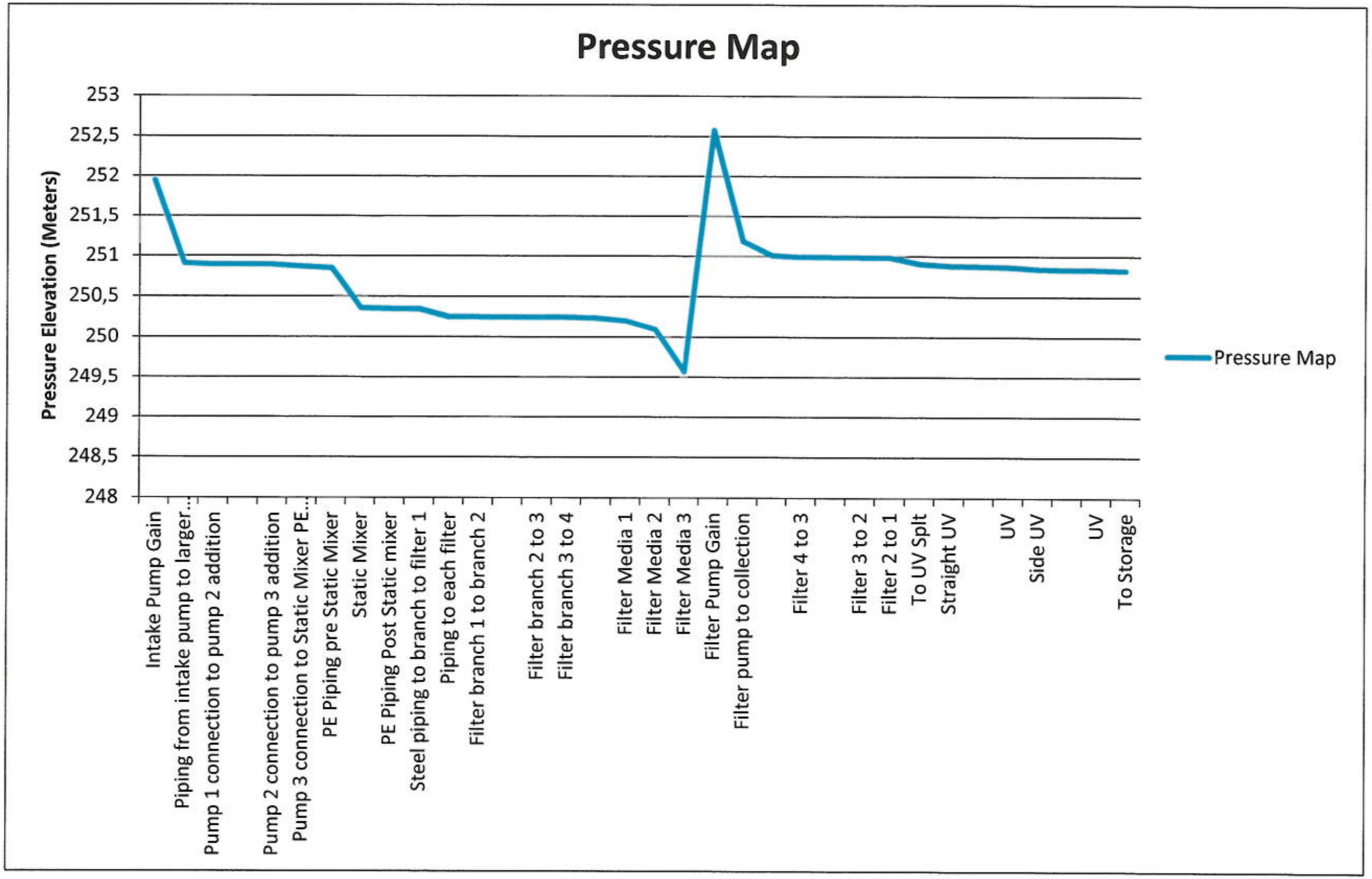
Flow 23	l/s				
	Raw Water	Loss		Post pump	
	P 2 Collect	1,1522948		Collection P	9,0857052
		0,05			
	Static	0,129			
		0,05			
		10,238			
	0	10,238		10,238	
Piping from intake pump to	1,55	9,20309028	1,152	9,086	
Pump 1 connection to pump 2 addition	2,79	9,18446843	0,01	9,076	0,65269486
	3,04	9,18440904	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	
	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	



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
Pressure Elevation (Meters)
253
252,5
252
251,5
251
250,5
250
249,5
249
248,5
248
Intake Pump Gain
Piping from intake pump to larger...
Pump 1 connection to pump 2 addition
Pump 2 connection to pump 3 addition
Pump 3 connection to Static Mixer PE...
PE Piping pre Static Mixer
Static Mixer
PE Piping Post Static mixer
Steel piping to branch to filter 1
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
Pressure Map

		Pressure Elevation
Intake Pump Gain	9,024522	251,944522
Piping from intake pump to	1,034909724	250,909612
Pump 1 connection to pump 2 addition	0,018621846	250,89099
	5,93907E-05	250,890931
Pump 2 connection to	0	250,890931
Pump 3 connection to	0,020506664	250,870424
PE Piping pre Static Mixer	0,020533192	250,849891
Static Mixer	0,490226293	250,359665
PE Piping Post Static mixer	0,009965683	250,349699
Steel piping to branch to	0,00188882	250,34781
Piping to each filter	0,096486335	250,251324
Filter branch 1 to branch 2	0,000267375	250,251057
	0,001859255	250,249197
Filter branch 2 to 3	0,001245977	250,247951
Filter branch 3 to 4	0,000123125	250,247828
	0,009532754	250,238296
Filter Media 1	0,034227448	250,204068
Filter Media 2	0,108329831	250,095738
Filter Media 3	0,525161477	249,570577
Filter Pump Gain	6,63	252,58
Filter pump to collection	1,392656584	251,187343
	0,176084229	251,011259
Filter 4 to 3	0,019093385	250,992166
	0,000360039	250,991806
Filter 3 to 2	0,00133976	250,990466
Filter 2 to 1	0,002776098	250,98769
To UV Splt	0,080062849	250,907627
Straight UV	0,022164848	250,885462
	0,006241226	250,879221
UV	0,01	250,869221
Side UV	0,020971024	250,84825
	0,00966325	250,838587
UV	0	250,838587
To Storage	0,010233876	250,828353