

Project name:	Clearwater Master Plan	Project no.	408831
Project component:	Task 3.4.3 Hydraulic Analysis of Existing and Projected Future Flow Conditions		
Subject of calculation:	Northeast WRF Hydraulic Profile		

Summary of revision history:

Rev.	Issue date	Description of calculation	Preparer	Checker	Reviewer	Approved
A	12/8/2022	Internal Recycle Calculations	N Garcia	Z Smierciak	J Turnbull	9/21/2023
A	12/8/2022	Chlorine Contact Calculations	N Garcia	Z Smierciak	J Turnbull	9/21/2023
A	12/8/2022	Filter to Screw Lift Calculations	N Garcia	Z Smierciak	J Turnbull	9/21/2023
A	12/8/2022	Screw Lift to Headworks Calculations	Z Smierciak	N Garcia	J Turnbull	9/21/2023

The full revision history of the calculation or document should normally be recorded by using the attributes in ProjectWise.
 If there are several reviewers (such as for different disciplines), enter the details in successive rows.
 In ProjectWise, use document type 'CL'. Store in folder 3.nn.dd.GD (the 'Generated documents' folder relevant to the 'location' and 'discipline' of the calculation). See GA280D for the recommended routing.

Description of calculation

Purpose of calculation	Northeast WRF Hydraulic Profile
Method of calculation	Excel spreadsheet using BV Hydraulics Spreadsheet v7.1 (metric).
Source documents used (including codes, standards & drawings)	As-builts and information provided by the City: NE WRF Record Drawings_Hydraulic Profile Model Mtg.pdf & NEWRF CCT Record Drawing_Dec 2003.pdf (pw://pwprod-is-kaci.kc.bv.com:PW_BVW_AMERICAS/Documents/P{a5ac3410-fd18-4faf-8eef-9bf287c067d4}/)
Design conditions considered	Flows were reviewed with the process team (Timur Deniz 10/26/22). Additional test flow was included which was determined iteratively until hydraulic failure was observed. Flow split per component or treatment unit is specified in green in the row on top of the flows for each component.
Health, safety and environmental risks considered	Not considered.
Key parameters used	Hazen Williams roughness coefficient of 110 was used for Ductile Iron Pipe due to age of the pipe (the first phase of the plant was built in 1975), and biofilm accumulation which can result from wastewater service application. Manning's coefficient (n) = 0.013 was used for cast in situ concrete channels.
Other comments	
Conclusions	<ul style="list-style-type: none"> - It was observed that for the MMAD and AAD flows, all weirs perform adequately although freeboard is less than 1.5 ft at some structures. - The Grit Chamber Effluent weir and 2nd Anoxic tank effluent weirs are predicted to be drowned from downstream at the design PHF of 27 MGD and above. - The 2050 projected AADF of 14.55 mgd falls below the existing design PHF and no additional hydraulic failures are predicted than the results provided for the design AADF. - Flows higher than the design PHF would increase the number and severity of the hydraulic failures. Where freeboard is less than 1.5 ft in the AADF flow condition, the 2050 projected AADF will decrease the freeboard marginally.



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Revision

Calculation no.

CAL-NEWRF Hydraulic Model-A

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Resulting drawings	See hydraulic profile drawing in Clearwater WRF Master Plan - Task 3.4 Hydraulic Profile & Pump Evaluation Technical Memorandum
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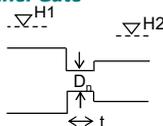
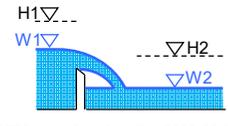
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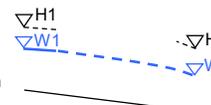
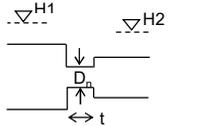
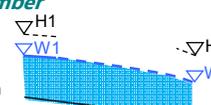
Calculation no. **CAL-NEWRF Hydraulic Model-A**

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Revision
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No.	Clearwater NE WRF Hydraulic Profile - Chlorine Contact Chamber					COMMENTS																																																																																																
<p>0 GENERAL</p> <p>Inputs in yellow boxes</p> <p>Units selection in pale yellow boxes</p> <p>Output results in blue boxes</p> <p>Drawing Reference Sheets Purple</p>	<p>Max Month Average Daily Flow Average Daily Flow Min Flow Original Plant Peak Hour</p> <p>Day</p> <table border="1" data-bbox="948 401 1370 621"> <thead> <tr> <th></th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th></th> </tr> <tr> <th>Case Description</th> <th>MMAD</th> <th>AADF (Permitted)</th> <th>Min</th> <th>ORIGINAL PH</th> <th></th> </tr> </thead> <tbody> <tr> <td>Flow rate A</td> <td>17.4</td> <td>13.5</td> <td>4</td> <td>27</td> <td>MGD</td> </tr> <tr> <td>RAS Recycle Ratio to AADF</td> <td>0.85</td> <td>0.7</td> <td>0.5</td> <td>1</td> <td></td> </tr> <tr> <td>RAS flow</td> <td>11.48</td> <td>9.45</td> <td>6.75</td> <td>13.5</td> <td>MGD</td> </tr> <tr> <td>Flow rate B: A + RAS</td> <td>28.9</td> <td>23.0</td> <td>10.8</td> <td>40.5</td> <td>MGD</td> </tr> <tr> <td>IR Recycle Ratio to AADF</td> <td>4.4</td> <td>4.4</td> <td>1.3</td> <td>4.4</td> <td></td> </tr> <tr> <td>Internal Recycle</td> <td>59.4</td> <td>59.4</td> <td>17.55</td> <td>59.4</td> <td>MGD</td> </tr> <tr> <td>Flow rate C: A + RAS + IR</td> <td>88.29</td> <td>82.35</td> <td>28.3</td> <td>99.9</td> <td>MGD</td> </tr> </tbody> </table>					1	2	3	4		Case Description	MMAD	AADF (Permitted)	Min	ORIGINAL PH		Flow rate A	17.4	13.5	4	27	MGD	RAS Recycle Ratio to AADF	0.85	0.7	0.5	1		RAS flow	11.48	9.45	6.75	13.5	MGD	Flow rate B: A + RAS	28.9	23.0	10.8	40.5	MGD	IR Recycle Ratio to AADF	4.4	4.4	1.3	4.4		Internal Recycle	59.4	59.4	17.55	59.4	MGD	Flow rate C: A + RAS + IR	88.29	82.35	28.3	99.9	MGD																																												
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<p>73 Chlorine Contact Tank By-Pass Channel</p> <p>CHANNEL BACKWATER</p> <p>Subcritical flow calculation proceeds upstream</p>  <p>Shape Rectangular [select] Length 7.5 ft Equation Manning [select] Manning n 0.013 Outlet loss K 1 Used only if outlet drowned Inlet loss K 0 U/s coping level 64 ftAD</p> <table border="1"> <tr> <td></td> <td>Upstream</td> <td>Downstream</td> <td></td> </tr> <tr> <td>Base width</td> <td>4</td> <td>4</td> <td>ft</td> </tr> <tr> <td>Not required</td> <td></td> <td>0</td> <td></td> </tr> <tr> <td>Not required</td> <td></td> <td>0</td> <td></td> </tr> <tr> <td>Invert level</td> <td>52</td> <td>52</td> <td>ftAD</td> </tr> </table> <p>Spatially varied flow options Side inflow No [select] uniformly distributed Side weir present No [select] Not required Not required</p> <p><i>Northeast Advanced Pollution Control Facility Improvements (Dec 2003), Sheets M-10, M-11</i></p>		Upstream	Downstream		Base width	4	4	ft	Not required		0		Not required		0		Invert level	52	52	ftAD	<p>Assume full plant flow through one Chlorine Contact Chamber</p> <table border="1"> <tr> <td>Flow rate</td> <td>17.4</td> <td>13.5</td> <td>4.0</td> <td>27.0</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>59.309</td> <td>59.266</td> <td>59.206</td> <td>59.462</td> <td>ftAD</td> </tr> <tr> <td>Not required</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Not required</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table> <table border="1"> <tr> <td>Downstream status</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> </tr> <tr> <td>U/s freeboard</td> <td>4.691</td> <td>4.734</td> <td>4.794</td> <td>4.537</td> <td>ft</td> </tr> <tr> <td>U/s flow (Q1)</td> <td>17.415</td> <td>13.500</td> <td>4.000</td> <td>27.000</td> <td>MGD</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.922</td> <td>0.719</td> <td>0.215</td> <td>1.399</td> <td>ft/s</td> </tr> <tr> <td>U/s water level (W1)</td> <td>59.309</td> <td>59.266</td> <td>59.206</td> <td>59.463</td> <td>ftAD</td> </tr> <tr> <td>U/s energy (H1)</td> <td>59.323</td> <td>59.274</td> <td>59.206</td> <td>59.493</td> <td>ftAD</td> </tr> </table> <p>Flow case plotted 1 [select]</p>	Flow rate	17.4	13.5	4.0	27.0	MGD	D/s energy (H2)	59.309	59.266	59.206	59.462	ftAD	Not required						Not required						Downstream status	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet	U/s freeboard	4.691	4.734	4.794	4.537	ft	U/s flow (Q1)	17.415	13.500	4.000	27.000	MGD	U/s velocity (V1)	0.922	0.719	0.215	1.399	ft/s	U/s water level (W1)	59.309	59.266	59.206	59.463	ftAD	U/s energy (H1)	59.323	59.274	59.206	59.493	ftAD	<p>BER (v9)</p>
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<p>70 Chlorine Contact Basin Influent Gate</p> <p>GENERAL SUBMERGED CONSTRICTION</p> <p>Idel'chik Diagram 4-12</p> <p>U/s shape Rectangular [select] U/s width 17.5 ft Opening shape Rectangular [select] Opening width 4 ft Opening thickness (t) 1.5 ft Opening edge radius 0 ft enter 0 if sharp D/s shape Rectangular [select] D/s width 8 ft</p> <p>Northeast Advanced Pollution Control Facility Improvements (Dec 2003), Sheets M-10, M-11</p>		<p>Assume full plant flow through one Chlorine Contact Chamber</p> <table border="1"> <tr> <td>Flow rate</td> <td>17.4</td> <td>13.5</td> <td>4.0</td> <td>27.0</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>61.428</td> <td>61.204</td> <td>60.536</td> <td>61.916</td> <td>ftAD</td> </tr> <tr> <td>U/s passage height</td> <td>12</td> <td>12</td> <td>12</td> <td>12</td> <td>ft</td> </tr> <tr> <td>Opening height</td> <td>4</td> <td>4</td> <td>4</td> <td>4</td> <td>ft</td> </tr> <tr> <td>D/s passage height</td> <td>12</td> <td>12</td> <td>12</td> <td>12</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>t/D_n</td> <td>0.375</td> <td>0.375</td> <td>0.375</td> <td>0.375</td> <td></td> </tr> <tr> <td>Orifice type</td> <td>LONG</td> <td>LONG</td> <td>LONG</td> <td>LONG</td> <td></td> </tr> <tr> <td>Flow stable?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>K (on orifice velocity)</td> <td>2.08</td> <td>2.08</td> <td>2.08</td> <td>2.08</td> <td></td> </tr> <tr> <td>Orifice velocity</td> <td>1.684</td> <td>1.305</td> <td>0.387</td> <td>2.611</td> <td>ft/s</td> </tr> <tr> <td>Headloss</td> <td>0.092</td> <td>0.055</td> <td>0.005</td> <td>0.220</td> <td>ft</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.128</td> <td>0.099</td> <td>0.029</td> <td>0.199</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>61.519</td> <td>61.259</td> <td>60.541</td> <td>62.136</td> <td>ftAD</td> </tr> </table>	Flow rate	17.4	13.5	4.0	27.0	MGD	D/s energy (H2)	61.428	61.204	60.536	61.916	ftAD	U/s passage height	12	12	12	12	ft	Opening height	4	4	4	4	ft	D/s passage height	12	12	12	12	ft	t/D _n	0.375	0.375	0.375	0.375		Orifice type	LONG	LONG	LONG	LONG		Flow stable?	NO	NO	NO	NO		K (on orifice velocity)	2.08	2.08	2.08	2.08		Orifice velocity	1.684	1.305	0.387	2.611	ft/s	Headloss	0.092	0.055	0.005	0.220	ft	U/s velocity (V1)	0.128	0.099	0.029	0.199	ft/s	U/s energy (H1)	61.519	61.259	60.541	62.136	ftAD	<p>PC (v4)</p>
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<p>Component 68 is for a pumped pipeline. It is used to estimate the required pump lift. Ignore warning regarding negative freeboard.</p>																																																																																	

68 Filters to Chlorine Contact Basin		Assume full plant flow		PL (v11)		
SURCHARGED CONDUIT		Flow rate	17.4	13.5	4.0	27.0 MGD
		D/s energy (H2)	61.543	61.274	60.542	62.186 ftAD
Shape	Circular [select]	Friction loss	0.235	0.147	0.015	0.530 ft
Length	142 ft	Fittings loss	0.406	0.244	0.021	0.977 ft
Diameter	3 ft 36" DIP Pipe	Surcharged loss	0.642	0.391	0.037	1.507 ft
Not required		Outlet controlled?	NO	NO	NO	NO
Equation	H-W [select]	Inlet controlled?	N/A	N/A	N/A	N/A
Hazen-Williams C	110	Total loss	0.642	0.391	0.037	1.507 ft
Inlet type	None [select]	U/s freeboard	-1.185	-0.665	0.421	-2.694 ft
Outlet loss K	0.5 Outlet into CCT	Velocity (V1)	3.812	2.955	0.876	5.910 ft/s
Other fittings total K	1.3 3 x 45 deg. + 1 x 90 deg. + 4 x 11.25 deg.	U/s energy (H1)	62.185	61.665	60.579	63.694 ftAD
U/s invert	48 ftAD					
D/s invert	56.5 ftAD					
U/s coping level	61 ftAD					
Northeast Advanced Pollution Control Facility Improvements (Dec 2003), Sheets C-7						

68.2 Filters to Chlorine Contact Basin		Assume full plant flow		PL (v11)		
SURCHARGED CONDUIT		Flow rate	17.4	13.5	4.0	27.0 MGD
		D/s energy (H2)	62.185	61.665	60.579	63.694 ftAD
Shape	Circular [select]	Friction loss	0.298	0.186	0.020	0.672 ft
Length	74 ft	Fittings loss	0.632	0.380	0.033	1.519 ft
Diameter	2.5 ft 30" DIP Pipe	Surcharged loss	0.930	0.566	0.053	2.191 ft
Not required		Outlet controlled?	NO	NO	NO	NO
Equation	H-W [select]	Inlet controlled?	N/A	N/A	N/A	N/A
Hazen-Williams C	110	Total loss	0.930	0.566	0.053	2.191 ft
Inlet type	None [select] No inlet or outlet since it is intermediate pipe	U/s freeboard	-2.115	-1.231	0.368	-4.884 ft
Outlet loss K		Velocity (V1)	5.489	4.255	1.261	8.510 ft/s
Other fittings total K	1.35 1 reducer + 1 x 45 deg. Bend + 1 x 90 deg. Bend + BFV	U/s energy (H1)	63.115	62.231	60.632	65.884 ftAD
U/s invert	48 ftAD					
D/s invert	56.5 ftAD					
U/s coping level	61 ftAD					
Northeast Advanced Pollution Control Facility Improvements (Dec 2003), Sheets C-7						

68.3 Filters to Chlorine Contact Basin		Assume full plant flow		PL (v11)		
SURCHARGED CONDUIT		Flow rate	17.4	13.5	4.0	27.0 MGD
		D/s energy (H2)	63.115	62.231	60.632	65.884 ftAD
Shape	Circular [select]	Friction loss	0.526	0.328	0.034	1.184 ft
Length	44 ft	Fittings loss	2.457	1.476	0.130	5.906 ft
Diameter	2 ft	Surcharged loss	2.983	1.805	0.164	7.090 ft
Not required		Outlet controlled?	NO	NO	NO	NO
Equation	H-W [select]	Inlet controlled?	NO	NO	NO	NO
Hazen-Williams C	110	Total loss	2.983	1.805	0.164	7.090 ft
Inlet type	Sharp-edged [select] Outlet modeled in component 68	U/s freeboard	-5.098	-3.036	0.204	-11.975 ft
Outlet loss K		Velocity (V1)	8.577	6.649	1.970	13.297 ft/s
Other fittings total K	1.65 One reducer + 5 x 90 deg. Bends	U/s energy (H1)	66.098	64.036	60.796	72.975 ftAD
U/s invert	48 ftAD					
D/s invert	56.5 ftAD					
U/s coping level	61 ftAD					
Northeast Filter and Effluent Pump Station (July 1983), pg. 17 & 18 of 27						

Upstream Energy (H1) required at Filter clearwell is: U/s energy (H1) 66.098 64.036 60.796 72.975

Head available: 53.75 Delta head provided by Filter Effluent Pumps.

Ignore negative freeboard since this is part of a pumped system.



No.	Clearwater NE WRF Hydraulic Profile - Final Filters to Screw Lift Station				COMMENTS			
0	GENERAL							
	Inputs in	yellow boxes	Case	1	2	3	4	
	Units selection in	pale yellow boxes	Description	MMAD	AADF (Permitted)	Min	PHF	
	Output results in	blue boxes						
	Drawing Reference Sheets	Purple	Flow rate A	17.4	13.5	4.0	27.0	MGD
			RAS Recycle Ratio to AADF	0.9	0.7	0.5	1.0	
			Ras Flow	11.5	9.5	6.8	13.5	
			Flow rate B: A + RAS	28.9	23.0	10.8	40.5	MGD
			IR Recycle Ratio to AADF	4.4	4.4	1.3	4.4	
			Internal Recycle	59.4	59.4	17.6	59.4	MGD
		Flow rate C: A + RAS + IR	88.3	82.4	28.3	99.9	MGD	

ONLY EDIT FLOWS ON
CALC_CHLORINE CONTACT

1 SUMMARY TABLE							
Generate table once all components added. Uses coloured reference numbers in column A. Can select energy, water level, velocity or freeboard.							
NO.	COMPONENT DESCRIPTION	COMPONENT TYPE	U/S ENERGY				[select]
67	Water Surface Elevation at Filters Clearwell	KNOWN CONDITIONS	53.750	53.750	53.750	53.751	ftAD
66	Filters Clearwell (Original Side)	CHANNEL BACKWATER	53.751	53.751	53.750	53.752	ftAD
65	Filter Effluent Pipe to Clearwell	SURCHARGED CONDUIT	53.866	53.820	53.756	54.026	ftAD
65.2	Filter Effluent Pipe to Trough Transition	CHANNEL TRANSITION	53.879	53.828	53.757	54.059	ftAD
64	Filter Trough	CHANNEL BACKWATER	53.883	53.830	53.757	54.067	ftAD
63	Tertiary Filter	SAND / ANTHRACITE FILTER MEDIA	56.518	55.959	54.966	58.256	ftAD
62	Weir Box at Filter Influent	THIN PLATE WEIR	59.475	59.363	59.024	59.721	ftAD
61	Pipe from Influent Channel to Filter	SURCHARGED CONDUIT	59.548	59.529	59.503	59.836	ftAD
60	Filters Influent Channel (Old Side) Filters 5 - 8	CHANNEL BACKWATER	59.590	59.555	59.505	59.908	ftAD
59	Filters Influent Channel Gate - New Side to Old Side Passag	GENERAL SUBMERGED CONSTRICTION	59.591	59.556	59.509	59.914	ftAD
59.2	Filters Influent Channel Gate - Influent Box to Passage	GENERAL SUBMERGED CONSTRICTION	59.674	59.608	59.514	60.073	ftAD
58	Influent Box	CHANNEL BACKWATER	59.674	59.609	59.514	60.073	ftAD
57	Filters Influent Box Transition	CHANNEL TRANSITION	59.677	59.610	59.514	60.078	ftAD
57.2	Influent Box Channel	CHANNEL BACKWATER	59.678	59.611	59.514	60.080	ftAD
56	Filters Influent Pipe to Junction Box	SURCHARGED CONDUIT	61.719	61.632	61.512	62.020	ftAD
55	Junction Box	0					
54	Junction Box to Concrete Box (Clarifiers 1-4 Effluent)	SURCHARGED CONDUIT	61.907	61.747	61.523	62.461	ftAD
53	Concrete Box to Concrete Box (Clarifiers 1-4 Effluent)	SURCHARGED CONDUIT	61.999	61.803	61.528	62.680	ftAD
52	Concrete Box to Clarifiers 1-4 Effluent	SURCHARGED CONDUIT	62.122	61.878	61.535	62.968	ftAD
52.2	Clarifiers 1-4 Effluent Channel	CHANNEL BACKWATER	62.128	61.882	61.536	62.977	ftAD
52.3	Pentagon outlet chamber	0	62.128	61.882	61.536	62.977	ftAD
51	Transition Component	0	62.128	61.882	61.536	62.977	ftAD
50	Clarifier No. 1 Effluent Pipe	SURCHARGED CONDUIT	62.171	61.909	61.538	63.078	ftAD
49	Clarifier Effluent Channel	SURCHARGED CONDUIT	62.188	61.919	61.539	63.119	ftAD
48	Clarifier No. 1 Effluent Trough (Half of it)	CHANNEL BACKWATER	62.344	62.258	61.998	63.164	ftAD
47	Clarifier No. 1 V-Notch Weirs	THIN PLATE V NOTCH WEIRS	63.354	63.344	63.308	63.374	ftAD
46	Clarifier Baffle and Center Column	CHANNEL FIXED LOSS	63.454	63.444	63.408	63.474	ftAD
45	Clarifier Influent Pipe	SURCHARGED CONDUIT	63.625	63.553	63.432	63.807	ftAD
44	Clarifier Splitter Box (Clarifiers 5-8)	CHANNEL BACKWATER	63.625	63.553	63.432	63.807	ftAD
43	Effluent Channel - Second Anoxic Tanks (9 - 10) to Clarifier	CHANNEL BACKWATER	63.705	63.605	63.445	63.950	ftAD
43.2	Effluent Channel - Second Anoxic Tanks (9 - 10)	CHANNEL BACKWATER	63.769	63.648	63.455	64.061	ftAD
43.3	Gates at Effluent Channel - Second Anoxic Tanks (9 - 10), G	GENERAL SUBMERGED CONSTRICTION	63.773	63.650	63.455	64.068	ftAD
43.4	Gates at Effluent Channel - Second Anoxic Tanks (5-8), Gate	GENERAL SUBMERGED CONSTRICTION	63.774	63.651	63.456	64.069	ftAD
43.5	Gates at Effluent Channel - Second Anoxic Tanks (5 - 8), Ga	GENERAL SUBMERGED CONSTRICTION	63.774	63.651	63.456	64.070	ftAD
42	Effluent Channel - Second Anoxic Tanks (1-8) to (9-10) Cros	0	63.774	63.651	63.456	64.070	0
41	Effluent Channel - Second Anoxic Tanks (1-8) to (9-10) Cros	SURCHARGED CONDUIT	63.836	63.690	63.464	64.191	ftAD
40	Effluent Channel - Second Anoxic Tanks (1-8) to (9-10) Cros	0	63.836	63.690	63.464	64.191	ft
39	2nd Anoxic Tanks (6-8) Effluent Channel	CHANNEL BACKWATER	63.864	63.709	63.469	64.238	ftAD
38	2nd Anoxic Tank (No. 6) Effluent Weir	BROAD-CRESTED WEIR	64.161	64.138	64.083	64.259	ftAD
37	2nd Anoxic Tank (No. 6) Baffle Wall	GENERAL SUBMERGED CONSTRICTION	64.161	64.138	64.083	64.261	ftAD
36	Gate from Influent Channel to Anoxic Tank (No. 8)	GENERAL SUBMERGED CONSTRICTION	64.164	64.140	64.084	64.271	ftAD
35	2nd Anoxic Tank Influent Telescoping Valve Weir	THIN PLATE WEIR	64.219	64.177	64.094	64.353	ftAD
34	2nd Anoxic Tank (No. 8) Influent Channel (Vertical Segmen	SURCHARGED CONDUIT	64.282	64.217	64.102	64.477	ftAD
33	Second Anoxic Tanks Influent Chanel	GENERAL SURCHARGED CONDUIT	64.527	64.371	64.136	64.959	ftAD
33.2	2nd Anoxic Tanks Flow Diversion Structure to Influent Chan	GENERAL SUBMERGED CONSTRICTION	64.579	64.404	64.144	65.061	ftAD
33.3	2nd Anoxic Tanks Flow Diversion Structure (Vertical Segmen	SURCHARGED CONDUIT	64.704	64.483	64.161	65.307	ftAD
32	2nd Anoxic Tanks Pipe to Flow Diversion Structure	CHANNEL TRANSITION	64.883	64.596	64.185	65.663	ftAD
31	2nd Anoxic Tanks to Oxidation Reactor Wye	SURCHARGED CONDUIT	65.497	64.992	64.279	66.829	ftAD
30	Wye to Oxidation Reactor East Effluent Line	SURCHARGED CONDUIT	65.952	65.286	64.350	67.692	ftAD
29	Oxidation Reactor Effluent Box/Channel	CHANNEL BACKWATER	68.043	67.829	67.318	68.422	ftAD
28	Oxidation Reactor Effluent Weir	THIN PLATE WEIR	69.501	69.430	69.261	69.626	ftAD
27	Oxidation Reactor	CHANNEL BACKWATER	69.501	69.430	69.261	69.626	ftAD
26	Oxidation Reactor Inlet from Culvert	CHANNEL TRANSITION	69.504	69.433	69.261	69.630	ftAD
25	Oxidation Reactor Inlet Culvert	SURCHARGED CONDUIT	70.107	69.958	69.323	70.403	ftAD
24	Screw Lifts Effluent Common Channel	CHANNEL BACKWATER	70.291	70.129	69.350	70.611	ftAD
24.2	Screw Lift Outlet Stop Gate	GENERAL SUBMERGED CONSTRICTION	70.337	70.172	69.358	70.663	ftAD



Calculation no. **CAL-NEWRF Hydraulic Model-A**

(Sheet no. given in header)

A

67 Water Surface Elevation at Filters Clearwell

KNOWN CONDITIONS

Shape: **Rectangular** [select]

Known variable: **Water level** [select]

Width: 29 ft

Not required

Invert level: 48.5 ftAD

Coping level: 61 ftAD

Flow rate: 17.415, 13.5, 4, 27 MGD

Water level: 53.75, 53.75, 53.75, 53.75 ftAD

Freeboard: 7.250, 7.250, 7.250, 7.250 ft

Velocity (V1): 0.177, 0.137, 0.041, 0.274 ft/s

Water level (W1): 53.750, 53.750, 53.750, 53.750 ftAD

Energy (H1): 53.750, 53.750, 53.750, 53.751 ftAD

Diagram: $H1 \nabla \dots$, $W1 \nabla$, $V1 \rightarrow$

Diagram: $\nabla H1$, $\nabla W1$, $\nabla H2$, $\nabla W2$

Diagram: $H1$, $H2$

SG (v6)

Assume 2/3 of flow goes through old clearwell side.

CHANNEL BACKWATER

Subcritical flow calculation proceeds upstream

Downstream status: Drowned outlet

U/s freeboard: 7.249, 7.249, 7.250, 7.248 ft

U/s flow (Q1): 0.000, 0.000, 0.000, 0.000 MGD

U/s velocity (V1): 0.000, 0.000, 0.000, 0.000 ft/s

U/s water level (W1): 53.751, 53.751, 53.750, 53.752 ftAD

U/s energy (H1): 53.751, 53.751, 53.750, 53.752 ftAD

Base width: 29 ft (Upstream), 29 ft (Downstream)

Invert level: 48.5 ftAD (Upstream), 48 ftAD (Downstream)

Spatially varied flow options

Side inflow: Yes [select] uniformly distributed

Side weir present: No [select]

Flow case plotted: 1 [select]

66 Filters Clearwell (Original Side)

Diagram: $\nabla H1$, $\nabla W1$, $\nabla H2$, $\nabla W2$

Diagram: $H1$, $H2$

65 Filter Effluent Pipe to Clearwell

SURCHARGED CONDUIT

Assume one filter out of service, flow per filter is total flow/11

Flow rate: 1.58, 1.23, 0.36, 2.45 MGD

D/s energy (H2): 53.751, 53.751, 53.750, 53.752 ftAD

Friction loss: 0.010, 0.006, 0.001, 0.023 ft

Fittings loss: 0.104, 0.063, 0.006, 0.251 ft

Surcharged loss: 0.115, 0.069, 0.006, 0.274 ft

Outlet controlled?: NO, NO, NO, NO

Inlet controlled?: NO, NO, NO, NO

Total loss: 0.115, 0.069, 0.006, 0.274 ft

U/s freeboard: 7.134, 7.180, 7.244, 6.974 ft

Velocity (V1): 1.386, 1.075, 0.318, 2.149 ft/s

U/s energy (H1): 53.866, 53.820, 53.756, 54.026 ftAD

65.2 Filter Effluent Pipe to Trough Transition

CHANNEL TRANSITION

Assume one filter out of service, flow per filter is total flow/11

Flow rate: 1.58, 1.23, 0.36, 2.45 MGD

D/s energy (H2): 53.866, 53.820, 53.756, 54.026 ftAD

Transition type?: Contraction

Loss K: 0.5, 0.5, 0.5, 0.5

Fitting loss: 0.013, 0.008, 0.001, 0.032 ft

Critical check

U/s freeboard: 7.125, 7.174, 7.243, 6.948 ft

D/s velocity (V2): 1.386, 1.075, 0.318, 2.149 ft/s

D/s water level (W2): 53.875, 53.826, 53.757, 54.052 ftAD

U/s velocity (V1): 0.466, 0.369, 0.112, 0.678 ft/s

U/s water level (W1): 53.875, 53.826, 53.757, 54.052 ftAD

U/s energy (H1): 53.879, 53.828, 53.757, 54.059 ftAD

64 Filter Trough

CHANNEL BACKWATER

Subcritical flow calculation proceeds upstream

Assume one filter out of service, flow per filter is total flow/11

D/s flow (Q2)	1.58	1.23	0.36	2.45	MGD
D/s energy (H2)	53.879	53.828	53.757	54.059	ftAD
Side inflow (total)	1.58	1.23	0.36	2.45	MGD
Not required					

Downstream status

	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet	
U/s freeboard	7.117	7.170	7.243	6.933	ft
U/s flow (Q1)	0.000	0.000	0.000	0.000	MGD
U/s velocity (V1)	0.000	0.000	0.000	0.000	ft/s
U/s water level (W1)	53.883	53.830	53.757	54.067	ftAD
U/s energy (H1)	53.883	53.830	53.757	54.067	ftAD

Shape: **Rectangular** [select]
 Length: 30 ft
 Equation: Manning [select]
 Manning n: 0.013
 Outlet loss K: Used only if outlet drowned
 Inlet loss K: 0.5
 U/s coping level: 61 ftAD

Upstream Downstream
 Base width: 2 ft 2 ft
 Not required: 0 0
 Not required: 0 0
 Invert level: 51.25 ftAD 51.25 ftAD

Spatially varied flow options
 Side inflow: Yes [select] uniformly distributed
 Side weir present: No [select]
 Not required
 Not required

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 81 and 82 of 166

Flow case plotted: 1 [select]

63 Tertiary Filter

SAND / ANTHRACITE FILTER MEDIA

Must be reviewed with filter designer
 BV guidance doc GCD332

This component uses total flow since number of units in service and specified and accounted for in formulas

Total flow rate	17.42	13.50	4.00	27.00	MGD
D/s energy (H2)	53.883	53.830	53.757	54.067	ftAD
No. units in service	11	11	11	11	Excl. maint., inc. washing
No. backwashing	1	1	1	1	

Value from BOD and As-builts

Filtration rate	0.082	0.063	0.019	0.127	in/s
Media 1 clean loss	0.964	0.745	0.219	1.508	ft
Media 2 clean loss	0.000	0.000	0.000	0.000	ft
Dirt allowance	0.952	0.952	0.952	0.952	ft
Underdrain loss	0.719	0.432	0.038	1.729	ft

U/s water level (W1): 56.518, 55.959, 54.966, 58.256 ftAD
 U/s energy (H1): 56.518, 55.959, 54.966, 58.256 ftAD

Goal seek

Per Basis of Design Manual pages (found in document titled: NEWRF Tertiary Filtration BOD), Operating head is 4.17 ft above filter media (Distance T in manual). There is a backwash trough and v-notch weir that runs along the length of each filter cell. During normal operations and low water levels, the trough is used to distribute the water evenly throughout the filter and prevent filter media displacement at the head of the filter where water is falling from influent weir box; however, it appears backwash trough is not used during higher flows/head since high operating head per BOD manual (distance T) is above the backwash trough weir invert elevation. Since highest water level governs, the backwash trough is not included in this calculation. Filter upstream water level per BOD matches influent weir crest elevation; therefore, using Goal Seek iteratively calculated the dirt allowance that would result in this water level for the Max Day condition.

Project Wise Location: [pw://pwprod-is-kaci.kc.bv.com:PW_BW_AMERICAS/Documents/D{714fba8-1c5a-4d13-a17a-1ea155ca1e1f}](http://pwprod-is-kaci.kc.bv.com:PW_BW_AMERICAS/Documents/D{714fba8-1c5a-4d13-a17a-1ea155ca1e1f})

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 81 and 82 of 166

62 Weir Box at Filter Influent

THIN PLATE WEIR

Kindsvater-Carter Eqn: $Q=C_d(2/3)\sqrt{2g}b_e h_e^{1.5}$
 BS ISO 1438:2017
 Villemonthe's drowned weir equation

Assume one filter out of service, flow per filter is total flow/11

Flow rate (Q)	1.58	1.23	0.36	2.45	MGD
D/s water level (W2)	56.518	55.959	54.966	58.256	ftAD

Undrowned head (h_e): 0.723, 0.611, 0.274, 0.966 ft
 C_d: 0.595, 0.595, 0.593, 0.597
 Weir status: Free, Free, Free, Free

U/s freeboard: 0.777, 0.889, 1.226, 0.534 ft
 U/s velocity (V1): 0.401, 0.327, 0.115, 0.560 ft/s
 U/s water level (W1): 59.473, 59.361, 59.024, 59.716 ftAD
 U/s energy (H1): 59.475, 59.363, 59.024, 59.721 ftAD

Note: The rectangular weir model has a higher/more conservative value than actual existing trapezoidal weir.
 Coping level of top of weir box was added to check for spillage. top of weir box at 61'00"-2'3"+1'6" = 60.25

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 88 of 166



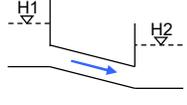
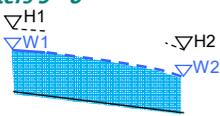
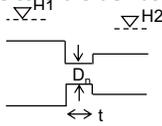
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ProjectWise document code

Calculation no. **CAL-NEWRF Hydraulic Model-A**

(Sheet no. given in header)

Revision
A

<p>61 <i>Pipe from Influent Channel to Filter</i></p> <p>SURCHARGED CONDUIT</p> <p>Shape Circular [select] Length 5.5 ft Diameter 18 in Not required Equation H-W [select] Hazen-Williams C 110 Inlet type Sharp-edged [select] Outlet loss K 1 Other fittings total K 0 See guidance sheet U/s invert 58 ftAD D/s invert 58 ftAD U/s coping level 61 ftAD</p>	 <p>Flow rate D/s energy (H2)</p> <table border="1"> <tr> <td>1.58</td> <td>1.23</td> <td>0.36</td> <td>2.45</td> <td>MGD</td> </tr> <tr> <td>59.475</td> <td>59.363</td> <td>59.024</td> <td>59.721</td> <td>ftAD</td> </tr> </table> <p>Friction loss 0.003 ft Fittings loss 0.045 ft Surcharged loss 0.048 ft</p> <p>Outlet controlled? YES Inlet controlled? NO Total loss 0.072 ft</p> <p>U/s freeboard 1.452 ft Velocity (V1) 1.386 ft/s U/s energy (H1) 59.548 ftAD</p>	1.58	1.23	0.36	2.45	MGD	59.475	59.363	59.024	59.721	ftAD	<p>Assume one filter out of service, flow per filter is total flow/11</p> <p>PL (v11)</p>																																				
1.58	1.23	0.36	2.45	MGD																																												
59.475	59.363	59.024	59.721	ftAD																																												
<p>60 <i>Filters Influent Channel (Old Side) Filters 5 - 8</i></p> <p>CHANNEL BACKWATER</p> <p>Subcritical flow calculation proceeds upstream</p> <p>Shape Rectangular [select] Length 48 ft Equation Manning [select] Manning n 0.013 Outlet loss K 1.5 Used only if outlet drowned Inlet loss K 1.5 For 90 deg. Line to branch turn. U/s coping level 61 ftAD</p> <p>Upstream Downstream Base width 4.5 4.5 ft Not required 0 Not required 0 Invert level 58 58 ftAD</p> <p>Spatially varied flow options Side inflow Yes [select] uniformly distributed Side weir present No [select] Not required Not required</p>	 <p>D/s flow (Q2) 0 MGD D/s energy (H2) 59.548 ftAD Side inflow (total) -5.805 MGD Not required</p> <p>Downstream status U/s freeboard 1.435 ft U/s flow (Q1) 5.805 MGD U/s velocity (V1) 1.276 ft/s U/s water level (W1) 59.565 ftAD U/s energy (H1) 59.590 ftAD</p>	<p>Assume 1/3 of the flow through this section and spatially varying a</p> <table border="1"> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>MGD</td> </tr> <tr> <td>59.548</td> <td>59.529</td> <td>59.503</td> <td>59.836</td> <td>ftAD</td> </tr> <tr> <td>-5.805</td> <td>-4.5</td> <td>-1.33333</td> <td>-9</td> <td>MGD</td> </tr> </table> <table border="1"> <tr> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td></td> </tr> <tr> <td>1.461</td> <td>1.497</td> <td>1.135</td> <td>1.135</td> <td>ft</td> </tr> <tr> <td>4.500</td> <td>1.333</td> <td>9.000</td> <td>9.000</td> <td>MGD</td> </tr> <tr> <td>1.005</td> <td>0.305</td> <td>1.659</td> <td>1.659</td> <td>ft/s</td> </tr> <tr> <td>59.539</td> <td>59.503</td> <td>59.865</td> <td>59.865</td> <td>ftAD</td> </tr> <tr> <td>59.555</td> <td>59.505</td> <td>59.908</td> <td>59.908</td> <td>ftAD</td> </tr> </table>	0	0	0	0	MGD	59.548	59.529	59.503	59.836	ftAD	-5.805	-4.5	-1.33333	-9	MGD	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet		1.461	1.497	1.135	1.135	ft	4.500	1.333	9.000	9.000	MGD	1.005	0.305	1.659	1.659	ft/s	59.539	59.503	59.865	59.865	ftAD	59.555	59.505	59.908	59.908	ftAD	<p>BER (v9)</p> <p>Flow case plotted 1 [select]</p>
0	0	0	0	MGD																																												
59.548	59.529	59.503	59.836	ftAD																																												
-5.805	-4.5	-1.33333	-9	MGD																																												
Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet																																													
1.461	1.497	1.135	1.135	ft																																												
4.500	1.333	9.000	9.000	MGD																																												
1.005	0.305	1.659	1.659	ft/s																																												
59.539	59.503	59.865	59.865	ftAD																																												
59.555	59.505	59.908	59.908	ftAD																																												
<p>59 <i>Filters Influent Channel Gate - New Side to Old Side Passage</i></p> <p>GENERAL SUBMERGED CONSTRICTION</p> <p>Idel'chik Diagram 4-12</p> <p>U/s shape Rectangular [select] U/s width 8.5 ft Opening shape Rectangular [select] Opening width 5 ft Opening thickness (t) 1 ft Opening edge radius 0 ft enter 0 if sharp D/s shape Rectangular [select] D/s width 48 ft</p>	 <p>Flow rate D/s energy (H2) U/s passage height Opening height D/s passage height</p> <table border="1"> <tr> <td>0.666667</td> <td>1.333333</td> <td>2</td> <td>2.666667</td> <td>MGD</td> </tr> <tr> <td>59.590</td> <td>59.555</td> <td>59.505</td> <td>59.908</td> <td>ftAD</td> </tr> <tr> <td>1.565</td> <td>1.539</td> <td>1.503</td> <td>1.865</td> <td>ft</td> </tr> <tr> <td>1.565</td> <td>1.539</td> <td>1.503</td> <td>1.865</td> <td>ft</td> </tr> <tr> <td>1.565</td> <td>1.539</td> <td>1.503</td> <td>1.865</td> <td>ft</td> </tr> </table> <p>t/D_n 0.420 Orifice type LONG Flow stable? NO K (on orifice velocity) 1.76 Orifice velocity 0.132 ft/s Headloss 0.000 ft U/s velocity (V1) 0.078 ft/s U/s energy (H1) 59.591 ftAD</p>	0.666667	1.333333	2	2.666667	MGD	59.590	59.555	59.505	59.908	ftAD	1.565	1.539	1.503	1.865	ft	1.565	1.539	1.503	1.865	ft	1.565	1.539	1.503	1.865	ft	<p>Assume 2/3 of total flow go through old influent channel</p> <p>PC (v4)</p>																					
0.666667	1.333333	2	2.666667	MGD																																												
59.590	59.555	59.505	59.908	ftAD																																												
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1.565	1.539	1.503	1.865	ft																																												
<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 80 of 166</p> <p>New side to old side passage component omitted due to short length</p>																																																



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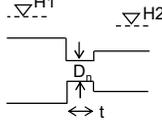
(Sheet no. given in header)

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A

59.2 Filters Influent Channel Gate - Influent Box to Passage

Assume 2/3 of total flow go through old influent channel

GENERAL SUBMERGED CONSTRICTION



Idel'chik Diagram 4-12

U/s shape **Rectangular** [select]
 U/s width **8** ft
 Opening shape **Rectangular** [select]
 Opening width **5** ft
 Opening thickness (t) **1** ft
 Opening edge radius **0** ft enter 0 if sharp
 D/s shape **Rectangular** [select]
 D/s width **8.5** ft

Flow rate	11.61	9	2.666667	18	MGD
D/s energy (H2)	59.591	59.556	59.509	59.914	ftAD
U/s passage height	5.565	5.539	5.503	-52.209	ft
Opening height	1.565	1.539	1.503	1.865	ft
D/s passage height	1.565	1.539	1.503	1.865	ft
t/D _n	0.420	0.425	0.433	0.368	
Orifice type	LONG	LONG	LONG	LONG	
Flow stable?	NO	NO	NO	NO	
K (on orifice velocity)	1.02	1.02	1.02	1.15	
Orifice velocity	2.296	1.810	0.549	2.986	ft/s
Headloss	0.084	0.052	0.005	0.160	ft
U/s velocity (V1)	0.404	0.314	0.094	-0.067	ft/s
U/s energy (H1)	59.674	59.608	59.514	60.073	ftAD

PC (v4)

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58 Influent Box

Assume all flow goes through influent box

CHANNEL BACKWATER



Subcritical flow calculation proceeds upstream

Shape **Rectangular** [select]
 Length **12** ft
 Equation **Manning** [select]
 Manning n **0.013**
 Outlet loss K **Used only if outlet drowned**
 Inlet loss K **0**
 U/s coping level **61** ftAD

Flow rate	17.4	13.5	4.0	27.0	MGD
D/s energy (H2)	59.674	59.608	59.514	60.073	ftAD
Not required					
Not required					
Downstream status	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet	
U/s freeboard	1.331	1.395	1.486	0.938	ft
U/s flow (Q1)	17.415	13.500	4.000	27.000	MGD
U/s velocity (V1)	0.594	0.466	0.140	0.861	ft/s
U/s water level (W1)	59.669	59.605	59.514	60.062	ftAD
U/s energy (H1)	59.674	59.609	59.514	60.073	ftAD

BER (v9)

	Upstream	Downstream
Base width	8	8
Not required		0
Not required		0
Invert level	54	54

ftAD

Spatially varied flow options

Side inflow **No** [select] uniformly distributed
 Side weir present **No** [select]
 Not required
 Not required

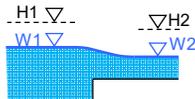
Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 80 and 82 of 166

Flow case plotted
1 [select]

57 Filters Influent Box Transition

Assume all flow goes through influent box

CHANNEL TRANSITION



$H_1 = H_2 + k(V_1^2 - V_2^2)/2g$ for expansion
 $H_1 = H_2 + k(V_2^2 - V_1^2)/2g$ for contraction

U/s shape **Rectangular** [select]
 D/s shape **Rectangular** [select]
 Type of transition **Square-ended** [select]
 Not required
 U/s width **8** ft
 D/s width **8** ft
 Not required
 Not required
 U/s invert level **45.25** ftAD
 D/s invert level **54** ftAD
 U/s coping level **61** ftAD

Flow rate	17.415	13.5	4	27	MGD
D/s energy (H2)	59.674	59.609	59.514	60.073	ftAD
Transition type?	Contraction	Contraction	contraction	contraction	
Loss K	0.5	0.5	0.5	0.5	
Fitting loss	0.002	0.001	0.000	0.005	ft
Critical check					
U/s freeboard	1.324	1.391	1.486	0.924	ft
D/s velocity (V2)	0.594	0.466	0.140	0.861	ft/s
D/s water level (W2)	59.669	59.605	59.514	60.062	ftAD
U/s velocity (V1)	0.233	0.182	0.054	0.352	ft/s
U/s water level (W1)	59.676	59.609	59.514	60.076	ftAD
U/s energy (H1)	59.677	59.610	59.514	60.078	ftAD

CT (v8)

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57.2 Influent Box Channel

CHANNEL BACKWATER



Assume all flow goes through influent box

Flow rate	17.4	13.5	4.0	27.0	MGD
D/s energy (H2)	59.677	59.610	59.514	60.078	ftAD
Not required					
Not required					
Downstream status	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet	
U/s freeboard	1.323	1.390	1.486	0.922	ft
U/s flow (Q1)	17.415	13.500	4.000	27.000	MGD
U/s velocity (V1)	0.233	0.182	0.054	0.352	ft/s
U/s water level (W1)	59.677	59.610	59.514	60.078	ftAD
U/s energy (H1)	59.678	59.611	59.514	60.080	ftAD

BER (v9)

Subcritical flow calculation proceeds upstream

Shape	Rectangular [select]
Length	12 ft
Equation	Manning [select]
Manning n	0.013
Outlet loss K	1 Used only if outlet drowned
Inlet loss K	0
U/s coping level	61 ftAD

	Upstream	Downstream
Base width	8	8 ft
Not required		0
Not required		0
Invert level	45.25	45.25 ftAD

Spatially varied flow options

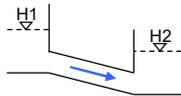
Side inflow	No [select] uniformly distributed
Side weir present	No [select]
Not required	
Not required	

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 80 and 82 of 166

Flow case plotted
1 [select]

56 Filters Influent Pipe to Junction Box

SURCHARGED CONDUIT



Assume all flow goes through Junction Box

Flow rate	17.415	13.5	4	27	MGD
D/s energy (H2)	59.678	59.611	59.514	60.080	ftAD
Friction loss	0.036	0.022	0.002	0.081	ft
Fittings loss	0.183	0.110	0.010	0.439	ft
Surcharged loss	0.219	0.132	0.012	0.520	ft
Outlet controlled?	YES	YES	YES	YES	
Inlet controlled?	NO	NO	NO	NO	
Total loss	2.041	2.022	1.998	1.940	ft
U/s freeboard	1.281	1.368	1.488	0.980	ft
Velocity (V1)	2.801	2.171	0.643	4.342	ft/s
U/s energy (H1)	61.719	61.632	61.512	62.020	ftAD

PL (v11)

Shape	Circular [select]
Length	46 ft
Diameter	3.5 ft 42" DIP
Not required	
Equation	H-W [select]
Hazen-Williams C	110
Inlet type	Sharp-edged [select]
Outlet loss K	1
Other fittings total K	0 See guidance sheet
U/s invert	50 ftAD
D/s invert	58 ftAD
U/s coping level	63 ftAD

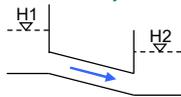
Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 17, 85 and 89 of 166

55 Junction Box COMPONENT DELETED

BER (v9)

54 Junction Box to Concrete Box (Clarifiers 1-4 Effluent)

SURCHARGED CONDUIT



Assumes half of the total flow (from Clarifiers 1-4 only)

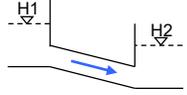
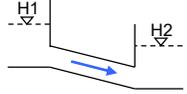
Flow rate	8.7075	6.75	2	13.5	MGD
D/s energy (H2)	61.719	61.632	61.512	62.020	ftAD
Friction loss	0.081	0.051	0.005	0.183	ft
Fittings loss	0.107	0.064	0.006	0.258	ft
Surcharged loss	0.189	0.115	0.011	0.441	ft
Outlet controlled?	NO	NO	NO	NO	
Inlet controlled?	NO	NO	NO	NO	
Total loss	0.189	0.115	0.011	0.441	ft
U/s freeboard	1.093	1.253	1.477	0.539	ft
Velocity (V1)	1.906	1.477	0.438	2.955	ft/s
U/s energy (H1)	61.907	61.747	61.523	62.461	ftAD

PL (v11)

Shape	Circular [select]
Length	177 ft
Diameter	3 ft
Not required	
Equation	H-W [select]
Hazen-Williams C	110
Inlet type	Sharp-edged [select]
Outlet loss K	1 Outlet to Junction Box
Other fittings total K	0.4 2 x 45 bends
U/s invert	50.25 ftAD
D/s invert	50.25 ftAD
U/s coping level	63 ftAD

Yard piping does not show upstream invert or coping level elevation for this pipe segment. Assumed same upstream and downstream invert elevation. Assumed same coping level as downstream diversion box of 63 ft.

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 17, 89 and 91 of 166

<p>53 <i>Concrete Box to Concrete Box (Clarifiers 1-4 Effluent)</i></p>	<p>SURCHARGED CONDUIT</p>  <p>Assumes half of the total flow (from Clarifiers 1-4 only)</p> <p>Shape: Circular [select] Length: 14.5 ft Diameter: 3 ft Not required Equation: H-W [select] Hazen-Williams C: 110 Inlet type: Sharp-edged [select] <i>Yard piping does not show upstream invert or coping level elevation for this pipe segment. Assumed same upstream and downstream invert elevation.</i> Outlet loss K: 1 Other fittings total K: See guidar U/s invert: 50.25 ftAD D/s invert: 50.25 ftAD U/s coping level: 63 ftAD <i>Assumed same coping level as downstream diversion box of 63 ft.</i></p>	<p>Flow rate: 8.7075, 6.75, 2, 13.5 MGD D/s energy (H2): 61.907, 61.747, 61.523, 62.461 ftAD</p> <p>Friction loss: 0.007, 0.004, 0.000, 0.015 ft Fittings loss: 0.085, 0.051, 0.004, 0.203 ft Surcharged loss: 0.091, 0.055, 0.005, 0.218 ft</p> <p>Outlet controlled?: NO, NO, NO, NO Inlet controlled?: NO, NO, NO, NO Total loss: 0.091, 0.055, 0.005, 0.218 ft</p> <p>U/s freeboard: 1.001, 1.197, 1.472, 0.320 ft Velocity (V1): 1.906, 1.477, 0.438, 2.955 ft/s U/s energy (H1): 61.999, 61.803, 61.528, 62.680 ftAD</p>	<p>PL (v11)</p>
<p>52 <i>Concrete Box to Clarifiers 1-4 Effluent</i></p>	<p>SURCHARGED CONDUIT</p>  <p>Assumes half of the total flow (from Clarifiers 1-4 only)</p> <p>Shape: Circular [select] Length: 140.5 ft Diameter: 3 ft Not required Equation: H-W [select] Hazen-Williams C: 110 Inlet type: Bellmouth [select] <i>Pipe to channel connection not shown in drawings for clarifiers 1-4 but shown in drawings for clarifiers 5-8 on pg 62 of 166.</i> Outlet loss K: 1 Other fittings total K: See guidar U/s invert: 57.5 ftAD D/s invert: 50.25 ftAD U/s coping level: 64.5 ftAD <i>U/s Invert el assumed to be the s</i></p>	<p>Flow rate: 8.7075, 6.75, 2, 13.5 MGD D/s energy (H2): 61.999, 61.803, 61.528, 62.680 ftAD</p> <p>Friction loss: 0.065, 0.040, 0.004, 0.145 ft Fittings loss: 0.059, 0.036, 0.003, 0.142 ft Surcharged loss: 0.124, 0.076, 0.007, 0.288 ft</p> <p>Outlet controlled?: NO, NO, NO, NO Inlet controlled?: NO, NO, NO, NO Total loss: 0.124, 0.076, 0.007, 0.288 ft</p> <p>U/s freeboard: 2.378, 2.622, 2.965, 1.532 ft Velocity (V1): 1.906, 1.477, 0.438, 2.955 ft/s U/s energy (H1): 62.122, 61.878, 61.535, 62.968 ftAD</p>	<p>PL (v11)</p>
<p>52.2 <i>Clarifiers 1-4 Effluent Channel</i></p>	<p>CHANNEL BACKWATER</p>  <p>Assumes half of the total flow (from Clarifiers 1-4 only)</p> <p>Subcritical flow calculation proceeds upstream</p> <p>Shape: Rectangular [select] Length: 43 ft Equation: Manning [select] Manning n: 0.013 Outlet loss K: 0.5 Inlet loss K: 0.5 <i>Inlet loss was added for Pentagon to Channel</i> U/s coping level: 64.5 ftAD</p> <p>Upstream: 4 ft, Downstream: 4 ft Not required: 0 Invert level: 57.5 ftAD</p> <p>Spatially varied flow options Side inflow: No [select] uniformly distributed Side weir present: No [select]</p>	<p>Flow rate: 8.7075, 6.75, 2, 13.5 MGD D/s energy (H2): 62.122, 61.878, 61.535, 62.968 ftAD</p> <p>Downstream status: Drowned outlet, Drowned outlet, Drowned outlet, Drowned outlet</p> <p>U/s freeboard: 2.381, 2.624, 2.965, 1.538 ft U/s flow (Q1): 8.708, 6.750, 2.000, 13.500 MGD U/s velocity (V1): 0.729, 0.597, 0.192, 0.956 ft/s U/s water level (W1): 62.119, 61.876, 61.535, 62.962 ftAD U/s energy (H1): 62.128, 61.882, 61.536, 62.977 ftAD</p>	<p>BER (v9)</p> <p>Flow case plotted: 1 [select]</p>
<p>52.3 <i>Pentagon outlet chamber</i></p>	<p>Clarifier outlet flow discharges into this chamber Assume zero loss in the chamber Flow leaves the chamber into the 4ft wide outlet channel</p>	<p>U/s energy (H1): 62.128, 61.882, 61.536, 62.977 ftAD</p>	<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 62 of 166</p>
<p>51 <i>Transition Component</i></p>	<p>COMPONENT DELETED</p>	<p>U/s energy (H1): 62.128, 61.882, 61.536, 62.977 ftAD</p>	



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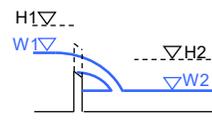
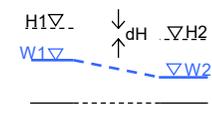
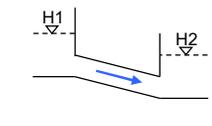
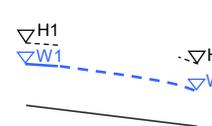
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Revision

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<p>50 Clarifier No. 1 Effluent Pipe</p> <p>SURCHARGED CONDUIT</p> <p>Shape Circular [select] Length 62.5 ft Diameter 2 ft Not required Equation H-W [select] Hazen-Williams C 110 Inlet type None [select] Outlet loss K 1 Other fittings total K 0 See guidance sheet U/s invert 55.5 ftAD D/s invert 56.5 ftAD U/s coping level 64.75 ftAD</p>		<p>Assumes flow from 1 out of 8 clarifiers with 1 out of service</p> <table border="1"> <tr> <td>Flow rate</td> <td>2.488</td> <td>1.929</td> <td>0.571</td> <td>3.857143</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>62.128</td> <td>61.882</td> <td>61.536</td> <td>62.977</td> <td>ftAD</td> </tr> <tr> <td>Friction loss</td> <td>0.020</td> <td>0.013</td> <td>0.001</td> <td>0.046</td> <td>ft</td> </tr> <tr> <td>Fittings loss</td> <td>0.023</td> <td>0.014</td> <td>0.001</td> <td>0.056</td> <td>ft</td> </tr> <tr> <td>Surcharged loss</td> <td>0.044</td> <td>0.027</td> <td>0.003</td> <td>0.102</td> <td>ft</td> </tr> <tr> <td>Outlet controlled?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>Inlet controlled?</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td></td> </tr> <tr> <td>Total loss</td> <td>0.044</td> <td>0.027</td> <td>0.003</td> <td>0.102</td> <td>ft</td> </tr> <tr> <td>U/s freeboard</td> <td>2.579</td> <td>2.841</td> <td>3.212</td> <td>1.672</td> <td>ft</td> </tr> <tr> <td>Velocity (V1)</td> <td>1.225</td> <td>0.950</td> <td>0.281</td> <td>1.900</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>62.171</td> <td>61.909</td> <td>61.538</td> <td>63.078</td> <td>ftAD</td> </tr> </table> <p>PL (v11)</p>	Flow rate	2.488	1.929	0.571	3.857143	MGD	D/s energy (H2)	62.128	61.882	61.536	62.977	ftAD	Friction loss	0.020	0.013	0.001	0.046	ft	Fittings loss	0.023	0.014	0.001	0.056	ft	Surcharged loss	0.044	0.027	0.003	0.102	ft	Outlet controlled?	NO	NO	NO	NO		Inlet controlled?	N/A	N/A	N/A	N/A		Total loss	0.044	0.027	0.003	0.102	ft	U/s freeboard	2.579	2.841	3.212	1.672	ft	Velocity (V1)	1.225	0.950	0.281	1.900	ft/s	U/s energy (H1)	62.171	61.909	61.538	63.078	ftAD																	
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<p>49 Clarifier Effluent Channel</p> <p>SURCHARGED CONDUIT</p> <p>Shape Box [select] Length 5.6 ft Width 2.0 ft Ref Height 2.7 ft Equation Manning [select] Manning n 0.013 Inlet type None [select] Outlet loss K 0.5 Other fittings total K 1.5 See guidar 2 x 90 Deg. Mitre bends U/s invert 0 ftAD Inverts set a zero to prevent D/s invert 0 ftAD inlet/outlet control. Length set to U/s coping level 64.75 ftAD downstream WSEL - Box Invert.</p>						<p>Assumes flow from 1 out of 8 clarifiers with 1 out of service</p> <table border="1"> <tr> <td>Flow rate</td> <td>2.488</td> <td>1.929</td> <td>0.571</td> <td>3.857</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>62.171</td> <td>61.909</td> <td>61.538</td> <td>63.078</td> <td>ftAD</td> </tr> <tr> <td>Friction loss</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.001</td> <td>ft</td> </tr> <tr> <td>Fittings loss</td> <td>0.016</td> <td>0.010</td> <td>0.001</td> <td>0.039</td> <td>ft</td> </tr> <tr> <td>Surcharged loss</td> <td>0.017</td> <td>0.010</td> <td>0.001</td> <td>0.040</td> <td>ft</td> </tr> <tr> <td>Outlet controlled?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>Inlet controlled?</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td></td> </tr> <tr> <td>Total loss</td> <td>0.017</td> <td>0.010</td> <td>0.001</td> <td>0.040</td> <td>ft</td> </tr> <tr> <td>U/s freeboard</td> <td>2.562</td> <td>2.831</td> <td>3.211</td> <td>1.631</td> <td>ft</td> </tr> <tr> <td>Velocity (V1)</td> <td>0.722</td> <td>0.559</td> <td>0.166</td> <td>1.119</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>62.188</td> <td>61.919</td> <td>61.539</td> <td>63.119</td> <td>ftAD</td> </tr> <tr> <td>dh</td> <td>0.017</td> <td>0.010</td> <td>0.001</td> <td>0.040</td> <td></td> </tr> </table> <p>PL (v11)</p>	Flow rate	2.488	1.929	0.571	3.857	MGD	D/s energy (H2)	62.171	61.909	61.538	63.078	ftAD	Friction loss	0.000	0.000	0.000	0.001	ft	Fittings loss	0.016	0.010	0.001	0.039	ft	Surcharged loss	0.017	0.010	0.001	0.040	ft	Outlet controlled?	NO	NO	NO	NO		Inlet controlled?	N/A	N/A	N/A	N/A		Total loss	0.017	0.010	0.001	0.040	ft	U/s freeboard	2.562	2.831	3.211	1.631	ft	Velocity (V1)	0.722	0.559	0.166	1.119	ft/s	U/s energy (H1)	62.188	61.919	61.539	63.119	ftAD	dh	0.017	0.010	0.001	0.040								
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<p>48 Clarifier No. 1 Effluent Trough (Half of it)</p> <p>CHANNEL BACKWATER</p> <p>Subcritical flow calculation proceeds upstream</p> <p>Shape Rectangular [select] Length 113.88 ft Equation Manning [select] Manning n 0.013 Outlet loss K 1 Used only if outlet drowned Inlet loss K Water trickles down wall from weir to trough U/s coping level 64.75 ftAD</p> <table border="1"> <tr> <td></td> <td>Upstream</td> <td>Downstream</td> <td></td> </tr> <tr> <td>Base width</td> <td>2</td> <td>2</td> <td>ft</td> </tr> <tr> <td>Not required</td> <td></td> <td>0</td> <td></td> </tr> <tr> <td>Not required</td> <td></td> <td>0</td> <td></td> </tr> <tr> <td>Invert level</td> <td>61.75</td> <td>61.75</td> <td>ftAD</td> </tr> </table> <p>Downstream status</p> <table border="1"> <tr> <td></td> <td>Critical depth</td> <td>Critical depth</td> <td>Critical depth</td> <td>Drowned outlet</td> <td></td> </tr> <tr> <td>U/s freeboard</td> <td>2.406</td> <td>2.492</td> <td>2.752</td> <td>1.586</td> <td>ft</td> </tr> <tr> <td>U/s flow (Q1)</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>MGD</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>ft/s</td> </tr> <tr> <td>U/s water level (W1)</td> <td>62.344</td> <td>62.258</td> <td>61.998</td> <td>63.164</td> <td>ftAD</td> </tr> <tr> <td>U/s energy (H1)</td> <td>62.344</td> <td>62.258</td> <td>61.998</td> <td>63.164</td> <td>ftAD</td> </tr> </table> <p>Trough Length</p> <ul style="list-style-type: none"> dia 75 ft Trough wi 2.5 ft cl dia 72.5 ft T L 227.765 ft TL half 113.883 ft Weir dian 70 ft weir Leng 219.911 ft Half 109.956 ft V Notche 0.5 ft No of V N 440 <p>Assumes HALF flow from 1 out of 8 clarifiers with 1 out of service</p> <table border="1"> <tr> <td>D/s flow (Q2)</td> <td>1.244</td> <td>0.964</td> <td>0.286</td> <td>1.929</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>62.188</td> <td>61.919</td> <td>61.539</td> <td>63.119</td> <td>ftAD</td> </tr> <tr> <td>Side inflow (total)</td> <td>1.244</td> <td>0.964</td> <td>0.286</td> <td>1.929</td> <td>MGD</td> </tr> <tr> <td>Not required</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table> <p>Flow case plotted 1 [select]</p> <p>BER (v9)</p>						Upstream	Downstream		Base width	2	2	ft	Not required		0		Not required		0		Invert level	61.75	61.75	ftAD		Critical depth	Critical depth	Critical depth	Drowned outlet		U/s freeboard	2.406	2.492	2.752	1.586	ft	U/s flow (Q1)	0.000	0.000	0.000	0.000	MGD	U/s velocity (V1)	0.000	0.000	0.000	0.000	ft/s	U/s water level (W1)	62.344	62.258	61.998	63.164	ftAD	U/s energy (H1)	62.344	62.258	61.998	63.164	ftAD	D/s flow (Q2)	1.244	0.964	0.286	1.929	MGD	D/s energy (H2)	62.188	61.919	61.539	63.119	ftAD	Side inflow (total)	1.244	0.964	0.286	1.929	MGD	Not required						
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Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 57, 61, 66, 67, 68, 71 and 72 of 166

<p>47 Clarifier No. 1 V-Notch Weirs</p>	<p>THIN PLATE V NOTCH WEIRS $Q = (8/15)\sqrt{2g}C_d \tan(\theta/2)h^{5/2}$ Villemonte's drowned weir equation Shape Triangular No. of notches 440 V notch elevation 63.25 ftAD Notch base angle (θ) 90 degrees Notch top width 0.33 ft U/s channel width 75 ft U/s channel invert 51.25 ftAD U/s coping level 64.75 ftAD C_d 0.58 Approx. obtain from BS ISO 1438:2017 for flow measurement weirs</p>  <p>Clarifier Diameter Clarifier Bottom</p>	<p>Assumes flow for 1 out of 8 clarifiers with 1 out of service. No RAS since RAS goes under. Total flow rate (Q) 2.49 1.93 0.57 3.86 MGD D/s water level (W2) 62.34 62.26 62.00 63.16 ftAD</p> <p>Undrowned head 0.104 0.094 0.058 0.124 ft Weir status Free Free Free Free discharge discharge discharge discharge</p> <p>Notch overtopped? NO NO NO NO</p> <p>U/s freeboard 1.396 1.406 1.442 1.376 m U/s velocity (V1) 0.004 0.003 0.001 0.007 ft/s U/s water level (W1) 63.354 63.344 63.308 63.374 ftAD U/s energy (H1) 63.354 63.344 63.308 63.374 ftAD</p>	<p>WTV (v5)</p>															
<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 61, 63 and 67 of 166 detail of weir plate - No elevation given. Water level (unknown flow) 3" above concrete weir</p>																		
<p>46 Clarifier Baffle and Center Column</p>	<p>CHANNEL FIXED LOSS $H_1 = H_2 + dH$</p>  <p>Shape Circular [select] Diameter 1 ft Not required Invert level 51.25 ftAD Coping level 64.75 ftAD</p>	<p>Assumes flow for 1 out of 8 clarifiers with 1 out of service plus RAS flow Flow rate 4.13 3.28 1.54 5.79 MGD D/s energy (H2) 63.35 63.34 63.31 63.37 ftAD Fixed loss (dH) 0.1 0.1 0.1 0.1 ft</p> <p>Value Assumed</p> <p>Critical check</p> <p>U/s freeboard 1.296 1.306 1.342 1.276 ft U/s velocity (V1) 8.130 6.459 3.025 11.398 ft/s U/s water level (W1) 63.454 63.444 63.408 63.474 ftAD U/s energy (H1) 63.454 63.444 63.408 63.474 ftAD</p>	<p>CE (v4)</p>															
<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 68 of 166</p>																		
<p>45 Clarifier Influent Pipe</p>	<p>SURCHARGED CONDUIT</p>  <p>Shape Circular [select] Length 74 ft Diameter 2.25 ft Not required Equation H-W [select] Hazen-Williams C 110 Inlet type Sharp-edged [select] Outlet loss K 1 Other fittings total K 1.9 2 x 45 deg. Bends + 1 x 90 deg. Bend U/s invert 55.62 ftAD D/s invert 44.94 ftAD U/s coping level 64.75 ftAD</p>	<p>Assumes flow for 1 out of 8 clarifiers with 1 out of service plus RAS flow Flow rate 4.13 3.28 1.54 5.79 MGD D/s energy (H2) 63.45 63.44 63.41 63.47 ftAD</p> <p>Friction loss 0.035 0.023 0.006 0.065 ft Fittings loss 0.136 0.086 0.019 0.268 ft Surcharged loss 0.171 0.109 0.024 0.332 ft</p> <p>Outlet controlled? NO NO NO NO Inlet controlled? NO NO NO NO Total loss 0.171 0.109 0.024 0.332 ft</p> <p>U/s freeboard 1.125 1.197 1.318 0.943 ft Velocity (V1) 1.606 1.276 0.598 2.251 ft/s U/s energy (H1) 63.625 63.553 63.432 63.807 ftAD</p>	<p>PL (v11)</p>															
<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 61, 62, 67, 68 and 71 of 166 Northeast Wastewater Treatment Facility (1975), Sheet 65 of 142</p>																		
<p>44 Clarifier Splitter Box (Clarifiers 5-8)</p>	<p>CHANNEL BACKWATER</p>  <p>Subcritical flow calculation proceeds upstream</p> <p>Shape Trapezoidal Octagonal Length 15 ft Equation Manning [select] Manning n 0.013 Outlet loss K 0 inlet loss into pipe (Component 45) Inlet loss K outlet loss from channel (component 43) U/s coping level 64.75 ftAD</p> <table border="1"> <thead> <tr> <th></th> <th>Upstream</th> <th>Downstream</th> </tr> </thead> <tbody> <tr> <td>Base width</td> <td>15</td> <td>15 ft</td> </tr> <tr> <td>Side angle</td> <td></td> <td>5 deg from horiz</td> </tr> <tr> <td>Not required</td> <td></td> <td>0</td> </tr> <tr> <td>Invert level</td> <td>55.62</td> <td>55.62 ftAD</td> </tr> </tbody> </table> <p>Spatially varied flow options Side inflow No [select] uniformly distributed Side weir present No [select] Not required Not required</p>		Upstream	Downstream	Base width	15	15 ft	Side angle		5 deg from horiz	Not required		0	Invert level	55.62	55.62 ftAD	<p>Assumes half of the total flow (Clarifiers 5-8 only) including RAS Flow rate 14.445 11.475 5.375 20.25 MGD D/s energy (H2) 63.625 63.553 63.432 63.81 ftAD</p> <p>Downstream status Drowned outlet Drowned outlet Drowned outlet Drowned outlet</p> <p>U/s freeboard 1.125 1.197 1.318 0.943 ft U/s flow (Q1) 14.445 11.475 5.375 20.250 MGD U/s velocity (V1) 0.000 0.000 0.000 0.000 ft/s U/s water level (W1) 63.625 63.553 63.432 63.807 ftAD U/s energy (H1) 63.625 63.553 63.432 63.807 ftAD</p>	<p>BER (v9)</p> <p>Flow case plotted 1 [select]</p>
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Side angle		5 deg from horiz																
Not required		0																
Invert level	55.62	55.62 ftAD																
<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 61 of 166</p>																		



BLACK & VEATCH

ProjectWise document code

Calculation no. **CAL-NEWRF Hydraulic Model-A**

(Sheet no. given in header)

Revision
A

43 Effluent Channel - Second Anoxic Tanks (9 - 10) to Clarifier 5-8 Splitter Box Assumes half of the total flow (Clarifiers 5-8 only) including RAS

CHANNEL BACKWATER

Subcritical flow calculation proceeds upstream

Flow rate	14.445	11.475	5.375	20.25	MGD
D/s energy (H2)	63.625	63.553	63.432	63.807	ftAD
Not required					
Not required					

Downstream status

	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet	
U/s freeboard	1.065	1.158	1.308	0.835	ft
U/s flow (Q1)	14.445	11.475	5.375	20.250	MGD
U/s velocity (V1)	1.136	0.924	0.451	1.505	ft/s
U/s water level (W1)	63.685	63.592	63.442	63.915	ftAD
U/s energy (H1)	63.705	63.605	63.445	63.950	ftAD

Shape: **Rectangular** [select]
 Length: 127 ft
 Equation: Manning [select]
 Manning n: 0.013
 Outlet loss K: 1 Used only if outlet drowned
 Inlet loss K: 2.52 1 x 90 degree bends in channel.
 U/s coping level: 64.75 ftAD

Base width: Upstream 5 ft, Downstream 5 ft
 Not required: 0
 Not required: 0
 Invert level: 59.75 ftAD

Spatially varied flow options

Side inflow: No [select] uniformly distributed
 Side weir present: No [select]
 Not required: 1. for 5ft wide channel, we have of these bends. However, the one at the junction with the 3ft channel will have a k of 1.181.2 = 1.32. There is no inlet loss
 Not required: 2. For the 3ft wide channel we will have no outlet loss but k=1.1*1.2=1.32 for the bend
 Miller = 'Internal Flow Systems' by D S Miller, standard textbook

There are several isolation gates in this segment not being modeled since they are considered fully open
 Miller would suggest k=1.1 for a bend with a sharp inner and rounded outer.
 Miller fig 10.2 would suggest a modifier of ~1.2 for bend bend interaction.
 However, we have the change in channel width between the two bends as well.

Flow case plotted 1 [select]

43.2 Effluent Channel - Second Anoxic Tanks (9 - 10) Assumes half of the total flow (Clarifiers 5-8 only) including RAS and 2/10 side flow from Second Anoxic Tanks

CHANNEL BACKWATER

Subcritical flow calculation proceeds upstream

D/s flow (Q2)	14.445	11.475	5.375	20.25	MGD
D/s energy (H2)	63.705	63.605	63.445	63.950	ftAD
Side inflow (total)	5.778	4.59	2.15	8.1	MGD
Not required					

Downstream status

	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet	
U/s freeboard	2.501	2.615	2.798	2.223	ft
U/s flow (Q1)	8.667	6.885	3.225	12.150	MGD
U/s velocity (V1)	1.118	0.914	0.449	1.465	ft/s
U/s water level (W1)	63.749	63.635	63.452	64.027	ftAD
U/s energy (H1)	63.769	63.648	63.455	64.061	ftAD

Shape: **Rectangular** [select]
 Length: 50 ft
 Equation: Manning [select]
 Manning n: 0.013 expansion loss only. Bend-bend in component 43
 Outlet loss K: 0.35
 Inlet loss K: 2.52
 U/s coping level: 66.25 ftAD

Base width: Upstream 3 ft, Downstream 3 ft
 Not required: 0
 Not required: 0
 Invert level: 59.75 ftAD

Spatially varied flow options

Side inflow: Yes [select] uniformly distributed
 Side weir present: No [select]
 Not required: 1
 Not required: 2

Flow case plotted 1 [select]

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 17, 49, 50, 51, 53 and 62 of 166

The following channel gates are not shown in the as-built drawings. Gate dimensions were assumed to be 2.8 ft wide and 2 inches thick. Channel height is based on downstream water surface elevation minus channel invert. Gate #4 between tanks 5 & 6 and Gate #5 prior to tank 5 are not modeled due to zero flow from the way flow is split with anoxic tanks 1-5 flow going to clarifiers 1-4.

43.3 Gates at Effluent Channel - Second Anoxic Tanks (9 - 10), Gate #1 Assumes Flow from Second Anoxic Tanks 6-9 including RAS

GENERAL SUBMERGED CONSTRICTION

Idel'chik Diagram 4-12

Flow rate	11.556	9.18	4.3	16.2	MGD
D/s energy (H2)	63.769	63.648	63.455	64.061	ftAD
U/s passage height	3.999	3.885	3.702	4.277	ft
Opening height	3.999	3.885	3.702	4.277	ft
D/s passage height	3.999	3.885	3.702	4.277	ft

t/D_n

0.051	0.051	0.052	0.049
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Orifice type: THIN
 Flow stable?: YES
 K (on orifice velocity): 0.10
 Orifice velocity: 1.597 ft/s
 Headloss: 0.004 ft
 U/s velocity (V1): 1.490 ft/s
 U/s energy (H1): 63.773 ftAD

U/s shape: **Rectangular** [select]
 U/s width: 3 ft
 Opening shape: **Rectangular** [select]
 Opening width: 2.8 ft
 Opening thickness (t): 0.17 ft
 Opening edge radius: 0 ft enter 0 if sharp
 D/s shape: **Rectangular** [select]
 D/s width: 3 ft

Sheets 49, 50 of 166 shows the stop gates



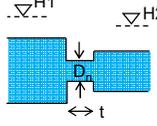
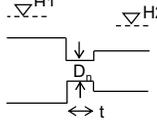
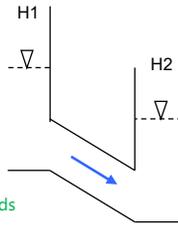
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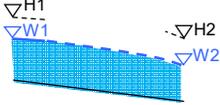
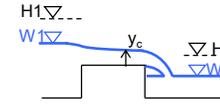
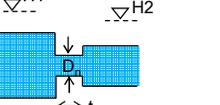
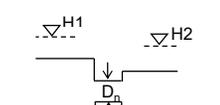
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Calculation no. **CAL-NEWRF Hydraulic Model-A**

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<p>43.4 <i>Gates at Effluent Channel - Second Anoxic Tanks (5-8), Gate #2</i></p> <p>GENERAL SUBMERGED CONSTRICTION</p> <p>Idel'chik Diagram 4-12</p>  <p>U/s shape Rectangular [select] U/s width 3 ft Opening shape Rectangular [select] Opening width 2.8 ft Opening thickness (t) 0.17 ft Opening edge radius 0 ft D/s shape Rectangular [select] D/s width 3 ft</p> <p>enter 0 if sharp</p>	<p>Assumes Flow from Second Anoxic Tanks 6-7 Including RAS</p> <table border="1"> <tr> <td>Flow rate</td> <td>5.778</td> <td>4.59</td> <td>2.15</td> <td>8.1</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>63.773</td> <td>63.650</td> <td>63.455</td> <td>64.068</td> <td>ftAD</td> </tr> <tr> <td>U/s passage height</td> <td>3.999</td> <td>3.885</td> <td>3.702</td> <td>4.277</td> <td>ft</td> </tr> <tr> <td>Opening height</td> <td>3.999</td> <td>3.885</td> <td>3.702</td> <td>4.277</td> <td>ft</td> </tr> <tr> <td>D/s passage height</td> <td>3.999</td> <td>3.885</td> <td>3.702</td> <td>4.277</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>t/D_n</td> <td>0.051</td> <td>0.051</td> <td>0.052</td> <td>0.049</td> <td></td> </tr> <tr> <td>Orifice type</td> <td>THIN</td> <td>THIN</td> <td>THIN</td> <td>THIN</td> <td></td> </tr> <tr> <td>Flow stable?</td> <td>YES</td> <td>YES</td> <td>YES</td> <td>YES</td> <td></td> </tr> <tr> <td>K (on orifice velocity)</td> <td>0.10</td> <td>0.10</td> <td>0.10</td> <td>0.10</td> <td></td> </tr> <tr> <td>Orifice velocity</td> <td>0.798</td> <td>0.653</td> <td>0.321</td> <td>1.046</td> <td>ft/s</td> </tr> <tr> <td>Headloss</td> <td>0.001</td> <td>0.001</td> <td>0.000</td> <td>0.002</td> <td>ft</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.745</td> <td>0.609</td> <td>0.300</td> <td>0.977</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>63.774</td> <td>63.651</td> <td>63.456</td> <td>64.069</td> <td>ftAD</td> </tr> </table>	Flow rate	5.778	4.59	2.15	8.1	MGD	D/s energy (H2)	63.773	63.650	63.455	64.068	ftAD	U/s passage height	3.999	3.885	3.702	4.277	ft	Opening height	3.999	3.885	3.702	4.277	ft	D/s passage height	3.999	3.885	3.702	4.277	ft	t/D _n	0.051	0.051	0.052	0.049		Orifice type	THIN	THIN	THIN	THIN		Flow stable?	YES	YES	YES	YES		K (on orifice velocity)	0.10	0.10	0.10	0.10		Orifice velocity	0.798	0.653	0.321	1.046	ft/s	Headloss	0.001	0.001	0.000	0.002	ft	U/s velocity (V1)	0.745	0.609	0.300	0.977	ft/s	U/s energy (H1)	63.774	63.651	63.456	64.069	ftAD	<p>PC (v4)</p>
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<p>42 <i>Effluent Channel - Second Anoxic Tanks (1-8) to (9-10) Crossing</i></p>	<p>COMPONENT DELETED</p> <table border="1"> <tr> <td>U/s energy (H1)</td> <td>63.774</td> <td>63.651</td> <td>63.456</td> <td>64.070</td> <td></td> </tr> </table>	U/s energy (H1)	63.774	63.651	63.456	64.070		<p>0</p>																																																																								
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<p>41 <i>Effluent Channel - Second Anoxic Tanks (1-8) to (9-10) Crossing (Culvert)</i></p> <p>SURCHARGED CONDUIT</p> <p>Shape Box [select] Length 21 ft Width 4.5 ft Height 3 ft Equation Manning [select] Manning n 0.013 Inlet type Slightly rounded [select] Outlet loss K 1 Other fittings total K 2.64 2 x 90 deg. Bends U/s invert 56 ftAD D/s invert 56 ftAD U/s coping level 66.25 ftAD</p> 	<p>Assumes half of the total flow (Clarifiers 5-8 only) including RAS minus 2/5 side flow from Second Anoxic Tanks 9-10</p> <table border="1"> <tr> <td>Flow rate</td> <td>8.667</td> <td>6.885</td> <td>3.225</td> <td>12.15</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>63.774</td> <td>63.651</td> <td>63.456</td> <td>64.070</td> <td>ftAD</td> </tr> </table> <table border="1"> <tr> <td>Friction loss</td> <td>0.002</td> <td>0.001</td> <td>0.000</td> <td>0.004</td> <td>ft</td> </tr> <tr> <td>Fittings loss</td> <td>0.060</td> <td>0.038</td> <td>0.008</td> <td>0.117</td> <td>ft</td> </tr> <tr> <td>Surcharged loss</td> <td>0.061</td> <td>0.039</td> <td>0.009</td> <td>0.121</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>Outlet controlled?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>Inlet controlled?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>Total loss</td> <td>0.061</td> <td>0.039</td> <td>0.009</td> <td>0.121</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>U/s freeboard</td> <td>2.414</td> <td>2.560</td> <td>2.786</td> <td>2.059</td> <td>ft</td> </tr> <tr> <td>Velocity (V1)</td> <td>0.993</td> <td>0.789</td> <td>0.370</td> <td>1.393</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>63.836</td> <td>63.690</td> <td>63.464</td> <td>64.191</td> <td>ftAD</td> </tr> </table> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 50 of 166</p>	Flow rate	8.667	6.885	3.225	12.15	MGD	D/s energy (H2)	63.774	63.651	63.456	64.070	ftAD	Friction loss	0.002	0.001	0.000	0.004	ft	Fittings loss	0.060	0.038	0.008	0.117	ft	Surcharged loss	0.061	0.039	0.009	0.121	ft	Outlet controlled?	NO	NO	NO	NO		Inlet controlled?	NO	NO	NO	NO		Total loss	0.061	0.039	0.009	0.121	ft	U/s freeboard	2.414	2.560	2.786	2.059	ft	Velocity (V1)	0.993	0.789	0.370	1.393	ft/s	U/s energy (H1)	63.836	63.690	63.464	64.191	ftAD	<p>PL (v11)</p>												
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<p>40 <i>Effluent Channel - Second Anoxic Tanks (1-8) to (9-10) Crossing</i></p>	<p>COMPONENT DELETED</p> <table border="1"> <tr> <td>U/s energy (H1)</td> <td>63.836</td> <td>63.690</td> <td>63.464</td> <td>64.191</td> <td>ft</td> </tr> </table>	U/s energy (H1)	63.836	63.690	63.464	64.191	ft	<p></p>																																																																								
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<p>39 2nd Anoxic Tanks (6-8) Effluent Channel</p> <p>CHANNEL BACKWATER</p> <p>Subcritical flow calculation proceeds upstream</p>  <p>Shape Rectangular [select] Length 78 ft Equation Manning [select] Manning n 0.013 Outlet loss K 0.35 Expansion Inlet loss K U/s coping level 66.25 ftAD</p> <p>Upstream Downstream Base width 3 3 ft Not required 0 Not required 0 Invert level 59.75 59.75 ftAD</p> <p>Spatially varied flow options Side inflow Yes [select] uniformly distributed Side weir present No [select] Not required Not required</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 49, 50 and 53 of 166</p>	<p>Assumes 3/10 of the total flow (Second Anoxic Tanks 6-8) including BER (v9)</p> <table border="1"> <tr> <td>D/s flow (Q2)</td> <td>8.667</td> <td>6.885</td> <td>3.225</td> <td>12.15</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>63.836</td> <td>63.690</td> <td>63.464</td> <td>64.191</td> <td>ftAD</td> </tr> <tr> <td>Side inflow (total)</td> <td>8.667</td> <td>6.885</td> <td>3.225</td> <td>12.15</td> <td>MGD</td> </tr> <tr> <td>Not required</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table> <p>Downstream status</p> <table border="1"> <tr> <td></td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td></td> </tr> <tr> <td>U/s freeboard</td> <td>2.386</td> <td>2.541</td> <td>2.781</td> <td>2.012</td> <td>ft</td> </tr> <tr> <td>U/s flow (Q1)</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>MGD</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>ft/s</td> </tr> <tr> <td>U/s water level (W1)</td> <td>63.864</td> <td>63.709</td> <td>63.469</td> <td>64.238</td> <td>ftAD</td> </tr> <tr> <td>U/s energy (H1)</td> <td>63.864</td> <td>63.709</td> <td>63.469</td> <td>64.238</td> <td>ftAD</td> </tr> </table> <p>The conceptual split would be anoxic 1-5 to clarifiers 1-4 and anoxic 6-10 to clarifiers 5-8</p> <p>Flow case plotted 1 [select]</p>	D/s flow (Q2)	8.667	6.885	3.225	12.15	MGD	D/s energy (H2)	63.836	63.690	63.464	64.191	ftAD	Side inflow (total)	8.667	6.885	3.225	12.15	MGD	Not required							Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet		U/s freeboard	2.386	2.541	2.781	2.012	ft	U/s flow (Q1)	0.000	0.000	0.000	0.000	MGD	U/s velocity (V1)	0.000	0.000	0.000	0.000	ft/s	U/s water level (W1)	63.864	63.709	63.469	64.238	ftAD	U/s energy (H1)	63.864	63.709	63.469	64.238	ftAD																			
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<p>38 2nd Anoxic Tank (No. 6) Effluent Weir</p> <p>BROAD-CRESTED WEIR</p> <p>$Q=C_d \sqrt{g} b H^{1.5}$ Kolkman drowned weir eqn (see word doc)</p>  <p>Shape Rectangular Crest elevation 64 ftAD Weir width (b) 25.00 ft U/s channel width 25 ft U/s channel invert 49.25 ftAD U/s coping level 66.25 ftAD C_d 0.544 see guidance sheet</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 50, 53 and 54 of 166</p>	<p>Assume flow out of 1 Anoxic tank with 1 out of 10 out of service including RAS WBR (v7)</p> <table border="1"> <tr> <td>Flow rate (Q)</td> <td>3.21</td> <td>2.55</td> <td>1.194444</td> <td>4.5</td> <td>MGD</td> </tr> <tr> <td>D/s water level (W2)</td> <td>63.864</td> <td>63.709</td> <td>63.469</td> <td>64.238</td> <td>ftAD</td> </tr> <tr> <td>Plunge</td> <td>0.136</td> <td>0.291</td> <td>0.531</td> <td>-0.238</td> <td></td> </tr> <tr> <td>Undrowned head</td> <td>0.161</td> <td>0.138</td> <td>0.083</td> <td>0.201</td> <td>ft</td> </tr> <tr> <td>Weir status</td> <td>Free discharge</td> <td>Free discharge</td> <td>Free discharge</td> <td>Drowned</td> <td></td> </tr> </table> <table border="1"> <tr> <td>U/s freeboard</td> <td>2.089</td> <td>2.112</td> <td>2.167</td> <td>1.991</td> <td>ft</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.013</td> <td>0.011</td> <td>0.005</td> <td>0.019</td> <td>ft/s</td> </tr> <tr> <td>U/s water level (W1)</td> <td>64.161</td> <td>64.138</td> <td>64.083</td> <td>64.259</td> <td>ftAD</td> </tr> <tr> <td>U/s energy (H1)</td> <td>64.161</td> <td>64.138</td> <td>64.083</td> <td>64.259</td> <td>ftAD</td> </tr> </table> <p>drowned outlet</p>	Flow rate (Q)	3.21	2.55	1.194444	4.5	MGD	D/s water level (W2)	63.864	63.709	63.469	64.238	ftAD	Plunge	0.136	0.291	0.531	-0.238		Undrowned head	0.161	0.138	0.083	0.201	ft	Weir status	Free discharge	Free discharge	Free discharge	Drowned		U/s freeboard	2.089	2.112	2.167	1.991	ft	U/s velocity (V1)	0.013	0.011	0.005	0.019	ft/s	U/s water level (W1)	64.161	64.138	64.083	64.259	ftAD	U/s energy (H1)	64.161	64.138	64.083	64.259	ftAD																									
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<p>37 2nd Anoxic Tank (No. 6) Baffle Wall</p> <p>GENERAL SUBMERGED CONSTRICTION</p> <p>Idel'chik Diagram 4-12</p>  <p>U/s shape Rectangular [select] U/s width 25 ft Opening shape Rectangular [select] Opening width 25 ft Opening thickness (t) 1 ft Opening edge radius 0 ft enter 0 if sharp D/s shape Rectangular [select] D/s width 25 ft</p> <p>Anoxic Tank is large and not modeled due to low velocity. Assumed zero headloss through tank</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 51 and 54 of 166</p>	<p>Assume flow of 1 out of 10 tanks with 1 out of service including RAS PC (v4)</p> <table border="1"> <tr> <td>Flow rate</td> <td>3.21</td> <td>2.55</td> <td>1.194444</td> <td>4.5</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>64.161</td> <td>64.138</td> <td>64.083</td> <td>64.259</td> <td>ftAD</td> </tr> <tr> <td>U/s passage height</td> <td>14.911</td> <td>14.888</td> <td>14.833</td> <td>15.009</td> <td>ft</td> </tr> <tr> <td>Opening height</td> <td>1.5</td> <td>1.5</td> <td>1.5</td> <td>1.5</td> <td>ft</td> </tr> <tr> <td>D/s passage height</td> <td>14.911</td> <td>14.888</td> <td>14.833</td> <td>15.009</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>t/D_n</td> <td>0.353</td> <td>0.353</td> <td>0.353</td> <td>0.353</td> <td></td> </tr> <tr> <td>Orifice type</td> <td>LONG</td> <td>LONG</td> <td>LONG</td> <td>LONG</td> <td></td> </tr> <tr> <td>Flow stable?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>K (on orifice velocity)</td> <td>2.26</td> <td>2.26</td> <td>2.26</td> <td>2.27</td> <td>ft/s</td> </tr> <tr> <td>Orifice velocity</td> <td>0.132</td> <td>0.105</td> <td>0.049</td> <td>0.186</td> <td>ft/s</td> </tr> <tr> <td>Headloss</td> <td>0.001</td> <td>0.000</td> <td>0.000</td> <td>0.001</td> <td>ft</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.013</td> <td>0.011</td> <td>0.005</td> <td>0.019</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>64.161</td> <td>64.138</td> <td>64.083</td> <td>64.261</td> <td>ftAD</td> </tr> </table>	Flow rate	3.21	2.55	1.194444	4.5	MGD	D/s energy (H2)	64.161	64.138	64.083	64.259	ftAD	U/s passage height	14.911	14.888	14.833	15.009	ft	Opening height	1.5	1.5	1.5	1.5	ft	D/s passage height	14.911	14.888	14.833	15.009	ft	t/D _n	0.353	0.353	0.353	0.353		Orifice type	LONG	LONG	LONG	LONG		Flow stable?	NO	NO	NO	NO		K (on orifice velocity)	2.26	2.26	2.26	2.27	ft/s	Orifice velocity	0.132	0.105	0.049	0.186	ft/s	Headloss	0.001	0.000	0.000	0.001	ft	U/s velocity (V1)	0.013	0.011	0.005	0.019	ft/s	U/s energy (H1)	64.161	64.138	64.083	64.261	ftAD	
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<p>36 Gate from Influent Channel to Anoxic Tank (No. 8)</p> <p>GENERAL SUBMERGED CONSTRICTION</p> <p>Idel'chik Diagram 4-12</p>  <p>U/s shape Rectangular [select] U/s width 3 ft Opening shape Rectangular [select] Opening width 3 ft Opening thickness (t) 1.3 ft Opening edge radius 0 ft enter 0 if sharp D/s shape Rectangular [select] D/s width 25 ft</p> <p>Original tanks seem to have 10" wall sleeve</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 51 of 166</p>	<p>Assume flow of 1 out of 10 tanks with 1 out of service including RAS PC (v4)</p> <table border="1"> <tr> <td>Flow rate</td> <td>3.21</td> <td>2.55</td> <td>1.194444</td> <td>4.5</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>64.161</td> <td>64.138</td> <td>64.083</td> <td>64.261</td> <td>ftAD</td> </tr> <tr> <td>U/s passage height</td> <td>3.911</td> <td>3.888</td> <td>3.833</td> <td>8.011</td> <td>ft</td> </tr> <tr> <td>Opening height</td> <td>3.911</td> <td>3.888</td> <td>3.833</td> <td>4.011</td> <td>ft</td> </tr> <tr> <td>D/s passage height</td> <td>14.911</td> <td>14.888</td> <td>14.833</td> <td>15.011</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>t/D_n</td> <td>0.393</td> <td>0.394</td> <td>0.396</td> <td>0.388</td> <td></td> </tr> <tr> <td>Orifice type</td> <td>LONG</td> <td>LONG</td> <td>LONG</td> <td>LONG</td> <td></td> </tr> <tr> <td>Flow stable?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>K (on orifice velocity)</td> <td>0.94</td> <td>0.94</td> <td>0.94</td> <td>2.07</td> <td>ft/s</td> </tr> <tr> <td>Orifice velocity</td> <td>0.423</td> <td>0.338</td> <td>0.161</td> <td>0.579</td> <td>ft/s</td> </tr> <tr> <td>Headloss</td> <td>0.003</td> <td>0.002</td> <td>0.000</td> <td>0.011</td> <td>ft</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.423</td> <td>0.338</td> <td>0.161</td> <td>0.290</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>64.164</td> <td>64.140</td> <td>64.084</td> <td>64.271</td> <td>ftAD</td> </tr> </table>	Flow rate	3.21	2.55	1.194444	4.5	MGD	D/s energy (H2)	64.161	64.138	64.083	64.261	ftAD	U/s passage height	3.911	3.888	3.833	8.011	ft	Opening height	3.911	3.888	3.833	4.011	ft	D/s passage height	14.911	14.888	14.833	15.011	ft	t/D _n	0.393	0.394	0.396	0.388		Orifice type	LONG	LONG	LONG	LONG		Flow stable?	NO	NO	NO	NO		K (on orifice velocity)	0.94	0.94	0.94	2.07	ft/s	Orifice velocity	0.423	0.338	0.161	0.579	ft/s	Headloss	0.003	0.002	0.000	0.011	ft	U/s velocity (V1)	0.423	0.338	0.161	0.290	ft/s	U/s energy (H1)	64.164	64.140	64.084	64.271	ftAD	
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35 2nd Anoxic Tank Influent Telescoping Valve Weir

Assume flow of 1 out of 10 tanks with 1 out of service including RAS

Flow rate (Q)

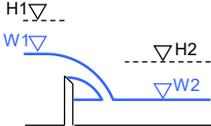
3.21	2.55	1.194444	4.5
------	------	----------	-----

 MGD WTR (v8)
D/s water level (W2)

64.164	64.140	64.084	64.271
--------	--------	--------	--------

 ftAD

THIN PLATE WEIR
Kindsvater-Carter Eqn: $Q=C_d(2/3)\sqrt{2g}b_e h_e^{1.5}$
BS ISO 1438:2017
Villemonte's drowned weir equation



Shape **Rectangular**
Crest elevation

63.3

 ftAD
Weir width (b)

75.4

 in
U/s channel width (B)

24

 in
U/s channel invert

60.25

 ftAD
U/s coping level

67.25

 ftAD

Undrowned head (h_e)

0.391	0.337	0.205	0.488
-------	-------	-------	-------

 ft
 C_d

0.612	0.610	0.607	0.614
-------	-------	-------	-------

Weir status

Drowned	Drowned	Drowned	Drowned
---------	---------	---------	---------

U/s freeboard

3.037	3.077	3.157	2.908
-------	-------	-------	-------

 ft
U/s velocity (V1)

0.627	0.503	0.240	0.851
-------	-------	-------	-------

 ft/s
U/s water level (W1)

64.213	64.173	64.093	64.342
--------	--------	--------	--------

 ftAD
U/s energy (H1)

64.219	64.177	64.094	64.353
--------	--------	--------	--------

 ftAD

This weir is meant to be drowned. Field observations confirm it is drowned during normal operations.
Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 53 of 166

34 2nd Anoxic Tank (No. 8) Influent Channel (Vertical Segment)

Assume flow of 1 out of 10 tanks with 1 out of service including RAS

Flow rate

3.21	2.55	1.194444	4.5
------	------	----------	-----

 MGD PL (v11)
D/s energy (H2)

64.219	64.177	64.094	64.353
--------	--------	--------	--------

 ftAD

SURCHARGED CONDUIT

Shape **Circular** [select]
Length

6.08

 ft
Diameter

24

 in
Not required
Equation Manning [select]
Manning n

0.013

Inlet type **Bellmouth** [select]
Outlet loss K
Other fittings total K

1.5

 1 x 90 degree mitre bend.
U/s invert

0

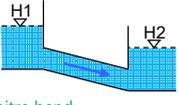
 ftAD
D/s invert

0

 ftAD
U/s coping level

67.25

 ftAD



Friction loss

0.003	0.002	0.000	0.006
-------	-------	-------	-------

 ft
Fittings loss

0.060	0.038	0.008	0.118
-------	-------	-------	-------

 ft
Surcharged loss

0.063	0.040	0.009	0.124
-------	-------	-------	-------

 ft

Outlet controlled?

NO	NO	NO	NO
----	----	----	----

Inlet controlled?

NO	NO	NO	NO
----	----	----	----

Total loss

0.063	0.040	0.009	0.124
-------	-------	-------	-------

 ft

U/s freeboard

2.968	3.033	3.148	2.773
-------	-------	-------	-------

 ft
Velocity (V1)

1.581	1.256	0.588	2.216
-------	-------	-------	-------

 ft/s
U/s energy (H1)

64.282	64.217	64.102	64.477
--------	--------	--------	--------

 ftAD

set to zero to prevent outlet control

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 53 of 166

33 Second Anoxic Tanks Influent Chanel

Assume full plant flow including RAS

Total flow rate

28.9	23.0	10.8	40.5
------	------	------	------

 MGD PG (v9)
D/s energy (H2)

64.282	64.217	64.102	64.477
--------	--------	--------	--------

 ftAD

GENERAL SURCHARGED CONDUIT

Shape **Box** [select]
Width

4

 ft
Height

3.17

 ft
Equation Manning [select]
Manning n

0.013

U/s invert

56.25

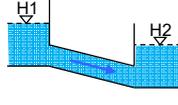
 ftAD
D/s invert

56.25

 ftAD
U/s coping level

67.25

 ftAD



Sheets 49 7 50 of 166, page 52 of 128

Surcharged loss

0.245	0.155	0.034	0.482
-------	-------	-------	-------

 ft
Outlet controlled?

NO	NO	NO	NO
----	----	----	----

Inlet controlled?

NO	NO	NO	NO
----	----	----	----

U/s freeboard

2.723	2.879	3.114	2.291
-------	-------	-------	-------

 ft
U/s velocity (V1)

0.471	0.374	0.175	0.660
-------	-------	-------	-------

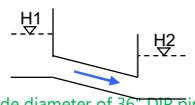
 ft/s
U/s energy (H1)

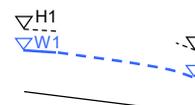
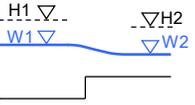
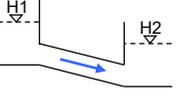
64.527	64.371	64.136	64.959
--------	--------	--------	--------

 ftAD

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 59 and 50 of 166

Item	No. of fittings	Length ft	Width ft	Height ft	Proportio n of flow	Fittings K	U/s Energy ftAD	U/s Energy ftAD	U/s Energy ftAD	U/s Energy ftAD
Pipe	1	32.5	4	3.16667	1	0.000	64.319	64.240	64.108	64.549
Tank 1 Tee Straight Through	1	4	3.16667	0.9	0.200	64.350	64.259	64.112	64.611	
Tank 2 Tee Straight Through	1	4	3.16667	0.8	0.200	64.375	64.275	64.115	64.659	
Pipe	1	53.5	4	3.16667	0.8	0.000	64.413	64.299	64.121	64.735
Tank 3 Tee Straight Through	1	4	3.16667	0.7	0.200	64.434	64.313	64.124	64.777	
Tank 4 Tee Straight Through	1	4	3.16667	0.6	0.200	64.448	64.322	64.125	64.804	
Pipe	1	53.5	4	3.16667	0.6	0.000	64.470	64.335	64.128	64.846
Tank 5 Tee Straight Through	1	4	3.16667	0.5	0.200	64.480	64.341	64.130	64.865	
Tank 6 Tee Straight Through	1	4	3.16667	0.4	0.200	64.486	64.345	64.131	64.878	
Pipe	1	44	4	3.16667	0.4	0.000	64.494	64.350	64.132	64.893
Tank 7 Tee Straight Through	1	4	3.16667	0.3	0.200	64.497	64.352	64.132	64.900	
Tank 8 Tee Straight Through	1	4	3.16667	0.2	0.200	64.499	64.353	64.132	64.903	
Pipe	1	4	3.16667	0.2	0.000	64.499	64.353	64.133	64.903	
Contraction 4:3	1	3	3.16667	0.2	0.200	64.502	64.355	64.133	64.909	
Pipe	1	16	3	3.16667	0.2	0.000	64.503	64.356	64.133	64.912
Culvert Short Radius 90° Bend	1	3	3.16667	0.2	0.300	64.507	64.359	64.134	64.920	
Culvert Short Radius 90° Bend	1	3	3.16667	0.2	0.300	64.511	64.361	64.134	64.928	
Culvert Pipe	1	16	3	3.16667	0.2	0.000	64.513	64.362	64.134	64.931
Culvert Short Radius 90° Bend	1	3	3.16667	0.2	0.300	64.517	64.365	64.135	64.939	
Culvert Short Radius 90° Bend	1	3	3.16667	0.2	0.300	64.521	64.368	64.136	64.947	
Pipe	1	19	3	3.16667	0.2	0.000	64.523	64.369	64.136	64.951
Tank 9 Tee Straight Through	1	3	3.16667	0.1	0.200	64.524	64.369	64.136	64.952	
Tank 10 Tee Line To Branch 90°	1	3	3.16667	0.1	1.000	64.527	64.371	64.136	64.959	
Pipe	3	3	3.16667	0.1	0.000	64.527	64.371	64.136	64.959	
Pipe	3	3	3.16667	0.1	0.000	64.527	64.371	64.136	64.959	

<p>30 <i>Wye to Oxidation Reactor East Effluent Line</i></p>	<p>SURCHARGED CONDUIT</p>  <p>Assumes full plant flow including RAS</p> <table border="1"> <tr> <td>Flow rate</td> <td>14.445</td> <td>11.475</td> <td>5.375</td> <td>20.25</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>65.497</td> <td>64.992</td> <td>64.279</td> <td>66.829</td> <td>ftAD</td> </tr> </table> <p>PL (v11)</p> <p>Shape: Circular [select] Length: 312 ft Diameter: 36.70 in Inside diameter of 36" DIP pipe Not required Equation: H-W [select] Hazen-Williams C: 110 Inlet type: Bellmouth [select] Outlet loss K: 0.2 K value for 2:3 expansion at wye Other fittings total K: 0.6 See guidar 2 x 90 Deg Bends U/s invert: 47 ftAD D/s invert: 47 ftAD U/s coping level: 72.17 ftAD</p> <table border="1"> <tr> <td>Friction loss</td> <td>0.333</td> <td>0.218</td> <td>0.053</td> <td>0.623</td> <td>ft</td> </tr> <tr> <td>Fittings loss</td> <td>0.122</td> <td>0.077</td> <td>0.017</td> <td>0.240</td> <td>ft</td> </tr> <tr> <td>Surcharged loss</td> <td>0.455</td> <td>0.295</td> <td>0.070</td> <td>0.863</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>Outlet controlled?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> </tr> <tr> <td>Inlet controlled?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> </tr> <tr> <td>Total loss</td> <td>0.455</td> <td>0.295</td> <td>0.070</td> <td>0.863</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>U/s freeboard</td> <td>6.218</td> <td>6.884</td> <td>7.820</td> <td>4.478</td> <td>ft</td> </tr> <tr> <td>Velocity (V1)</td> <td>3.042</td> <td>2.417</td> <td>1.132</td> <td>4.265</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>65.952</td> <td>65.286</td> <td>64.350</td> <td>67.692</td> <td>ftAD</td> </tr> </table> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 15, 16 and 40 of 166</p>	Flow rate	14.445	11.475	5.375	20.25	MGD	D/s energy (H2)	65.497	64.992	64.279	66.829	ftAD	Friction loss	0.333	0.218	0.053	0.623	ft	Fittings loss	0.122	0.077	0.017	0.240	ft	Surcharged loss	0.455	0.295	0.070	0.863	ft	Outlet controlled?	NO	NO	NO	NO	Inlet controlled?	NO	NO	NO	NO	Total loss	0.455	0.295	0.070	0.863	ft	U/s freeboard	6.218	6.884	7.820	4.478	ft	Velocity (V1)	3.042	2.417	1.132	4.265	ft/s	U/s energy (H1)	65.952	65.286	64.350	67.692	ftAD					
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	<p>Note Component 30 calculates the upstream water level in the pipe At higher flows this is predicted to be at the top of the pipe , above the invert elevation of the oxidation ditch outlet chamber At lower flows this is predicted that the water level shall be in the vertical pipe, below the invert of the oxidation ditch outlet chamber Component 29 calculates the exit flow condition from the oxidation ditch outlet channel.</p>																																																																					
<p>29 <i>Oxidation Reactor Effluent Box/Channel</i></p>	<p>CHANNEL BACKWATER</p>  <p>Assumes 1/2 Plant flow plus 1/2 RAS Flow (There are two OX Reactors)</p> <table border="1"> <tr> <td>Flow rate</td> <td>14.445</td> <td>11.475</td> <td>5.375</td> <td>20.25</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>65.952</td> <td>65.286</td> <td>64.350</td> <td>67.692</td> <td>ftAD</td> </tr> </table> <p>Subcritical flow calculation proceeds upstream</p> <table border="1"> <tr> <td>Not required</td> <td>14.445</td> <td>11.475</td> <td>5.375</td> <td>20.25</td> </tr> <tr> <td>Not required</td> <td></td> <td></td> <td></td> <td></td> </tr> </table> <p>Downstream status</p> <table border="1"> <tr> <td>Critical depth</td> <td>4.45671</td> <td>4.61677</td> <td>5.00350</td> <td>4.17375</td> <td>ft</td> </tr> <tr> <td>U/s freeboard</td> <td>14.44500</td> <td>11.47500</td> <td>5.37500</td> <td>20.25000</td> <td>MGD</td> </tr> <tr> <td>U/s flow (Q1)</td> <td>4.60518</td> <td>4.21430</td> <td>3.11939</td> <td>5.23499</td> <td>ft/s</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>67.713</td> <td>67.553</td> <td>67.167</td> <td>67.996</td> <td>ftAD</td> </tr> <tr> <td>U/s water level (W1)</td> <td>68.043</td> <td>67.829</td> <td>67.318</td> <td>68.422</td> <td>ftAD</td> </tr> </table> <p>Upstream Downstream</p> <table border="1"> <tr> <td>Base width</td> <td>4</td> <td>4</td> <td>ft</td> </tr> <tr> <td>Not required</td> <td></td> <td>0</td> <td></td> </tr> <tr> <td>Not required</td> <td></td> <td>0</td> <td></td> </tr> <tr> <td>Invert level</td> <td>66.5</td> <td>66.5</td> <td>ftAD</td> </tr> </table> <p>Weir crest El. 69 To check for drowned condition</p> <p>Spatially varied flow options</p> <p>Side inflow: No [select] uniformly distributed Side weir present: No [select] Not required Not required</p> <p>Side inflow into the channel from effluent weir but also outflow from both RAS and Outlet Pipes IF WATER LEVEL IS IN PIPE EXPECT DS STATUS TO BE CRITICAL IF OPOSITE, DROWNED</p> <p>Flow case plotted: 1 [select]</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 38 of 166</p>	Flow rate	14.445	11.475	5.375	20.25	MGD	D/s energy (H2)	65.952	65.286	64.350	67.692	ftAD	Not required	14.445	11.475	5.375	20.25	Not required					Critical depth	4.45671	4.61677	5.00350	4.17375	ft	U/s freeboard	14.44500	11.47500	5.37500	20.25000	MGD	U/s flow (Q1)	4.60518	4.21430	3.11939	5.23499	ft/s	U/s velocity (V1)	67.713	67.553	67.167	67.996	ftAD	U/s water level (W1)	68.043	67.829	67.318	68.422	ftAD	Base width	4	4	ft	Not required		0		Not required		0		Invert level	66.5	66.5	ftAD	<p>BER (v9)</p> <p>Flow case plotted 1 [select]</p>
Flow rate	14.445	11.475	5.375	20.25	MGD																																																																	
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<p>28 <i>Oxidation Reactor Effluent Weir</i></p>	<p>THIN PLATE WEIR</p>  <p>Assumes 1/2 Plant flow plus 1/2 RAS Flow (There are two OX Reactors)</p> <table border="1"> <tr> <td>Flow rate (Q)</td> <td>14.445</td> <td>11.475</td> <td>5.375</td> <td>20.25</td> <td>MGD</td> </tr> <tr> <td>D/s water level (W2)</td> <td>68.043</td> <td>67.829</td> <td>67.318</td> <td>68.422</td> <td>ftAD</td> </tr> </table> <p>Undrowned head (h_e)</p> <table border="1"> <tr> <td>0.501</td> <td>0.430</td> <td>0.261</td> <td>0.626</td> <td>ft</td> </tr> </table> <p>C_d</p> <table border="1"> <tr> <td>0.595</td> <td>0.595</td> <td>0.595</td> <td>0.596</td> </tr> </table> <p>Weir status</p> <table border="1"> <tr> <td>Free</td> <td>Free</td> <td>Free</td> <td>Free</td> </tr> </table> <p>discharge</p> <table border="1"> <tr> <td>2.669</td> <td>2.740</td> <td>2.909</td> <td>2.544</td> <td>ft</td> </tr> <tr> <td>0.057</td> <td>0.046</td> <td>0.022</td> <td>0.079</td> <td>ft/s</td> </tr> <tr> <td>69.501</td> <td>69.430</td> <td>69.261</td> <td>69.626</td> <td>ftAD</td> </tr> <tr> <td>69.501</td> <td>69.430</td> <td>69.261</td> <td>69.626</td> <td>ftAD</td> </tr> </table> <p>U/s freeboard</p> <table border="1"> <tr> <td>2.669</td> <td>2.740</td> <td>2.909</td> <td>2.544</td> <td>ft</td> </tr> </table> <p>U/s velocity (V1)</p> <table border="1"> <tr> <td>0.057</td> <td>0.046</td> <td>0.022</td> <td>0.079</td> <td>ft/s</td> </tr> </table> <p>U/s channel invert: 55.5 ftAD U/s coping level: 72.17 ftAD</p> <p>Normal Weir Plate El.</p> <p>WS El at OX Ditch per As-built is 69.60</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 43 and 44 of 166</p>	Flow rate (Q)	14.445	11.475	5.375	20.25	MGD	D/s water level (W2)	68.043	67.829	67.318	68.422	ftAD	0.501	0.430	0.261	0.626	ft	0.595	0.595	0.595	0.596	Free	Free	Free	Free	2.669	2.740	2.909	2.544	ft	0.057	0.046	0.022	0.079	ft/s	69.501	69.430	69.261	69.626	ftAD	69.501	69.430	69.261	69.626	ftAD	2.669	2.740	2.909	2.544	ft	0.057	0.046	0.022	0.079	ft/s	<p>WTR (v8)</p>													
Flow rate (Q)	14.445	11.475	5.375	20.25	MGD																																																																	
D/s water level (W2)	68.043	67.829	67.318	68.422	ftAD																																																																	
0.501	0.430	0.261	0.626	ft																																																																		
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<p>27 Oxidation Reactor</p> <p>CHANNEL BACKWATER</p> <p>Subcritical flow calculation proceeds upstream</p> <p>Shape Rectangular [select] Length 550 ft [select] <i>Length of entire reactor pass</i> Equation Manning [select] Manning n 0.013 Outlet loss K 0 <i>Used only if outlet drowned</i> Inlet loss K 0 U/s coping level 72.17 ftAD</p> <p>Upstream Downstream Base width 25 25 ft Not required 0 Not required 0 Invert level 55.5 55.5 ftAD</p> <p>Spatially varied flow options Side inflow No [select] <i>uniformly distributed</i> Side weir present No [select] Not required Not required</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 43 of 166</p>	 <p>Assumes 1/2 Plant flow plus 1/2 RAS Flow + 1/2 Internal Recycle</p> <p>Flow rate 44.145 41.175 14.15 49.95 MGD D/s energy (H2) 69.501 69.430 69.261 69.626 ftAD Not required Not required</p> <p>Downstream status Drowned outlet Drowned outlet Drowned outlet Drowned outlet U/s freeboard 2.670 2.741 2.909 2.545 ft U/s flow (Q1) 44.145 41.175 14.150 49.950 MGD U/s velocity (V1) 0.195 0.183 0.064 0.219 ft/s U/s water level (W1) 69.500 69.429 69.261 69.625 ftAD U/s energy (H1) 69.501 69.430 69.261 69.626 ftAD</p> <p>Flow case plotted 1 [select]</p>	<p>BER (v9)</p>
<p>26 Oxidation Reactor Inlet from Culvert</p> <p>CHANNEL TRANSITION</p> <p>$H_1 = H_2 + k(V_1^2 - V_2^2)/2g$ for expansion $H_1 = H_2 + k(V_2^2 - V_1^2)/2g$ for contraction</p> <p>U/s shape Rectangular [select] D/s shape Rectangular [select] Type of transition Square-ended [select] Not required U/s width 6.5 ft D/s width 28 ft Not required Not required U/s invert level 48.33 ftAD D/s invert level 55.5 ftAD U/s coping level 71.5 ftAD</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 38 and 41 of 166</p>	 <p>Assumes 1/2 Plant flow plus 1/2 RAS Flow + 1/2 Internal Recycle</p> <p>Flow rate 44.145 41.175 14.15 49.95 MGD D/s energy (H2) 69.501 69.430 69.261 69.626 ftAD</p> <p>Transition type? Expansion Expansion Expansion Expansion Loss K 1.0 1.0 1.0 1.0 Fitting loss 0.003 0.003 0.000 0.004 ft Critical check</p> <p>U/s freeboard 2.000 2.070 2.239 1.874 ft D/s velocity (V2) 0.174 0.163 0.057 0.195 ft/s D/s water level (W2) 69.500 69.430 69.261 69.626 ftAD U/s velocity (V1) 0.496 0.465 0.161 0.558 ft/s U/s water level (W1) 69.500 69.430 69.261 69.626 ftAD U/s energy (H1) 69.504 69.433 69.261 69.630 ftAD</p>	<p>CT (v8)</p>
<p>25 Oxidation Reactor Inlet Culvert</p> <p>SURCHARGED CONDUIT</p> <p>Shape Box [select] Length 54 ft Width 4.5 ft Height 5.5 ft Equation Manning [select] Manning n 0.013 Inlet type None [select] Outlet loss K 0 Other fittings total K 4.9 <i>See guidar</i> U/s invert 48.33 ftAD D/s invert 48.33 ftAD U/s coping level 78 ftAD</p> <p>$k = 1.5$ for 90 deg. Mitre after entry + 1.1 for a bend with a sharp inner and rounded outer + 0.8 for 60 deg. Mitre + 1.5 for 90 deg. Mitre before the outlet. Outlet loss is captured in component 26</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 35 of 166 Inlet loss captured in component 24</p>	 <p>Assumes 1/2 Plant flow plus 1/2 RAS Flow + 1/2 Internal Recycle</p> <p>Flow rate 44.145 41.175 14.15 49.95 MGD D/s energy (H2) 69.504 69.433 69.261 69.630 ftAD</p> <p>Friction loss 0.024 0.021 0.002 0.030 ft Fittings loss 0.580 0.504 0.060 0.742 ft Surcharged loss 0.603 0.525 0.062 0.773 ft</p> <p>Outlet controlled? NO NO NO NO Inlet controlled? N/A N/A N/A N/A Total loss 0.603 0.525 0.062 0.773 ft</p> <p>U/s freeboard 7.893 8.042 8.677 7.597 ft Velocity (V1) 2.760 2.574 0.885 3.123 ft/s U/s energy (H1) 70.107 69.958 69.323 70.403 ftAD</p>	<p>PL (v11)</p>



BLACK & VEATCH

ProjectWise document code

Calculation no. **CAL-NEWRF Hydraulic Model-A**

(Sheet no. given in header)

Revision

A

24 Screw Lifts Effluent Common Channel

CHANNEL BACKWATER

Subcritical flow calculation proceeds upstream

Shape **Rectangular** [select]
 Length **20** ft
 Equation **Manning** [select]
 Manning n **0.013**
 Outlet loss K **0** Used only if outlet drowned
 Inlet loss K Not required
 U/s coping level **78** ftAD

Base width **4.5** ft Upstream **4.5** ft Downstream
 Not required **0**
 Not required **0**
 Invert level **65.5** ftAD

Spatially varied flow options
 Side inflow **Yes** [select] uniformly distributed
 Side weir present **No** [select]
 Not required
 Not required

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 36 of 166

Assumes 1/2 Plant flow plus 1/2 RAS Flow + 1/2 Internal Recycle

D/s flow (Q2)	44.145	41.175	14.15	49.95	MGD
D/s energy (H2)	70.107	69.958	69.323	70.403	ftAD
Side inflow (total)	44.145	41.175	14.15	49.95	MGD
Not required					

Downstream status

	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet	
U/s freeboard	7.709	7.871	8.650	7.389	ft
U/s flow (Q1)	0.000	0.000	0.000	0.000	MGD
U/s velocity (V1)	0.000	0.000	0.000	0.000	ft/s
U/s water level (W1)	70.291	70.129	69.350	70.611	ftAD
U/s energy (H1)	70.291	70.129	69.350	70.611	ftAD

Flow case plotted **1** [select]

24.2 Screw Lift Outlet Stop Gate

GENERAL SUBMERGED CONSTRICTION

Idel'chik Diagram 4-12

U/s shape **Rectangular** [select]
 U/s width **8.17** ft
 Opening shape **Rectangular** [select]
 Opening width **5** ft
 Opening thickness (t) **1** ft
 Opening edge radius **0** ft enter 0 if sharp
 D/s shape **Rectangular** [select]
 D/s width **20** ft

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 36 of 166

Assumes 1/4 Plant flow plus 1/4 RAS Flow + 1/4 Internal Recycle

Flow rate	22.0725	20.5875	7.075	24.975	MGD
D/s energy (H2)	70.291	70.129	69.350	70.611	ftAD
U/s passage height	4.791	4.629	3.850	5.111	ft
Opening height	4.791	4.629	3.850	5.111	ft
D/s passage height	4.791	4.629	3.850	5.111	ft

t/D _n	0.204	0.208	0.230	0.198	
Orifice type	LONG	LONG	LONG	LONG	
Flow stable?	NO	NO	NO	NO	
K (on orifice velocity)	1.46	1.46	1.45	1.46	
Orifice velocity	1.426	1.376	0.569	1.512	ft/s
Headloss	0.046	0.043	0.007	0.052	ft
U/s velocity (V1)	0.873	0.843	0.348	0.926	ft/s
U/s energy (H1)	70.337	70.172	69.358	70.663	ftAD

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17 of 17

Date printed: 10/3/2023



BLACK & VEATCH

ProjectWise document code

Calculation no. **CAL-NEWRF Hydraulic Model-A** (Sheet no. given in header)

Revision
A

No. *Clearwater NE WRF Hydraulic Profile - Screw Lift Station to Headworks* **COMMENTS**

0 GENERAL

Inputs in yellow boxes
 Units selection in pale yellow boxes
 Output results in blue boxes
 Drawing Reference Sheets Purple

ONLY EDIT FLOWS ON
CALC_CHLORINE CONTACT

Case Description	1	2	3	4	
	MMAD	AADF (Permitted)	Min	PHF	
Flow rate A	17.4	13.5	4.0	27.0	MGD
Ras Recycle Ratio to AADF	0.9	0.7	0.5	1.0	
RAS Flow	11.5	9.5	6.8	13.5	
Flow rate B: A + RAS	28.9	23.0	10.8	40.5	MGD
IR Recycle Ratio to AADF	4.4	4.4	1.3	4.4	
Internal Recycle	59.4	59.4	17.6	59.4	
Flow rate C: A + RAS + IR	88.3	82.4	28.3	99.9	MGD

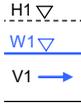
1 SUMMARY TABLE
 Generate table once all components added. Uses coloured reference numbers in column A. Can select energy, water level, velocity or freeboard. [select]

NO.	COMPONENT DESCRIPTION	COMPONENT TYPE	U/S ENERGY			
23	Water Surface Elevation at Screw Lifts	KNOWN CONDITIONS	59.001	59.001	59.000	59.001 ftAD
22	1st Anoxic Tank Effluent Weir	THIN PLATE WEIR	60.556	60.508	59.997	60.647 ftAD
21	1st Anoxic Tank Opening	0	60.611	60.556	60.002	60.716 ftAD
20	1st Anoxic Influent Channel	0				
19	Channel between Fermentation and 1st Anoxic	Modelling as a surcharged conduit shows a	60.889	60.798	60.031	61.073 ftAD
18	Fermentation Effluent Channel	0				
17	Fermentation Tank Opening	0	60.942	60.844	60.036	61.140 ftAD
17.1	Gate from Fermentation Influent Channel to Fe	The calculated headloss is manually added i	61.688	61.545	60.237	61.967 ftAD
16	Fermentation Tank Influent Channel	0	62.196	62.006	60.388	62.558 ftAD
15	Fermentation Tank Influent Weir	THIN PLATE WEIR	63.287	63.176	62.910	63.484 ftAD
15.1	Flow A + RAS Conversion Box and Chimney	SURCHARGED CONDUIT	63.319	63.196	62.914	63.546 ftAD
14	Fermentation Tank Influent 48" Pipe	SURCHARGED CONDUIT	63.765	63.464	62.938	64.618 ftAD
13	Transition from Flow Diversion Structure to 48"	GENERAL SUBMERGED CONSTRUCTION	63.782	63.474	62.938	64.659 ftAD
13.1	Flow Diversion Structure	SURCHARGED CONDUIT	63.818	63.496	62.940	64.747 ftAD
12	Primary Treatment Effluent Channel	SURCHARGED CONDUIT	63.939	63.569	62.947	65.038 ftAD
11	Salnes Filter Bypass	SURCHARGED CONDUIT	64.133	63.660	62.948	65.646 ftAD
10	Flume Effluent Channel	CHANNEL BACKWATER	64.168	63.693	62.956	65.676 ftAD
9	Parshall Flume	PARSHALL FLUME	67.579	67.340	66.612	68.096 ftAD
8	Headworks Effluent Channel	CHANNEL BACKWATER	67.582	67.342	66.613	68.100 ftAD
7	Grit Chamber Effluent Channel	CHANNEL BACKWATER	67.618	67.370	66.618	68.158 ftAD
6	Grit Chamber Effluent Weir	THIN PLATE WEIR	68.251	68.213	68.096	68.366 ftAD
5	Headloss through Grit Chamber	CHANNEL FIXED LOSS	68.835	68.796	68.680	69.032 ftAD
4	Bar Screen Effluent Channel	CHANNEL BACKWATER	68.845	68.802	68.680	69.055 ftAD
3	Fixed Loss through the Mechanical Bar Screens	CHANNEL FIXED LOSS	69.695	69.652	69.530	70.055 ftAD

23 Water Surface Elevation at Screw Lifts

KNOWN CONDITIONS

Shape: **Rectangular** [select]
 Known variable: Water level [select]
 Width: 53.34 ft
 Not required
 Invert level: 53.98 ftAD
 Coping level: 59 ftAD



Flow rate: 44.1, 41.2, 14.2, 50.0 MGD
 Water level: 59, 59, 59, 59 ftAD

Freeboard: 0.000 ft
 Velocity (V1): 0.255, 0.238, 0.082, 0.289 ft/s
 Water level (W1): 59.000, 59.000, 59.000, 59.000 ftAD
 Energy (H1): 59.001, 59.001, 59.000, 59.001 ftAD

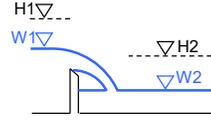
SG (v6)

Northeast Water Reclamation Facility Screw Lift Station Upgrades (City PN. 12-0017-UT, 2015), Sheet M-2
 Coping level set at 1st anoxic effluent weir elevation. Water level set to HWL listed within the screw lift upgrade drawings from 2015
 Flow rate is A + RAS + IR divided by 2 since this flow is split between east/west tanks

22 1st Anoxic Tank Effluent Weir

THIN PLATE WEIR

Kindsvater-Carter Eqn: $Q=C_d(2/3)\sqrt{2g}b_e h_e^{1.5}$
 BS ISO 1438:2017
 Villomonte's drowned weir equation



Shape: **Rectangular**
 Crest elevation: 59.5 ftAD
 Weir width (b): 20 ft
 U/s channel width (B): 57.66 ft
 U/s channel invert: 45.5 ftAD
 U/s coping level: 63 ftAD

Flow rate (Q): 44.145, 41.175, 14.150, 49.950 MGD
 D/s water level (W2): 59.000, 59.000, 59.000, 59.000 ftAD

Undrowned head (h_e): 1.056, 1.008, 0.496, 1.147 ft
 C_d: 0.591, 0.591, 0.591, 0.591
 Weir status: Free discharge, Free discharge, Free discharge, Free discharge

U/s freeboard: 2.444, 2.492, 3.004, 2.353 ft
 U/s velocity (V1): 0.079, 0.074, 0.026, 0.088 ft/s
 U/s water level (W1): 60.556, 60.508, 59.996, 60.647 ftAD
 U/s energy (H1): 60.556, 60.508, 59.997, 60.647 ftAD

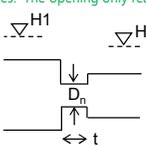
WTR (v8)

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 30 and 37 of 166
 Flow rate is A + RAS + IR divided by 2 since this flow is split between east/west tanks

21 1st Anoxic Tank Opening

Note: general constriction assumes contraction on all sides. The opening only really constricts the flow from the sides (minimal effect at the top, no contraction at bottom). It is likely to over estimate the headloss

GENERAL SUBMERGED CONSTRICTION



Flow rate: 44.145, 41.175, 14.150, 49.950 MGD
 D/s energy (H2): 60.556, 60.508, 59.997, 60.647 ftAD

U/s passage height: 15.056, 15.008, 14.496, 15.147 ft
 Opening height: 14.5, 14.5, 14.5, 14.5 ft
 D/s passage height: 15.056, 15.008, 14.496, 15.147 ft

U/s shape: **Rectangular**
 U/s width: 73 ft
 Opening shape: **Rectangular**
 Opening width: 4 ft
 Opening thickness (t): 1.33 ft
 Opening edge radius: 0 ft (enter 0 if sharp)
 D/s shape: **Rectangular**
 D/s width: 73 ft

t/D_n: 0.212, 0.212, 0.212, 0.212
 Orifice type: LONG, LONG, LONG, LONG
 Flow stable?: NO, NO, NO, NO
 K (on orifice velocity): 2.52, 2.52, 2.51, 2.52
 Orifice velocity: 1.178, 1.098, 0.377, 1.332 ft/s
 Headloss: 0.054, 0.047, 0.006, 0.070 ft
 U/s velocity (V1): 0.062, 0.058, 0.021, 0.070 ft/s
 U/s energy (H1): 60.611, 60.556, 60.002, 60.716 ftAD

PC (v4)
 assume same as d/s from drawings
 d/s WL minus invert

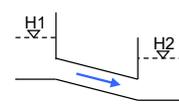
Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 29 and 31 of 166

20 1st Anoxic Influent Channel COMPONENT DELETED

19 Channel between Fermentation and 1st Anoxic Tank

Note: This is complicated. Using 2 orifices and a 90° bend is expected to give too high a head loss. Modelling as a surcharged conduit shows almost all of the losses to be associated with the fittings

SURCHARGED CONDUIT



Flow rate: 44.145, 41.175, 14.15, 49.95 MGD
 D/s energy (H2): 60.611, 60.556, 60.002, 60.716 ftAD

Friction loss: 0.001 ft
 Fittings loss: 0.277 ft
 Surcharged loss: 0.279 ft

Outlet controlled?: NO
 Inlet controlled?: NO
 Total loss: 0.279, 0.242, 0.029, 0.357 ft

U/s freeboard: 2.111, 2.202, 2.969, 1.927 ft
 Velocity (V1): 2.439, 2.275, 0.782, 2.760 ft/s
 U/s energy (H1): 60.889, 60.798, 60.031, 61.073 ftAD

PL (v11)

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 30 and 32 of 166
 Original component was Pipe Tee Junction (see snip beside). After further investigation, the IR flow travels through a channel to the beginning of the fermentation tank, therefore, this is a 90 degree channel flowing between the fermentation tank and the 1st anoxic tank. A k value of 1.5 was added for the 90 degree mitre bend

18 Fermentation Effluent Channel COMPONENT DELETED

Fermentation Tank
 Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 30 and 33 of 166
 Tank invert **45.5** ftAD

17 Fermentation Tank Opening

Note: general constriction assumes contraction on all sides. The opening only really constricts the flow from the sides (minimal effect at the top, none at bottom). It is likely to over estimate the headloss

GENERAL SUBMERGED CONSTRICTION
 Idel'chik Diagram 4-12

Flow rate	44.145	41.175	14.15	49.95	MGD
D/s energy (H2)	60.889	60.798	60.031	61.073	ftAD
U/s passage height	15.389	15.298	14.531	15.573	ft
Opening height	14.500	14.500	14.500	14.500	ft
D/s passage height	15.389	15.298	14.531	15.573	ft

U/s shape: **Rectangular** [select]
 U/s width: **50** ft
 Opening shape: **Rectangular** [select]
 Opening width: **4** ft
 Opening thickness (t): **1.33** ft
 Opening edge radius: **0** ft enter 0 if sharp
 D/s shape: **Rectangular** [select]
 D/s width: **50** ft

t/D _n	0.212	0.212	0.212	0.212	
Orifice type	LONG	LONG	LONG	LONG	
Flow stable?	NO	NO	NO	NO	
K (on orifice velocity)	2.43	2.43	2.42	2.44	
Orifice velocity	1.178	1.098	0.377	1.332	ft/s
Headloss	0.052	0.046	0.005	0.067	ft
U/s velocity (V1)	0.089	0.083	0.030	0.099	ft/s
U/s energy (H1)	60.942	60.844	60.036	61.140	ftAD

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 29 and 31 of 166

PC (v4)
 assume same as d/s from drawings, with function d/s WL minus invert

17.1 Gate from Fermentation Influent Channel to Fermentation Tank

This is an exit on the side of the channel at the downstream end. Some of the flow over the weir will jet straight across the channel and out through this opening
 The calculated headloss is manually added in this component to estimate the upstream water depth
 The opening height has been estimated as equal to the opening water height
 U/s width set to 4ft as flow to b turned by incoming water on weir. It would nto be stopped nd have to exit over the end
 Could replace this with a broad crested weir and consider using no backwater components (next to the opening and upstream of the opening)

GENERAL SUBMERGED CONSTRICTION
 Idel'chik Diagram 4-12

Flow rate	44.145	41.175	14.15	49.95	MGD
D/s energy (H2)	60.942	60.844	60.036	61.140	ftAD
U/s passage height	3.688	3.545	2.238	3.967	ft
Opening height	3.688	3.545	2.238	3.967	ft
D/s passage height	15.442	15.344	14.536	15.640	ft

U/s shape: **Rectangular** [select]
 U/s width: **10** ft
 Opening shape: **Rectangular** [select]
 Opening width: **4** ft
 Opening thickness (t): **1.33** ft
 Opening edge radius: **0** ft enter 0 if sharp
 D/s shape: **Rectangular** [select]
 D/s width: **52.5** ft

t/D _n	0.347	0.354	0.463	0.334	
Orifice type	LONG	LONG	LONG	LONG	
Flow stable?	NO	NO	NO	NO	
K (on orifice velocity)	2.24	2.24	2.17	2.24	
Orifice velocity	4.631	4.492	2.446	4.870	ft/s
Headloss	0.746	0.701	0.201	0.827	ft
U/s velocity (V1)	1.852	1.797	0.978	1.948	ft/s
U/s energy (H1)	61.688	61.545	60.237	61.967	ftAD
Copy of Headloss	0.746	0.702	0.202	0.827	ft
dH error	0.000	0.000	0.001	0.000	ft

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 30 and 32 of 166

NEEDS MANUAL UPDATE

PC (v4)
 including change in invert set to upstream level

manually copy headloss here until error becomes zero

16 Fermentation Tank Influent Channel

Exit loss applied to provide some loss as the flow turns into the opening.

CHANNEL BACKWATER

Subcritical flow calculation proceeds upstream

D/s flow (Q2)	44.145	41.175	14.15	49.95	MGD
D/s energy (H2)	61.688	61.545	60.237	61.967	ftAD
Side inflow (total)	14.445	11.475	5.375	20.25	MGD
Not required					

Downstream status

	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet	
U/s freeboard	2.928	3.131	4.644	2.545	ft
U/s flow (Q1)	29.700	29.700	8.775	29.700	MGD
U/s velocity (V1)	2.821	2.969	1.441	2.579	ft/s
U/s water level (W1)	62.072	61.869	60.356	62.455	ftAD
U/s energy (H1)	62.196	62.006	60.388	62.558	ftAD

Shape: **Rectangular** [select]
 Length: **10** ft
 Equation: **Manning** [select]
 Manning n: **0.013**
 Outlet loss K: **1** Used only if outlet drowned
 Inlet loss K: **0**
 U/s coping level: **65** ftAD

	Upstream	Downstream	
Base width	4	4	ft
Not required		0	
Not required		0	
Invert level	58	58	ftAD

Spatially varied flow options
 Side inflow: **Yes** [select] uniformly distributed
 Side weir present: **No** [select]
 Not required
 Not required

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 30 and 32 of 166

BER (v9)

internal recycle

Flow case plotted **1** [select]

15 Fermentation Tank Influent Weir

0.5*(PE + RAS) only. IR mixes downstream of weir

THIN PLATE WEIR
Kindsvater-Carter Eqn: $Q=C_d(2/3)\sqrt{2g}b_e h_e^{1.5}$
BS ISO 1438:2017
Villemonte's drowned weir equation

Shape: **Rectangular**

Crest elevation: 62.5 ftAD
Weir width (b): 10 ft
U/s channel width (B): 12.5 ft
U/s channel invert: 58 ftAD
U/s coping level: 65 ftAD

Flow rate (Q)	14.445	11.475	5.375	20.25	MGD
D/s water level (W2)	62.072	61.869	60.356	62.455	ftAD

Undrowned head (h _e)	0.785	0.675	0.409	0.980	ft
C _d	0.604	0.603	0.600	0.606	
Weir status	Free discharge	Free discharge	Free discharge	Free discharge	

U/s freeboard	1.715	1.825	2.091	1.520	ft
U/s velocity (V1)	0.338	0.274	0.136	0.457	ft/s
U/s water level (W1)	63.285	63.175	62.909	63.480	ftAD
U/s energy (H1)	63.287	63.176	62.910	63.484	ftAD
Plunge	0.428	0.631	2.144	0.045	ft

NOTE: Site Visit Photographs show that with dry weather flow the plunge over the weir is approx 3". (Flow A and internal Recycle are not recorded at time of photograph)
Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 30, 32, 34 and 128 of 166

15.1 Flow A + RAS Conversion Box and Chimney

SURCHARGED CONDUIT

Shape: **Box** [select]
Length: 8 ft
Width: 6 ft
Height: 6 ft
Equation: **Colebrook** [select]
Roughness ks: 3 mm
Inlet type: **None** [select]
Outlet loss K: 1
Other fittings total K: 0.3 See guidance sheet
U/s invert: 48.5 ftAD
D/s invert: 48.5 ftAD
U/s coping level: ftAD

Flow rate	28.9	23.0	10.8	40.5	MGD
D/s energy (H2)	63.287	63.176	62.910	63.484	ftAD

Friction loss	0.001	0.000	0.000	0.001	ft
Fittings loss	0.031	0.020	0.004	0.061	ft
Surcharged loss	0.032	0.020	0.004	0.063	ft

Outlet controlled?	NO	NO	NO	NO	
Inlet controlled?	N/A	N/A	N/A	N/A	
Total loss	0.032	0.020	0.004	0.063	ft

U/s freeboard					ft
Velocity (V1)	1.242	0.986	0.462	1.741	ft/s
U/s energy (H1)	63.319	63.196	62.914	63.546	ftAD

Component added to account for vertical chimney at the junction between Flow A and RAS.
Outlet loss and short radius 90° included to account for losses at top and bottom of chimney respectively
Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 30 of 166

14 Fermentation Tank Influent 48" Pipe

SURCHARGED CONDUIT

Shape: **Circular** [select]
Length: 892 ft
Diameter: 4 ft
Not required
Equation: **Manning** [select]
Manning n: 0.012
Inlet type: **Sharp-edged** [select]
Outlet loss K: 1 into bottom of Fermentation tank chimney
Other fittings total K: 1 90, (2) 45, (2) 22.5
U/s invert: 52 ftAD
D/s invert: 48.5 ftAD
U/s coping level: 64.65 ftAD

Flow rate	17.4	13.5	4.0	27.0	MGD
D/s energy (H2)	63.319	63.196	62.914	63.546	ftAD

Friction loss	0.267	0.161	0.014	0.643	ft
Fittings loss	0.179	0.107	0.009	0.429	ft
Surcharged loss	0.446	0.268	0.024	1.072	ft

Outlet controlled?	NO	NO	NO	NO	
Inlet controlled?	NO	NO	NO	NO	
Total loss	0.446	0.268	0.024	1.072	ft

U/s freeboard	0.885	1.186	1.712	0.032	ft
Velocity (V1)	2.144	1.662	0.492	3.324	ft/s
U/s energy (H1)	63.765	63.464	62.938	64.618	ftAD

sheet 16, pag 551'-8"
sheet 15, pag 340'-4"
Total **892'-0"**

13 Transition from Flow Diversion Structure to 48" Pipe

GENERAL SUBMERGED CONSTRICTION

U/s shape: **Rectangular** [select]
U/s width: 5 ft
Opening shape: **Circular** [select]
Opening diameter: 4 ft
Opening thickness (t): 0.01 ft
Opening edge radius: 0 ft enter 0 if sharp
D/s shape: **Circular** [select]
D/s diameter: 4 ft

Flow rate	17.4	13.5	4.0	27.0	MGD
D/s energy (H2)	63.765	63.464	62.938	64.618	ftAD
U/s passage height	4	4	4	4	ft
Not required					
Not required					

t/D _n	0.003	0.003	0.003	0.003	
Orifice type	THIN	THIN	THIN	THIN	
Flow stable?	YES	YES	YES	YES	
K (on orifice velocity)	0.24	0.24	0.24	0.24	
Orifice velocity	2.144	1.662	0.492	3.324	ft/s
Headloss	0.017	0.010	0.001	0.041	ft
U/s velocity (V1)	1.347	1.044	0.309	2.089	ft/s
U/s energy (H1)	63.782	63.474	62.938	64.659	ftAD

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 52 of 166

<p>13.1 Flow Diversion Structure</p> <p>SURCHARGED CONDUIT</p> <p>Shape Box [select] Length 10 ft Width 5 ft Height 5 ft Equation Manning [select] Manning n 0.013 Inlet type Sharp-edged [select] Outlet loss K 0 Other fittings total K 1.5 See guidance sheet U/s invert 59 ftAD D/s invert 20 ftAD U/s coping level 67 ftAD</p>		<p>Flow rate 17.4 13.5 4.0 27.0 MGD D/s energy (H2) 63.782 63.474 62.938 64.659 ftAD</p> <p>Friction loss 0.001 0.000 0.000 0.002 ft Fittings loss 0.036 0.022 0.002 0.087 ft Surcharged loss 0.037 0.022 0.002 0.088 ft</p> <p>Outlet controlled? NO NO NO NO Inlet controlled? NO NO NO NO Total loss 0.037 0.022 0.002 0.088 ft</p> <p>U/s freeboard 3.182 3.504 4.060 2.253 ft Velocity (V1) 1.078 0.836 0.248 1.671 ft/s U/s energy (H1) 63.818 63.496 62.940 64.747 ftAD</p>	<p>PL (v11)</p>
<p>Included 1.5 for 90 degree mitre bend Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 52 of 166</p>			
<p>12 Primary Treatment Effluent Channel</p> <p>SURCHARGED CONDUIT</p> <p>Shape Box [select] Length 124 ft Width 4 ft Height 3.17 ft Equation Manning [select] Manning n 0.013 Inlet type None [select] Tee line to branch in next comp Outlet loss K 1 Other fittings total K 0 See guidance sheet U/s invert 56.25 ftAD D/s invert 56.25 ftAD U/s coping level 67.5 ftAD Top of Salsnes filters</p>		<p>Flow rate 17.4 13.5 4.0 27.0 MGD D/s energy (H2) 63.818 63.496 62.940 64.747 ftAD</p> <p>Friction loss 0.051 0.030 0.003 0.122 ft Fittings loss 0.070 0.042 0.004 0.169 ft Surcharged loss 0.121 0.073 0.006 0.291 ft</p> <p>Outlet controlled? NO NO NO NO Inlet controlled? N/A N/A N/A N/A Total loss 0.121 0.073 0.006 0.291 ft</p> <p>U/s freeboard 3.561 3.931 4.553 2.462 ft Velocity (V1) 2.127 1.649 0.489 3.298 ft/s U/s energy (H1) 63.939 63.569 62.947 65.038 ftAD</p>	<p>PL (v11)</p>
<p>Assumes 2 out of 3 salsnes filters are operational for a total treatment of 5 MGD Remaining flow assumes bypassing salsnes filters through both 30" pipes</p>			
<p>11 Salsnes Filter Bypass</p> <p>SURCHARGED CONDUIT</p> <p>Shape Circular [select] Length 60 ft Diameter 2.5 ft (30" CP Primary Clarifier effluent) Not required Equation Manning [select] Manning n 0.013 Inlet type Sharp-edged [select] Tee line to branch Outlet loss K 1.5 (2) 45, 90 Other fittings total K 0.7 U/s invert 1 ftAD low invert used as D/s invert 0 ftAD no risk of inlet/outlet control U/s coping level 67.5 ftAD</p>		<p>Flow rate 6.2 4.3 -0.5 11.0 MGD D/s energy (H2) 63.939 63.569 62.947 65.038 ftAD</p> <p>Friction loss 0.033 0.015 0.000 0.103 ft Fittings loss 0.161 0.075 0.001 0.504 ft Surcharged loss 0.193 0.091 0.001 0.608 ft</p> <p>Outlet controlled? NO NO NO NO Inlet controlled? NO NO NO NO Total loss 0.193 0.091 0.001 0.608 ft</p> <p>U/s freeboard 3.367 3.840 4.552 1.854 ft Velocity (V1) 1.957 1.340 -0.158 3.467 ft/s U/s energy (H1) 64.133 63.660 62.948 65.646 ftAD</p>	<p>PL (v11)</p> <p>Sheet nam Page number C2.03 16 M2.02 62 M2.10 66 M2.11 67 M2.12 68 M2.13 69 M2.21 71 M2.23 73</p>
<p>Northeast Improvements Project (City PN. 19-0029-UT, 2016), Sheet 66 of 117</p>			
<p>10 Flume Effluent Channel</p> <p>CHANNEL BACKWATER</p> <p>Subcritical flow calculation proceeds upstream</p> <p>Shape Rectangular [select] Length 16 ft Equation Manning [select] Manning n 0.013 Outlet loss K 1 Used only if outlet drowned Inlet loss K 0 U/s coping level 67.5 ftAD</p> <p>Upstream Downstream Base width 8 8 ft Not required 0 Not required 0 Invert level 61.83 61.83 ftAD</p> <p>Spatially varied flow options Side inflow No [select] uniformly distributed Side weir present No [select] Not required Not required</p>		<p>Assume full flow</p> <p>Flow rate 17.4 13.5 4.0 27.0 MGD D/s energy (H2) 64.133 63.660 62.948 65.646 ftAD</p> <p>Not required Not required</p> <p>Downstream status Drowned outlet Drowned outlet Drowned outlet Drowned outlet</p> <p>U/s freeboard 3.366 3.839 4.551 1.853 ft U/s flow (Q1) 17.415 13.500 4.000 27.000 MGD U/s velocity (V1) 1.462 1.426 0.691 1.368 ft/s U/s water level (W1) 64.134 63.661 62.949 65.647 ftAD U/s energy (H1) 64.168 63.693 62.956 65.676 ftAD</p>	<p>BER (v9)</p> <p>Flow case plotted 1 [select]</p>

<p>9 Parshall Flume</p> <p>PARSHALL FLUME Free discharge only $Q = C_h a^n$ Discharge measurement structures (Boss)</p> <p>Throat width (size) 4 ft [select] Upstream width 8 ft Crest elevation 66 ftAD U/s invert level 65.25 ftAD U/s coping level 71.25 ftAD C 2.953 n 1.578 Modular limit 0.7</p> <p>Assume full flow</p> <table border="1"> <tr> <td>Flow rate (Q)</td> <td>17.4</td> <td>13.5</td> <td>4.0</td> <td>27.0</td> <td>MGD</td> </tr> <tr> <td>Throat water level</td> <td>64.168</td> <td>63.693</td> <td>62.956</td> <td>65.676</td> <td>ftAD</td> </tr> <tr> <td>Measured depth, h_a</td> <td>1.392</td> <td>1.184</td> <td>0.548</td> <td>1.837</td> <td>ft</td> </tr> <tr> <td>Submergence, h_b/h_a</td> <td>-1.317</td> <td>-1.948</td> <td>-5.556</td> <td>-0.176</td> <td></td> </tr> <tr> <td>Drowned?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>Flow within range?</td> <td>YES</td> <td>YES</td> <td>YES</td> <td>YES</td> <td></td> </tr> <tr> <td>U/s freeboard</td> <td>3.704</td> <td>3.935</td> <td>4.643</td> <td>3.208</td> <td>ft</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>1.467</td> <td>1.264</td> <td>0.570</td> <td>1.870</td> <td>ft/s</td> </tr> <tr> <td>U/s water level (W1)</td> <td>67.546</td> <td>67.315</td> <td>66.607</td> <td>68.042</td> <td>ftAD</td> </tr> <tr> <td>U/s energy (H1)</td> <td>67.579</td> <td>67.340</td> <td>66.612</td> <td>68.096</td> <td>ftAD</td> </tr> </table> <p>Flow case plotted 1 [select]</p>		Flow rate (Q)	17.4	13.5	4.0	27.0	MGD	Throat water level	64.168	63.693	62.956	65.676	ftAD	Measured depth, h_a	1.392	1.184	0.548	1.837	ft	Submergence, h_b/h_a	-1.317	-1.948	-5.556	-0.176		Drowned?	NO	NO	NO	NO		Flow within range?	YES	YES	YES	YES		U/s freeboard	3.704	3.935	4.643	3.208	ft	U/s velocity (V1)	1.467	1.264	0.570	1.870	ft/s	U/s water level (W1)	67.546	67.315	66.607	68.042	ftAD	U/s energy (H1)	67.579	67.340	66.612	68.096	ftAD	<p>FP (v4)</p>
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<p>8 Headworks Effluent Channel</p> <p>CHANNEL BACKWATER</p> <p>Subcritical flow calculation proceeds upstream</p> <p>Shape Rectangular [select] Length 30 ft Equation Manning [select] Manning n 0.013 Outlet loss K 0 Used only if outlet drowned Inlet loss K 0 U/s coping level 71.25 ftAD</p> <p>Upstream Downstream Base width 8 ft 8 ft Not required 0 Not required 0 Invert level 65.25 ftAD 65.25 ftAD</p> <p>Spatially varied flow options Side inflow No [select] uniformly distributed Side weir present No [select] Not required Not required</p> <p>Assume full flow</p> <table border="1"> <tr> <td>Flow rate</td> <td>17.4</td> <td>13.5</td> <td>4.0</td> <td>27.0</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>67.579</td> <td>67.340</td> <td>66.612</td> <td>68.096</td> <td>ftAD</td> </tr> <tr> <td>Not required</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Not required</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Downstream status</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td></td> </tr> <tr> <td>U/s freeboard</td> <td>3.701</td> <td>3.932</td> <td>4.643</td> <td>3.204</td> <td>ft</td> </tr> <tr> <td>U/s flow (Q1)</td> <td>17.415</td> <td>13.500</td> <td>4.000</td> <td>27.000</td> <td>MGD</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>1.465</td> <td>1.263</td> <td>0.570</td> <td>1.867</td> <td>ft/s</td> </tr> <tr> <td>U/s water level (W1)</td> <td>67.549</td> <td>67.318</td> <td>66.607</td> <td>68.046</td> <td>ftAD</td> </tr> <tr> <td>U/s energy (H1)</td> <td>67.582</td> <td>67.342</td> <td>66.613</td> <td>68.100</td> <td>ftAD</td> </tr> </table> <p>Flow case plotted 1 [select]</p>		Flow rate	17.4	13.5	4.0	27.0	MGD	D/s energy (H2)	67.579	67.340	66.612	68.096	ftAD	Not required						Not required						Downstream status	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet		U/s freeboard	3.701	3.932	4.643	3.204	ft	U/s flow (Q1)	17.415	13.500	4.000	27.000	MGD	U/s velocity (V1)	1.465	1.263	0.570	1.867	ft/s	U/s water level (W1)	67.549	67.318	66.607	68.046	ftAD	U/s energy (H1)	67.582	67.342	66.613	68.100	ftAD	<p>BER (v9)</p>
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<p>7 Grit Chamber Effluent Channel</p> <p>CHANNEL BACKWATER</p> <p>Subcritical flow calculation proceeds upstream</p> <p>Shape Rectangular [select] Length 46 ft Equation Manning [select] Manning n 0.013 Outlet loss K 0 Used only if outlet drowned Inlet loss K 0 U/s coping level 71.25 ftAD</p> <p>Upstream Downstream Base width 8 ft 8 ft Not required 0 Not required 0 Invert level 65.25 ftAD 65.25 ftAD</p> <p>Spatially varied flow options Side inflow Yes [select] uniformly distributed Side weir present No [select] Not required Not required</p> <p>Assume full flow</p> <table border="1"> <tr> <td>D/s flow (Q2)</td> <td>17.4</td> <td>13.5</td> <td>4.0</td> <td>27.0</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>67.582</td> <td>67.342</td> <td>66.613</td> <td>68.100</td> <td>ftAD</td> </tr> <tr> <td>Side inflow (total)</td> <td>17.4</td> <td>13.5</td> <td>4.0</td> <td>27.0</td> <td>MGD</td> </tr> <tr> <td>Not required</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Downstream status</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td>Drowned outlet</td> <td></td> </tr> <tr> <td>U/s freeboard</td> <td>3.632</td> <td>3.880</td> <td>4.632</td> <td>3.092</td> <td>ft</td> </tr> <tr> <td>U/s flow (Q1)</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>MGD</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>ft/s</td> </tr> <tr> <td>U/s water level (W1)</td> <td>67.618</td> <td>67.370</td> <td>66.618</td> <td>68.158</td> <td>ftAD</td> </tr> <tr> <td>U/s energy (H1)</td> <td>67.618</td> <td>67.370</td> <td>66.618</td> <td>68.158</td> <td>ftAD</td> </tr> </table> <p>Flow case plotted 1 [select]</p>		D/s flow (Q2)	17.4	13.5	4.0	27.0	MGD	D/s energy (H2)	67.582	67.342	66.613	68.100	ftAD	Side inflow (total)	17.4	13.5	4.0	27.0	MGD	Not required						Downstream status	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet		U/s freeboard	3.632	3.880	4.632	3.092	ft	U/s flow (Q1)	0.000	0.000	0.000	0.000	MGD	U/s velocity (V1)	0.000	0.000	0.000	0.000	ft/s	U/s water level (W1)	67.618	67.370	66.618	68.158	ftAD	U/s energy (H1)	67.618	67.370	66.618	68.158	ftAD	<p>BER (v9)</p>
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<p>6 Grit Chamber Effluent Weir</p> <p>THIN PLATE WEIR Kindsvater-Carter Eqn: $Q = C_d (2/3) \sqrt{2g} b_o h_o^{3/2}$ BS ISO 1438:2017 Villemonte's drowned weir equation</p> <p>Shape Rectangular Crest elevation 68 ftAD Weir width (b) 17 ft U/s channel width (B) 19 ft U/s channel invert 57.66 ftAD U/s coping level 71.25 ftAD</p> <p>Assume 4 out of 4 grit systems in operation</p> <table border="1"> <tr> <td>Flow rate (Q)</td> <td>4.35375</td> <td>3.375</td> <td>1</td> <td>6.75</td> <td>MGD</td> </tr> <tr> <td>D/s water level (W2)</td> <td>67.618</td> <td>67.370</td> <td>66.618</td> <td>68.158</td> <td>ftAD</td> </tr> <tr> <td>Undrowned head (h_o)</td> <td>0.251</td> <td>0.213</td> <td>0.096</td> <td>0.335</td> <td>ft</td> </tr> <tr> <td>C_d</td> <td>0.599</td> <td>0.599</td> <td>0.598</td> <td>0.600</td> <td></td> </tr> <tr> <td>Weir status</td> <td>Free discharge</td> <td>Free discharge</td> <td>Free discharge</td> <td>Drowned</td> <td></td> </tr> <tr> <td>U/s freeboard</td> <td>2.999</td> <td>3.037</td> <td>3.154</td> <td>2.884</td> <td>ft</td> </tr> <tr> <td>U/s velocity (V1)</td> <td>0.033</td> <td>0.026</td> <td>0.008</td> <td>0.051</td> <td>ft/s</td> </tr> <tr> <td>U/s water level (W1)</td> <td>68.251</td> <td>68.213</td> <td>68.096</td> <td>68.366</td> <td>ftAD</td> </tr> <tr> <td>U/s energy (H1)</td> <td>68.251</td> <td>68.213</td> <td>68.096</td> <td>68.366</td> <td>ftAD</td> </tr> </table> <p>Flow case plotted 1 [select]</p>		Flow rate (Q)	4.35375	3.375	1	6.75	MGD	D/s water level (W2)	67.618	67.370	66.618	68.158	ftAD	Undrowned head (h_o)	0.251	0.213	0.096	0.335	ft	C_d	0.599	0.599	0.598	0.600		Weir status	Free discharge	Free discharge	Free discharge	Drowned		U/s freeboard	2.999	3.037	3.154	2.884	ft	U/s velocity (V1)	0.033	0.026	0.008	0.051	ft/s	U/s water level (W1)	68.251	68.213	68.096	68.366	ftAD	U/s energy (H1)	68.251	68.213	68.096	68.366	ftAD	<p>WTR (v8)</p>						
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Revision
A

5 Headloss through Grit Chamber

CHANNEL FIXED LOSS

$H_1 = H_2 + dH$

Shape: **Rectangular** [select]
 Width: 19 ft
 Not required
 Invert level: 66.08 ftAD
 Coping level: 71.25 ftAD

Northeast Improvements Project (City PN. 19-0029-UT, 2016), Sheet 57 of 117

Assume 4 out of 4 grit systems in operation

Flow rate	4.35375	3.375	1	6.75	MGD
D/s energy (H2)	68.251	68.213	68.096	68.366	ftAD
Fixed loss (dH)	0.58	0.58	0.58	0.67	ft

Critical check

U/s freeboard	2.416	2.454	2.570	2.218	ft
U/s velocity (V1)	0.129	0.101	0.031	0.186	ft/s
U/s water level (W1)	68.834	68.796	68.680	69.032	ftAD
U/s energy (H1)	68.835	68.796	68.680	69.032	ftAD

CE (v4)

Sloping up invert creates higher water elevation. Invert sloping up was designed to bring water up to critical level for headcell.

4 Bar Screen Effluent Channel

CHANNEL BACKWATER

Subcritical flow calculation proceeds upstream

Shape: **Rectangular** [select]
 Length: 54.5 ft
 Equation: Manning [select]
 Manning n: 0.013
 Outlet loss K: 0
 Inlet loss K: 1.5
 U/s coping level: 71.25 ftAD

Used only if outlet drowned
Added loss from 90 degree bend

Upstream Downstream
 Base width: 6 ft / 6 ft
 Not required: 0 / 0
 Invert level: 65.25 ftAD / 66.08 ftAD

Spatially varied flow options
 Side inflow: No [select] uniformly distributed
 Side weir present: No [select]

Not required
Not required

Northeast Improvements Project (City PN. 19-0029-UT, 2016), Sheet ## of 117

Assume 2 bar screens in use

Flow rate	8.7075	6.75	2	13.5	MGD
D/s energy (H2)	68.835	68.796	68.680	69.032	ftAD

Downstream status

U/s freeboard	2.411	2.451	2.570	2.208	ft
U/s flow (Q1)	8.708	6.750	2.000	13.500	MGD
U/s velocity (V1)	0.626	0.491	0.150	0.918	ft/s
U/s water level (W1)	68.839	68.799	68.680	69.042	ftAD
U/s energy (H1)	68.845	68.802	68.680	69.055	ftAD

NOTE: sloped upwards to so that the channel invert rises to the Heacell critical dimension.

BER (v9)

Flow case plotted 1 [select]

3 Fixed Loss through the Mechanical Bar Screens

CHANNEL FIXED LOSS

$H_1 = H_2 + dH$

Shape: **Rectangular** [select]
 Width: 5 ft
 Not required
 Invert level: 65.25 ftAD
 Coping level: 71.25 ftAD

Headworks Screening and Grit Removal Improvements for NEWRF (2007), Sheet NE-M-03A

Assume 2 bar screens in use

Flow rate	8.7075	6.75	2	13.5	MGD
D/s energy (H2)	68.845	68.802	68.680	69.055	ftAD
Fixed loss (dH)	0.85	0.85	0.85	1	ft

Critical check

U/s freeboard	1.561	1.601	1.720	1.207	ft
U/s velocity (V1)	0.607	0.475	0.145	0.872	ft/s
U/s water level (W1)	69.689	69.649	69.530	70.043	ftAD
U/s energy (H1)	69.695	69.652	69.530	70.055	ftAD

Available Freeboard

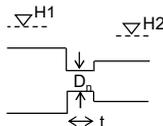
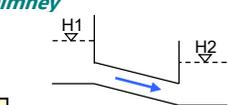
	1.555	1.598	1.720	1.195	
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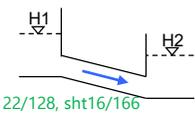
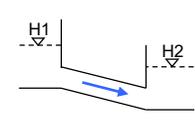
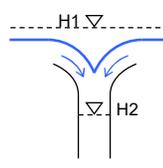
CE (v4)

Delta headloss provided by vendor for 14.65 MGD and 8.7 MGD. Assumed 35% Rlirdinn

14.48449

No.	Clearwater NE WRF Hydraulic Profile - Internal Recycle					COMMENTS																																																																																
<p>0 GENERAL</p> <p>Inputs in yellow boxes Units selection in pale yellow boxes Output results in blue boxes Drawing Reference Sheets Purple</p> <div style="border: 1px solid black; padding: 5px; color: red; font-weight: bold;"> These flow values are independent of the values in the other tabs. If values are updated in other tabs, they do not automatically update here. </div>	<p>Max Month Average Day</p> <p>Average Annual Daily Flow</p> <p>Min Flow Plant Peak Hour</p> <p>Original Plant Peak Hour</p> <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th>Case Description</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th></th> </tr> <tr> <td></td> <td>MMAD</td> <td>AADF (Permitted)</td> <td>Min</td> <td>ORIGINAL PH</td> <td></td> </tr> </thead> <tbody> <tr> <td>Flow rate A</td> <td>17.4</td> <td>13.5</td> <td>4</td> <td>27</td> <td>MGD</td> </tr> <tr> <td>RAS Recycle Ratio to AADF</td> <td>0.85</td> <td>0.7</td> <td>0.5</td> <td>1</td> <td></td> </tr> <tr> <td>RAS flow</td> <td>11.48</td> <td>9.45</td> <td>6.75</td> <td>13.5</td> <td>MGD</td> </tr> <tr> <td>Flow rate B: A + RAS</td> <td>28.9</td> <td>23.0</td> <td>10.8</td> <td>40.5</td> <td>MGD</td> </tr> <tr> <td>IR Recycle Ratio to AADF</td> <td>4.4</td> <td>4.4</td> <td>1.3</td> <td>4.4</td> <td></td> </tr> <tr> <td>Internal Recycle</td> <td>59.4</td> <td>59.4</td> <td>17.55</td> <td>59.4</td> <td>MGD</td> </tr> <tr> <td>Flow rate C: A + RAS + IR</td> <td>88.29</td> <td>82.35</td> <td>28.3</td> <td>99.9</td> <td>MGD</td> </tr> </tbody> </table> <p>Oxidation ditch weir discharge copied from component</p> <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Free discharge</td> <td>Free discharge</td> <td>Free discharge</td> <td>Free discharge</td> </tr> </table>				Case Description	1	2	3	4			MMAD	AADF (Permitted)	Min	ORIGINAL PH		Flow rate A	17.4	13.5	4	27	MGD	RAS Recycle Ratio to AADF	0.85	0.7	0.5	1		RAS flow	11.48	9.45	6.75	13.5	MGD	Flow rate B: A + RAS	28.9	23.0	10.8	40.5	MGD	IR Recycle Ratio to AADF	4.4	4.4	1.3	4.4		Internal Recycle	59.4	59.4	17.55	59.4	MGD	Flow rate C: A + RAS + IR	88.29	82.35	28.3	99.9	MGD	Free discharge	Free discharge	Free discharge	Free discharge	<p>Max calculated IR flow is 440% of AADF</p>																							
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Invert level	58	58	ftAD																																																																																					
Flow rate	29.7	29.7	8.775	29.7	MGD																																																																																			
D/s energy (H2)	62.447	62.260	60.447	62.808	ftAD																																																																																			
Not required																																																																																								
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Downstream status	Drowned outlet	Drowned outlet	Drowned outlet	Drowned outlet																																																																																				
U/s freeboard	2.086	2.227	4.415	1.799	ft																																																																																			
U/s flow (Q1)	29.700	29.700	8.775	29.700	MGD																																																																																			
U/s velocity (V1)	2.338	2.407	1.313	2.209	ft/s																																																																																			
U/s water level (W1)	62.914	62.773	60.585	63.201	ftAD																																																																																			
U/s energy (H1)	62.999	62.863	60.612	63.276	ftAD																																																																																			
	0.551	0.603	0.165	0.469	ft																																																																																			
<p>80 Internal Recycle Channel Vertical Chimney</p> <p>SURCHARGED CONDUIT</p>  <p>Shape Box [select] Length 10 ft Width 4 ft Height 4 ft Equation Manning [select] Manning n 0.013 Inlet type None [select] Outlet loss K 1 Other fittings total K 1.2 See guidar 90° mitre inlet from pipe U/s invert 0 ftAD Set to zero for no inlet/outlet control D/s invert 0 ftAD U/s coping level 65 ftAD</p> <p>Vertical Chimney deduced from invert Elevation differences</p> <p>90 Deg. Bend from vertical to hori</p> <p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 33 of 166</p>	<p>Flow rate</p> <table border="1"> <tr> <td></td> <td>29.7</td> <td>29.7</td> <td>8.775</td> <td>29.7</td> <td>MGD</td> </tr> <tr> <td>D/s energy (H2)</td> <td>62.999</td> <td>62.863</td> <td>60.612</td> <td>63.276</td> <td>ftAD</td> </tr> </table> <table border="1"> <tr> <td>Friction loss</td> <td>0.006</td> <td>0.006</td> <td>0.001</td> <td>0.006</td> <td>ft</td> </tr> <tr> <td>Fittings loss</td> <td>0.282</td> <td>0.282</td> <td>0.025</td> <td>0.282</td> <td>ft</td> </tr> <tr> <td>Surcharged loss</td> <td>0.288</td> <td>0.288</td> <td>0.025</td> <td>0.288</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>Outlet controlled?</td> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> <td></td> </tr> <tr> <td>Inlet controlled?</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td></td> </tr> <tr> <td>Total loss</td> <td>0.288</td> <td>0.288</td> <td>0.025</td> <td>0.288</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>U/s freeboard</td> <td>1.713</td> <td>1.848</td> <td>4.363</td> <td>1.435</td> <td>ft</td> </tr> <tr> <td>Velocity (V1)</td> <td>2.872</td> <td>2.872</td> <td>0.849</td> <td>2.872</td> <td>ft/s</td> </tr> <tr> <td>U/s energy (H1)</td> <td>63.287</td> <td>63.152</td> <td>60.637</td> <td>63.565</td> <td>ftAD</td> </tr> </table>		29.7	29.7	8.775	29.7	MGD	D/s energy (H2)	62.999	62.863	60.612	63.276	ftAD	Friction loss	0.006	0.006	0.001	0.006	ft	Fittings loss	0.282	0.282	0.025	0.282	ft	Surcharged loss	0.288	0.288	0.025	0.288	ft	Outlet controlled?	NO	NO	NO	NO		Inlet controlled?	N/A	N/A	N/A	N/A		Total loss	0.288	0.288	0.025	0.288	ft	U/s freeboard	1.713	1.848	4.363	1.435	ft	Velocity (V1)	2.872	2.872	0.849	2.872	ft/s	U/s energy (H1)	63.287	63.152	60.637	63.565	ftAD	<p>PL (v11)</p>																				
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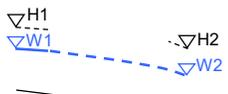
<p>81 <i>Internal Recycle Pipe</i></p> <p>SURCHARGED CONDUIT</p> <p>Shape Circular [select] Length 141 ft Diameter 36 in Not required Equation H-W [select] Hazen-Williams C 110 Inlet type None [select] none - reducing 90° into bottom of chimney Outlet loss K 0 Other fittings total K 0.8 See guidar 1 x 90 + 1 x 45 deg.+ 42" to 36" reducer U/s invert 48 ftAD D/s invert 48 ftAD U/s coping level 69 ftAD Set to Upstream Weir El.</p> <p>pg 22/128, sht16/166</p>		<p>Flow rate 29.7 MGD D/s energy (H2) 63.287 ftAD</p> <p>Friction loss 0.628 ft Fittings loss 0.525 ft Surcharged loss 1.154 ft</p> <p>Outlet controlled? NO Inlet controlled? N/A Total loss 1.154 ft</p> <p>U/s freeboard 4.559 ft Velocity (V1) 6.501 ft/s U/s energy (H1) 64.441 ftAD</p>	<table border="1"> <tr> <td>29.7</td> <td>29.7</td> <td>8.775</td> <td>29.7</td> <td>MGD</td> </tr> <tr> <td>63.287</td> <td>63.152</td> <td>60.637</td> <td>63.565</td> <td>ftAD</td> </tr> </table> <table border="1"> <tr> <td>0.628</td> <td>0.628</td> <td>0.066</td> <td>0.628</td> <td>ft</td> </tr> <tr> <td>0.525</td> <td>0.525</td> <td>0.046</td> <td>0.525</td> <td>ft</td> </tr> <tr> <td>1.154</td> <td>1.154</td> <td>0.112</td> <td>1.154</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> </tr> <tr> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> </tr> <tr> <td>1.154</td> <td>1.154</td> <td>0.112</td> <td>1.154</td> </tr> </table> <table border="1"> <tr> <td>4.559</td> <td>4.695</td> <td>8.251</td> <td>4.282</td> <td>ft</td> </tr> <tr> <td>6.501</td> <td>6.501</td> <td>1.921</td> <td>6.501</td> <td>ft/s</td> </tr> <tr> <td>64.441</td> <td>64.305</td> <td>60.749</td> <td>64.718</td> <td>ftAD</td> </tr> </table>	29.7	29.7	8.775	29.7	MGD	63.287	63.152	60.637	63.565	ftAD	0.628	0.628	0.066	0.628	ft	0.525	0.525	0.046	0.525	ft	1.154	1.154	0.112	1.154	ft	NO	NO	NO	NO	N/A	N/A	N/A	N/A	1.154	1.154	0.112	1.154	4.559	4.695	8.251	4.282	ft	6.501	6.501	1.921	6.501	ft/s	64.441	64.305	60.749	64.718	ftAD	<p>PL (v11)</p>
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<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 40 of 166, Section E. Sheet 16 of 166.</p>																																																								
<p>82 <i>Internal Recycle Pipe</i></p> <p>SURCHARGED CONDUIT</p> <p>Shape Circular [select] Length 13 ft Diameter 42 in Not required Equation H-W [select] Hazen-Williams C 110 Inlet type None [select] Outlet loss K Other fittings total K See guidance sheet U/s invert 48 ftAD to prevent inlet control D/s invert 48 ftAD U/s coping level 69 ftAD</p>		<p>1/2 of IR Flow</p> <p>Flow rate 29.7 MGD D/s energy (H2) 63.287 ftAD</p> <p>Friction loss 0.027 ft Fittings loss 0.000 ft Surcharged loss 0.027 ft</p> <p>Outlet controlled? NO Inlet controlled? N/A Total loss 0.027 ft</p> <p>U/s freeboard 5.686 ft Velocity (V1) 4.776 ft/s U/s energy (H1) 63.314 ftAD</p>	<table border="1"> <tr> <td>29.7</td> <td>29.7</td> <td>8.775</td> <td>29.7</td> <td>MGD</td> </tr> <tr> <td>63.287</td> <td>63.152</td> <td>60.637</td> <td>63.565</td> <td>ftAD</td> </tr> </table> <table border="1"> <tr> <td>0.027</td> <td>0.027</td> <td>0.003</td> <td>0.027</td> <td>ft</td> </tr> <tr> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>ft</td> </tr> <tr> <td>0.027</td> <td>0.027</td> <td>0.003</td> <td>0.027</td> <td>ft</td> </tr> </table> <table border="1"> <tr> <td>NO</td> <td>NO</td> <td>NO</td> <td>NO</td> </tr> <tr> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> </tr> <tr> <td>0.027</td> <td>0.027</td> <td>0.003</td> <td>0.027</td> </tr> </table> <table border="1"> <tr> <td>5.686</td> <td>5.821</td> <td>8.360</td> <td>5.408</td> <td>ft</td> </tr> <tr> <td>4.776</td> <td>4.776</td> <td>1.411</td> <td>4.776</td> <td>ft/s</td> </tr> <tr> <td>63.314</td> <td>63.179</td> <td>60.640</td> <td>63.592</td> <td>ftAD</td> </tr> </table>	29.7	29.7	8.775	29.7	MGD	63.287	63.152	60.637	63.565	ftAD	0.027	0.027	0.003	0.027	ft	0.000	0.000	0.000	0.000	ft	0.027	0.027	0.003	0.027	ft	NO	NO	NO	NO	N/A	N/A	N/A	N/A	0.027	0.027	0.003	0.027	5.686	5.821	8.360	5.408	ft	4.776	4.776	1.411	4.776	ft/s	63.314	63.179	60.640	63.592	ftAD	<p>PL (v11)</p>
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<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 44 of 166 Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 16 of 166</p>																																																								
<p>83 <i>{ENTER COMPONENT DESCRIPTION}</i></p> <p>VERTICAL PIPE INLET / BELLMOUTH Weir $Q = C_d \sqrt{g} b H^{1.5}$, Orifice $Q = C_v A \sqrt{2gH}$ Pipe inlet K from Idel'chik</p> <p>Top of bellmouth 66.5 ftAD Height of bellmouth 0 in Throat diameter 42 in Bell diameter 42 in Inlet type Re-entrant [select] U/s coping level 71.5 ftAD Weir C_d 0.513 see guidance sheet Orifice C_v 0.95 Pipe inlet K value 1.00</p>		<p>1/2 of IR Flow</p> <p>Flow rate (Q) 29.7 MGD D/s energy (H2) 63.314 ftAD</p> <p>Weir head 67.773 ftAD Pipe head 63.669 ftAD Orifice head 66.893 ftAD Inlet type Weir</p> <p>U/s freeboard 3.727 ft U/s water level (W1) 67.773 ftAD U/s energy (H1) 67.773 ftAD</p>	<table border="1"> <tr> <td>29.7</td> <td>29.7</td> <td>8.775</td> <td>29.7</td> <td>MGD</td> </tr> <tr> <td>63.314</td> <td>63.179</td> <td>60.640</td> <td>63.592</td> <td>ftAD</td> </tr> </table> <table border="1"> <tr> <td>67.773</td> <td>67.773</td> <td>67.065</td> <td>67.773</td> <td>ftAD</td> </tr> <tr> <td>63.669</td> <td>63.533</td> <td>60.671</td> <td>63.946</td> <td>ftAD</td> </tr> <tr> <td>66.893</td> <td>66.893</td> <td>66.534</td> <td>66.893</td> <td>ftAD</td> </tr> </table> <table border="1"> <tr> <td>Weir</td> <td>Weir</td> <td>Weir</td> <td>Weir</td> </tr> </table> <table border="1"> <tr> <td>3.727</td> <td>3.727</td> <td>4.435</td> <td>3.727</td> <td>ft</td> </tr> <tr> <td>67.773</td> <td>67.773</td> <td>67.065</td> <td>67.773</td> <td>ftAD</td> </tr> <tr> <td>67.773</td> <td>67.773</td> <td>67.065</td> <td>67.773</td> <td>ftAD</td> </tr> </table>	29.7	29.7	8.775	29.7	MGD	63.314	63.179	60.640	63.592	ftAD	67.773	67.773	67.065	67.773	ftAD	63.669	63.533	60.671	63.946	ftAD	66.893	66.893	66.534	66.893	ftAD	Weir	Weir	Weir	Weir	3.727	3.727	4.435	3.727	ft	67.773	67.773	67.065	67.773	ftAD	67.773	67.773	67.065	67.773	ftAD	<p>WTB (v8)</p>								
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<p>Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 40 of 166</p>																																																								

84

Oxydation Reactor Effluent Channel

CHANNEL BACKWATER

Subcritical flow calculation proceeds upstream



Shape: **Rectangular** [select] Sheet 38, 40 of 166

Length: 40 ft

Equation: Manning [select]

Manning n: 0.013

Outlet loss K: 0

Inlet loss K: 0

U/s coping level: 69 ftAD Set to Upstream Weir El.

	Upstream	Downstream
Base width	4.83	4.83 ft
Not required		0
Not required		0
Invert level	66.5	66.5 ftAD

Spatially varied flow options

Side inflow: Yes [select] uniformly distributed

Side weir present: No [select]

Not required

Not required

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 40 of 166

BER (v9)

1/2 of IR Flow

D/s flow (Q2)	29.7	29.7	8.775	29.7	MGD
D/s energy (H2)	67.773	67.773	67.065	67.773	ftAD
Side inflow (total)	29.7	29.7	8.775	29.7	MGD
Not required					

Downstream status	Critical depth	Critical depth	Critical depth	Critical depth
U/s freeboard	0.003	0.003	1.384	0.003
U/s flow (Q1)	0.000	0.000	0.000	0.000
U/s velocity (V1)	0.000	0.000	0.000	0.000
U/s water level (W1)	68.997	68.997	67.616	68.997
U/s energy (H1)	68.997	68.997	67.616	68.997

to weir elevation

Flow case plotted
1 [select]

85

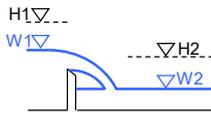
Oxydation Reactor Effluent Weir

THIN PLATE WEIR

Kindsvater-Carter Eqn: $Q = C_d (2/3) \sqrt{2g} b_e h_e^{1.5}$

BS ISO 1438:2017

Villemonte's drowned weir equation



Shape: **Rectangular**

Crest elevation: 69 ftAD

Weir width (b): 40 ft

U/s channel width (B): 44 ft

U/s channel invert: 55.5 ftAD

U/s coping level: 72.17 ftAD

'Normal'

Northeast Advanced Pollution Control Facility Record Drawing (City PN 92016, 1988) - Sheet 38, 40 & 44 of 166

WTR (v8)

1/2 of IR Flow

Flow rate (Q)	29.7	29.7	8.775	29.7	MGD
D/s water level (W2)	68.997	68.997	67.616	68.997	ftAD

Undrowned head (h _e)	C _d	Weir status
0.507	0.507	0.227
0.601	0.601	0.599
Free	Free	Free
discharge	discharge	discharge

U/s freeboard	U/s velocity (V1)	U/s water level (W1)	U/s energy (H1)
2.663	0.075	69.507	69.507
2.663	0.075	69.507	69.507
2.943	0.022	69.227	69.227
2.663	0.075	69.507	69.507