Collaboration Customer Service Safety Integrity Performance

UISCE ÉIREANN : IRISH WATER

The Provision of Safe and Secure Drinking Water

Drinking Water Safety Challenge

Asset Planning (Water Treatment)

March 2017

V0 3

Coagulation Control Workshop - Agenda

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09h00 – 09h30: Registration

09h30 – 10h15: Provision of safe drinking water [Victor van der Walt, IW]
10h15 – 11h00: Coagulation chemistry [David Speers, Jacobs]

11h00 – 11h30: Tea/Coffee

11h30 – 12h15: Jar testing best practice [Kevin Love, IW]
12h15 – 13h00: History of coagulation control [John Clark, Chemtrac]

13h00 – 14h00: Lunch

14h00 – 15h00: CoagSense Coagulation Control [John Clark, Chemtrac]
15h00 – 16h00: Practical Implications of Coagulation Control [Mike Riding, PI]

Why

Drinking Water Safety Challenge

Traditional approach (monitoring the end product)

- Monitoring of coliform bacteria, turbidity and disinfectant residuals has been demonstrated insufficient for the prevention of waterborne outbreaks (Payment *et al*., 1993)
- Waterborne outbreaks have been documented in regions where the drinking quality was met with existing microbiological criteria (Melnick and Gerba, 1979; Craun, 1981; Lippy and Waltrip, 1984; O'Neil *et al*., 1985)
- The presumed close correlation between pathogen occurrence and the detection of indicator organisms may not always be present, especially in the case of *Cryptosporidium* (Teunis *et al*., 1995)

New approach required

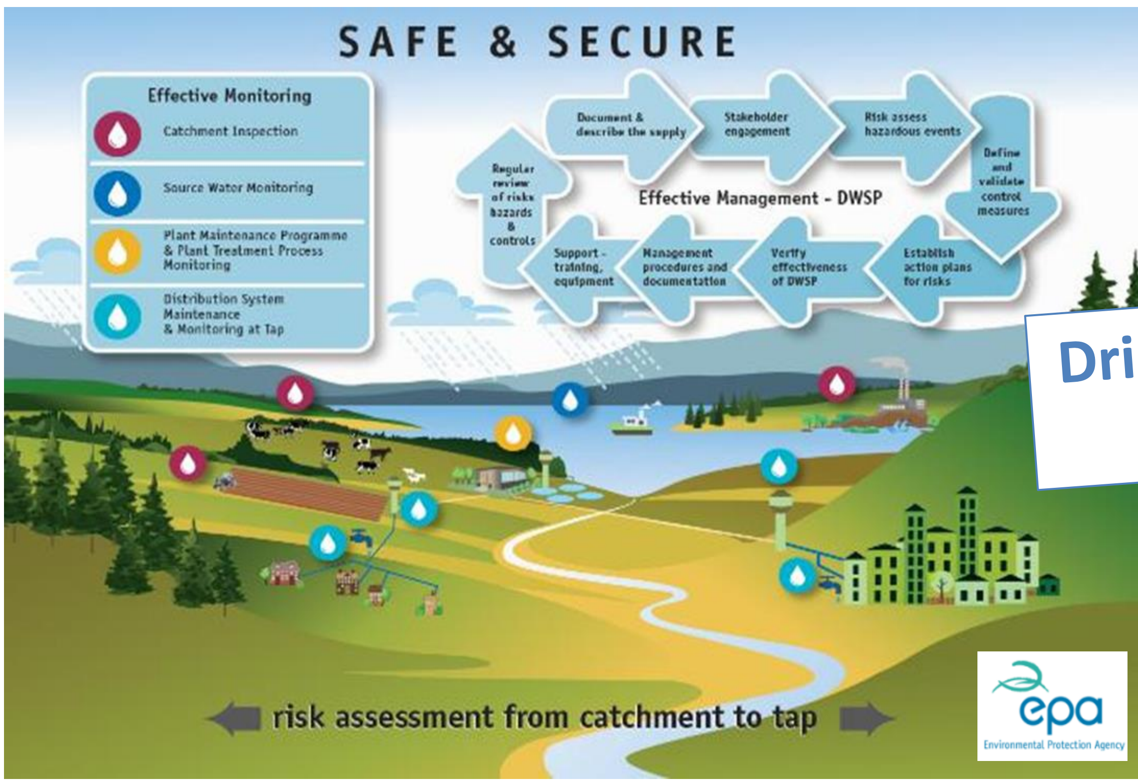
Galway (EPA 2012)

- *Outbreak of Cryptosporidium in Galway City in 2007 (242 cases of illness)*
- *Compliance with micro, chemical and indicator parametric values was 99.1% the previous year.*
- *Monitoring did not tell us whether the supply was safe and secure*

HOW Drinking Water Safety Challenge cont.

New approach (health based targets and microbial risk assessment)

- New WHO approach focuses explicitly on risks posed by waterborne pathogens in individual sources of drinking water (WHO Guidelines for drinking water quality, 4th ed., 2011)



Drinking Water Safety Plan approach

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HOW 212º the extra degree

At 211 ºF, water is hot
At 212 ºF, water it boils,
And with boiling water, comes steam.
And steam can power a train

AND … IT IS THAT
ONE EXTRA DEGREE

that makes all the difference! (Sam Parker, 2005)

DWSP Approach - by making small changes we can significantly improve the safety and security of drinking water we supply!

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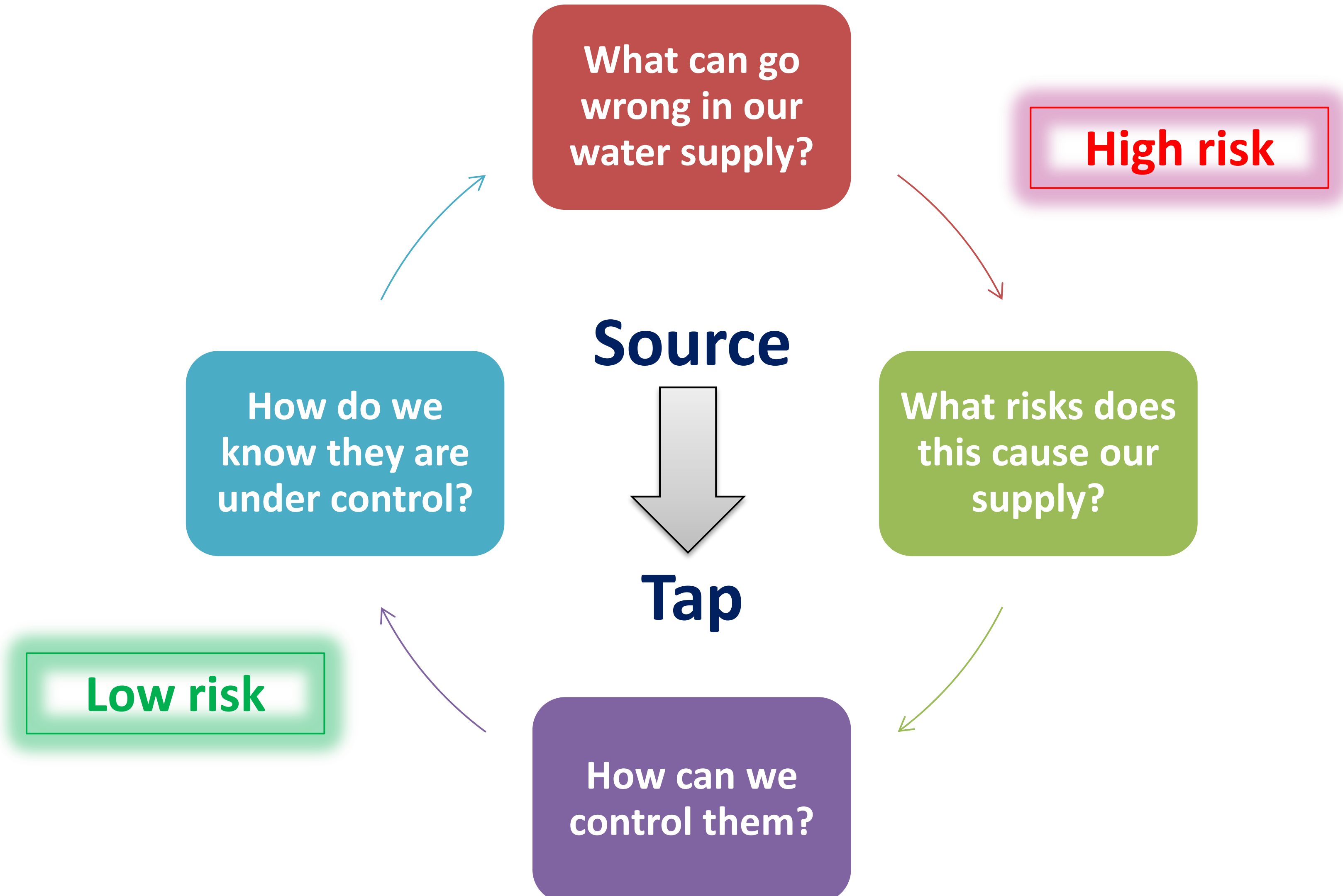
HOW

WHO Risk Assessment and Risk Management Approach – a new way of working



HOW

Challenges with health based target approach

Development/implementation of risk-based approach:

- Australia, Canada, Netherlands, New Zealand, Sweden, Norway, USA

Implementation challenges [UKWIR, 2016]:

- Recognised that a health target is not practical for assessing the microbiological safety of drinking water. Instead it has been converted to a performance target for water treatment, (i.e. specified log reductions for particular pathogens).
- Limited to assessing robustness of water treatment processes. No corresponding assessment for water in distribution systems.
- Log reduction targets are unsuitable for operational monitoring. In practise, verification of process performance requires checking of surrogate parameters.

WHO [2017]:

- Achieving specified turbidity targets at well-designed filtration plants that have been optimised to achieve particle removal is a critical component of demonstrating pathogen reductions (Table 4).

Treatment type	Turbidity target	Crypto reduction	Virus reduction
CFC+RGF	≤0.3NTU in 95%	3-log	2-log

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Step B.3.2 - Protozoa Log Credit Compliance Criteria – CFC + RGF (enhanced individual filtration)

- To obtain 4.0 protozoa log credits for CFC + RGF used as a coagulation, clarification and filtration process, the following requirements must be met during periods when treated water is being produced:

  a) *All water must pass through the full CFC and filtration process (no bypass or mixing of water without CFC + RFG);*

  b) *The filters must be operated at a steady flow rate. Maximum rate of change of flow – 1.5%/minute;*

  c) *Measurement of turbidity of the filtered water leaving each filter must satisfy the following conditions:*

     i. Shall be less than or equal to 0.1 NTU for at least 95% of each filter cycle. The filter cycle is the period between the filter being returned to supply following backwashing and being taken out of supply for backwashing;

     ii. Individual filtrate shall not exceed 0.3 NTU for the duration of any 15-minute period;

     iii. Individual filtrate shall not exceed 0.5 NTU for the duration of any 3-minute period; and

     iv. Filter run to waste until below 0.1 NTU – filters shall be capable of directing filtered water to waste immediately following a backwash for a period of time until the filtrate turbidity value is below 0.1 NTU.

- Protozoal compliance monitoring requirements for CFC + RGF are as follows (separation between data records must be less than 1-minute):

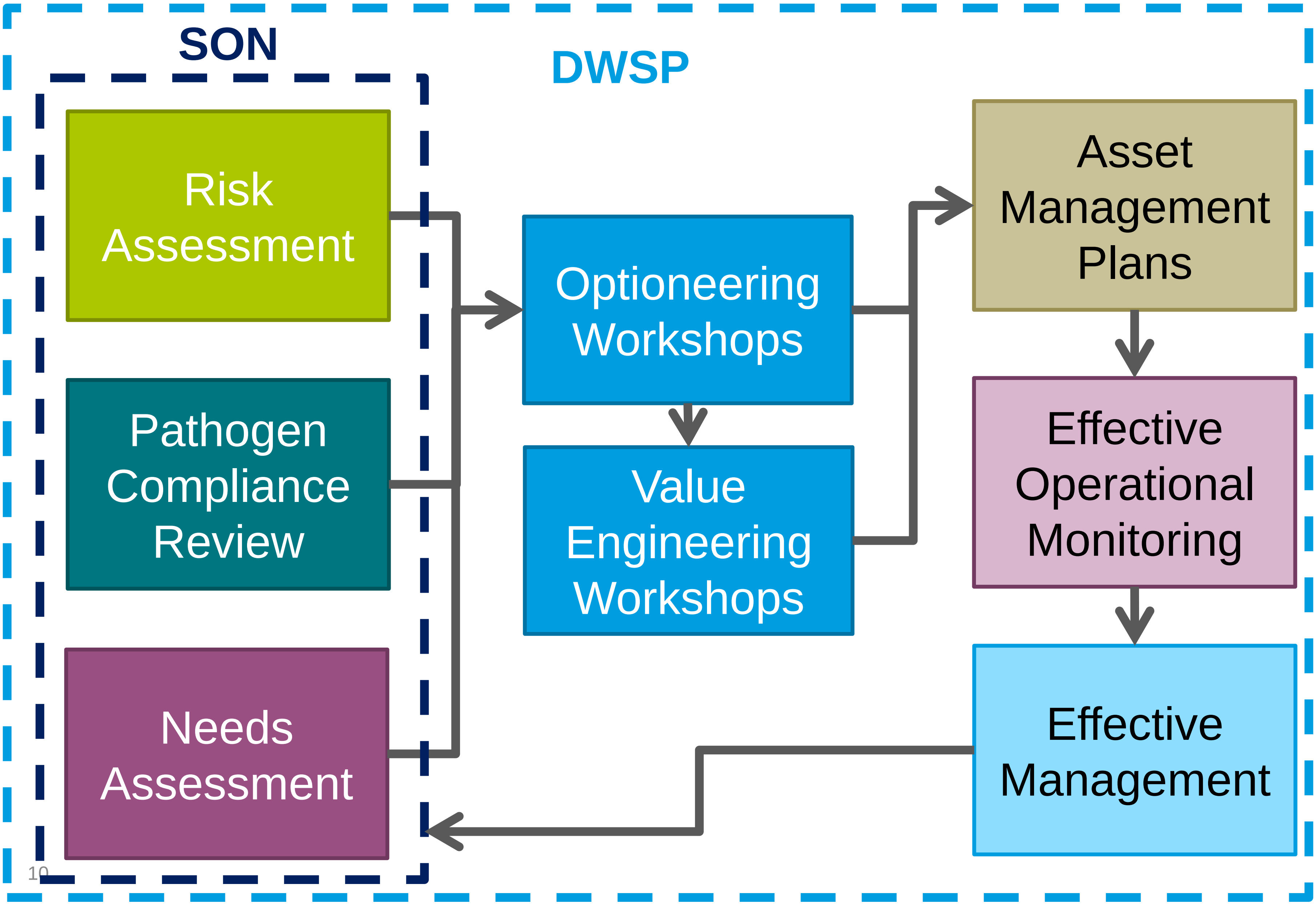
Parameter	Location	Frequency	Critical Control Point	Alarm	Compliance duration
Turbidity	Settled water	Continuous	>2.0NTU	>1.5NTU	Any 15-minute period
	Filtered water (individual)	Continuous	>0.1NTU	>0.08NTU	Any 15-minute period
	Filtered water (individual)	Continuous	>0.5NTU	>0.45NTU	Any 3-minute period
	Filtered water (individual)	Continuous	Settled water turbidity ≥ raw water turbidity		Any 3-minute period
Flow	Filtered water (individual)	Continuous	>design filtration rate $m^3/m^2/hr$		Any 15-minute period
Headloss	Individual filter	Continuous	>0.25m	>0.20m	Any 1-minute period
Rate of change of filtration rate	Filter water (individual)	Continuous	>1.5% of filtration rate through each filter/minute		Any 1-minute period
Filter cycle	Individual filter	Continuous	>48hrs	>40hrs	Any filter cycle

HOW Risk reduction: End to End

IW has adopted the **Drinking Water Safety Plans approach** to develop a more **standardised** and **consistent** set of **Policies**, **Strategies**, **Specifications**, **Standard Operating Procedures**, **Planned Maintenance**, across the organisation.

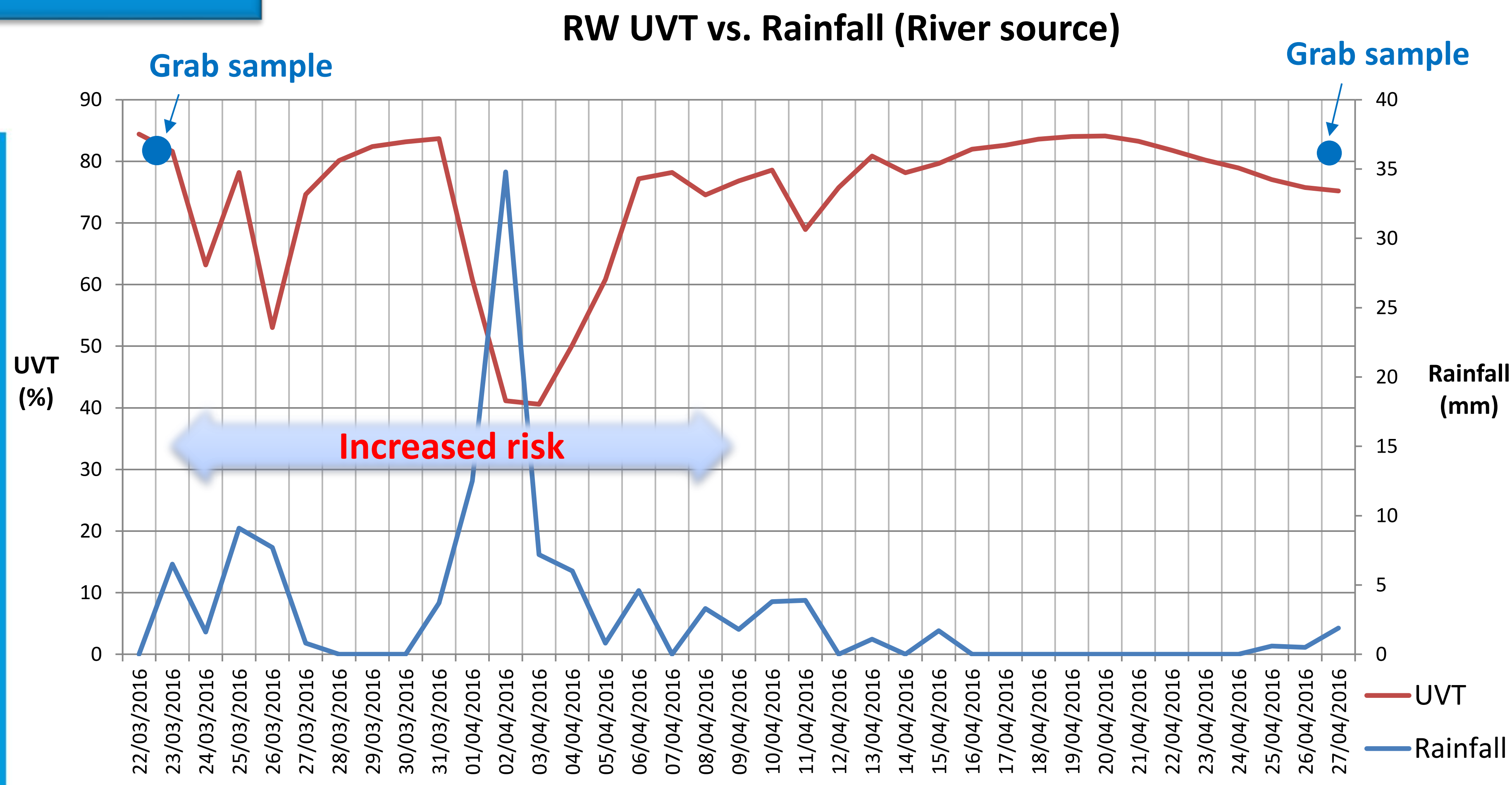
HOW

IW DWSP Approach



Risk Assessment

IW Raw Water Monitoring Programme

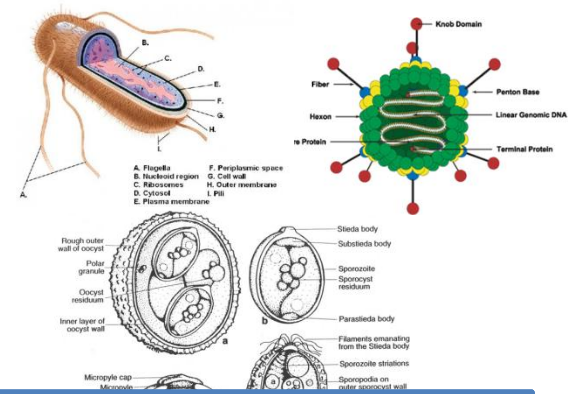


- Strong correlation between rainfall and RW UVT (high rainfall = low UVT)
- Grab sampling provides incomplete picture (grab sampling 58.1% vs on-line 40%)

Grab Samples	UVT	Turbidity	DOC
23/03/2016	83.3	3.68	1.3
28/04/2016	83.8	0.54	1.3
30/06/2016	58.1	0.44	4.3
28/07/2016	73.4	19.8	2.8

Operational Monitoring

DWSP Disinfection Control Measures



Disinfection Risk Control

Inactivation

Barrier 1: Bacteria and virus (≥4-log)	Eff Ct > Target Ct
Barrier 2: Maintain Barrier 1 (network)	>0.1mg/l at tap
Barrier 3: Protozoa (3-log) [UV]	UVI/UV RED > validation limit
Barrier 4: Protozoa (≥3-log) [CFC+RGF, SSF]	Turbidity < limit

Removal

IW WTP elimination capacity = 4.0B + 4.0V + (0 to 5.0)P

[Swedish WTP elimination capacity = (3.0 to 6.0)B + (3.0 to 6.0)V + (2.0 to 5.0)P]

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Operational Monitoring

Pathogen Compliance Review

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Primary Disinfection - Pathogen Compliance Criteria

- Removal (filtered water)
  - *Turbidity*
    - <1.0ntu – 100%
    - 3-log Crypto <0.3ntu – 95%
    - 4-log Crypto <0.1ntu – 95%
- Chlorination
  - *Primary (WTP final water) - adequate Ct*
- UV
  - *NSF, DVGW, ONORM -40mJ/cm2*
  - *USEPA – 3-log Crypto*

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v151

Pathogen Compliance Review

Irish Water Site:		County:	
Date:	21/01/2016	Data Source:	SCADA (1 minute intervals)
		Date from:	21/12/2013 15:58
		Date to:	21/12/2015 15:58
		No. of days:	730 days
Site Processes:	DAFF + UV + Chlorination		17520 hrs
Source:	S3	Data period with plant operating:	12039 hrs
		Theoretical total run time:	12363 hrs
Primary disinfection process:	UV	Protozoa Log Credits:	5
Note:			

Recorded SCADA Data Analysis

* Outlier values excluded from dataset analysis

Values	Raw Flow (m3/hr)	Raw Turbidity (NTU)	Raw pH	Treated Flow (m3/hr)	Treated Turbidity (NTU)
Max.	14.4	19.97	9.29	20.00	+5.00
95th percentile	12.5	2.43	na	14.67	0.32
Min.	0.1	0.00	3.92	0.01	0.00
Ave.	11.0	1.19	6.86	11.31	0.12

Values	UVT (%)	UVI (mW/cm2)	Residual Chlorine (mg/L)	Treated pH
Max.	99.99	57.56	+5.00	11.58
5th percentile	0.09	28.42	0.46	na
Min.	0.06	0.00	0.00	3.74
Ave.	75.63	34.71	0.90	7.29

CFC+RFG Removal Non-compliance (Step B.3.1 requirements not met when producing drinking water)

Parameter	Compliance Criteria	No. of Events	No. of Days	Max. duration	Ave. duration	% of total data period	Data period (hrs)
Turbidity	> 0.3NTU any 15min period	369	200	24.7hrs	2.2hrs	6.8%	12039
	RW turb. < TW turb. [+0.1NTU]	254	131	7.8hrs	7.5hrs	0.2%	12039
Flow (TW)	> 11m3/hr any 15min period	1356	405	2.6days	4.0hrs	45.1%	12039
Headloss	< 0.25m any 1min period	-	-	-	-	-	-
Rate of change	< 1.5% any 1min period	-	-	-	-	-	-
Filter cycle	> 48 hours	-	-	-	-	-	-

UV Disinfection Non-compliance (Step B.3.5 requirements not met when producing drinking water)

Parameter	Compliance Criteria	No. of Events	No. of Days	Max. duration	Ave. duration	% of total data period	Data period (hrs)
Turbidity	> 1.0NTU any 15min period	101	29	18hrs	3hrs	2.5%	12039
	> 2.0NTU any 3min period	90	20	7.8hrs	2.5hrs	1.9%	12039
Flow (TW)	> 11m3/hr any 15min period	1356	405	2.6days	4.0hrs	45.1%	12039
UVT	< [limit]% any 3min period	626	150	2.6days	3.4hrs	17.9%	12039
UVI or RED	< [limit] any 3min period	22	15	0.3hrs	0.1hrs	0.1%	4553

Chlorination Non-compliance (Step A.2 requirements not met when producing drinking water)

Parameter	Compliance Criteria	No. of Events	No. of Days	Max. duration	Ave. duration	% of total data period	Data period (hrs)
Turbidity	> 1.0NTU for any 3min period	132	31	18hrs	2.3hrs	2.6%	12039
	> 2.0NTU for any 1min period	96	24	7.8hrs	2.3hrs	1.9%	12039
	RW turb. < TW turb. [+0.1NTU]	254	131	7.8hrs	7.5hrs	0.2%	12039
Flow (TW)	> 11m3/hr any 15min period	1356	405	2.6days	4.0hrs	45.1%	12039
Total Chlorine	< 0.4mg/L any 3min period	-	-	-	-	-	-
Residual Chlorine	< 0.5mg/L any 3min period	1253	333	2.7days	0.7hrs	6.8%	12039
Cl Contact Time	Effective Ct < Required Ct any period	**Req. Ct**	18	**Eff. Ct**	4.15	Effective Ct figure from Galway Disinfection Review 08-02-2015	
pH (TW)	> [max design pH] any 15min period	571	225	2.8days	3.4hrs	16.0%	12039

Plant Shutdown

Ave. daily run time: Derived using theoretical run time 16.9 hrs

Parameter	Compliance Criteria	No. of Events	No. of Days	Max. duration	Ave. duration	% of total data period	Data period (hrs)
Turbidity	Non-compliance event > 7.1hrs	16	16	24.7hrs	13.3hrs	1.8%	12039
Flow	Non-compliance event > 7.1hrs	125	109	2.6days	15.9hrs	16.5%	12039
UVT	Non-compliance event > 7.1hrs	33	30	2.6days	20.4hrs	5.6%	12039
UVI	Non-compliance event > 7.1hrs	0	0	0days	0hrs	0.0%	4553
Residual Chlorine	Non-compliance event > 7.1hrs	10	10	2.7days	19.2hrs	1.6%	12039
pH	Non-compliance event > 7.1hrs	27	26	2.8days	22hrs	4.9%	12039

SCADA Data Gaps

	No. of Events	No. of Days	Max. duration	Ave. duration	% of total data period	Data period (hrs)
Missing data for any 1min interval	3,017	471	5.4days	6.4mins	3.2%	17520
> 1hr duration	4	4	5.4days	18.9hrs	0.4%	17520

Operational Monitoring

CFC+RGF Review - Example

Values	Raw Flow (m3/hr)	Raw Turbidity (NTU)	Raw pH	Treated Flow (m3/hr)	Treated Turbidity (NTU)
Max.	30.0	19.99	11.99	48.3	+5.00
95th percentile	28.0	0.93	na	27.6	0.62
Min.	0.1	0.26	5.10	0.0	0.00
Ave.	25.9	0.58	6.80	20.4	0.21

Values	UVT (%)	UVI (W/m2)	Residual Chlorine (mg/L)	Treated pH
Max.	100.0	66.0	3.81	9.36
5th percentile	79.7	18.6	0.52	na
Min.	29.2	0.0	0.00	3.45
Ave.	88.6	35.2	0.87	7.23

CFC+RFG Removal Non-compliance (Step B.3.1 requirements not met when producing drinking water)

Parameter	Compliance Criteria	No. of Events	No. of Days	Max. duration	Ave. duration	% of total data period	Data period (hrs)
Turbidity	> 0.3NTU any 15min period	1737	379	2.2days	1.8hrs	19.6%	16167
	RW turb. < TW turb. [+0.1NTU]	3163	231	3.1days	0.3hrs	4.9%	16167
Flow (TW)	> 30m3/hr any 15min period	0	0	0hrs	0hrs	0.0%	16167
Headloss	< 0.25m any 1min period	-	-	-	-	-	-
Rate of change	< 1.5% any 1min period	-	-	-	-	-	-
Filter cycle	> 48 hours	-	-	-	-	-	-

Operational Monitoring

DWSP Water Quality Control Measures

Physical/Chemical Risk Control

Removal

Barrier 5: Interruption to supply	supply > demand
Barrier 6: DBP (THMs)	≤100µg/l at tap
Barrier 7: Lead	≤10µg/l at tap
Barrier 8: Pesticides	≤0.5µg/l at tap
Barrier 9: Nitrates	≤50mg/l at tap
Barrier 10: Aluminium	≤200µg/l at tap
Barrier 11: Iron	≤200µg/l at tap
Barrier 12: Manganese	≤50µg/l at tap
Barrier 13: Taste and odour	acceptable at tap
Barrier 14: Pollution of environment	≤ discharge limit
Barrier 15: Other	≤ limit at tap

Risk Assessment

THM Compliance Data Review

THMs

a **Water Quality Risk Analysis**

2014-16
751no.
WSZs

Treated Water TTHM Risk Prioritisation		TTHM (maximum concentration) [µg/L]		
		100 - 200	200 - 300	>300
TTHM (average concentration) [µg/L]	<100	2	2	3
	100 - 150	2	3	4
	>150	3	4	5

TTHM Risk	No. of WSZs	Existing CFC
5	7	1
4	7	2
3	11	3
2	91	41
Total	116	47

- Existing WTP deficiencies:

  1) *No DBP precursor removal process (69no. – 60%);*

  2) *Existing DBP removal and/or disinfection process not optimised (47no. – 40%);*

  3) *Network exceedance after booster chlorination.*

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Disinfection Policy Comparison

Irish Water

- Removal (filtered water)
  - *Turbidity*
    - <1.0ntu – 100%
    - 3-log Crypto <0.3ntu – 95%
    - 4-log Crypto <0.1ntu – 95%
  - *$TTHM_t$ < 40 to 80µg/l (t > 24hrs)*
- Chlorination (WTP final water)
  - *WTP final water > 0.5mg/l*
  - *Customer tap = detectable FCR*

Scottish Water

- Removal (WTP final water)
  - *Turbidity*
    - <1.0ntu – 100%
    - <0.5ntu – 99%
    - <0.4ntu – 95%
  - *TTHM < 40µg/l*
- Chlorination (WTP final water)
  - *WTP final water > 0.5mg/l*
  - *Reservoir outlet > 0.25mg/l*
  - *Customer tap = detectable FCR*

CFC Optimisation

Risk Assessment

Draft IW Jar Testing and THMFP Specification

1) Preliminary design stage (before preparation of documents):

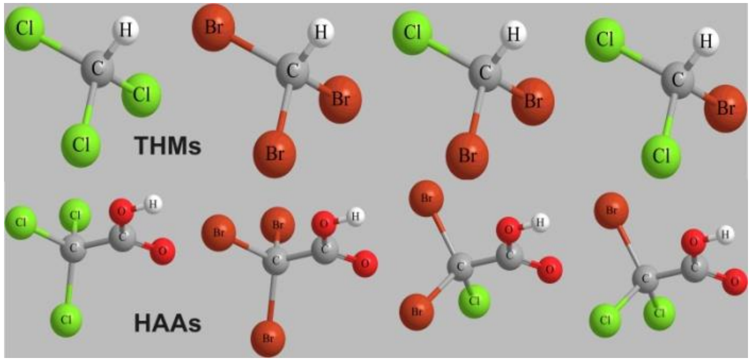
a. Jar test:
   i. pH/alkalinity control (acid or base)
   ii. coagulation (alum and PACL)
   iii. flocculation (no polymer)
   iv. sedimentation
   v. filtration

b. THMFP (8mg/l Cl dose with THM measured at 72-hrs)

2) Contractor design stage (after contract award):

a. Jar test:
   i. pH/alkalinity control (acid or base)
   ii. coagulation (alum and PACL)
   iii. flocculation (polymer)
   iv. sedimentation
   v. filtration

b. THMFP (8mg/l Cl dose with THM measured at 72-hrs)



3) Jar testing and THMFP testing frequency:

a. RW UVT ±5% change;
b. RW true colour ±10PtCo unit change; or
c. RW turbidity ±10NTU unit change

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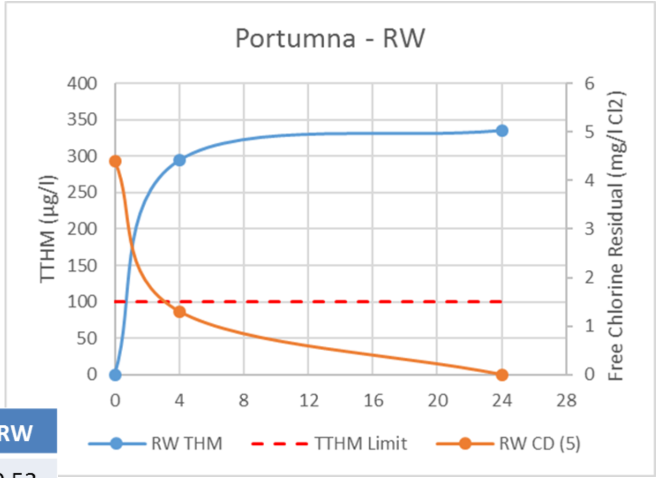
Risk Assessment

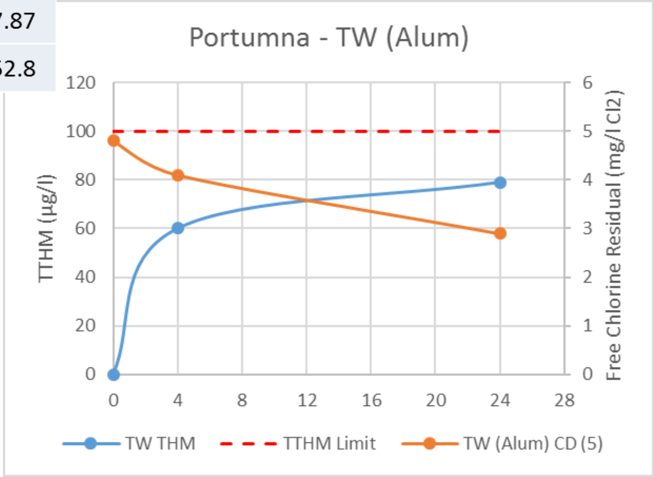
Jar Testing and THMFP

TTHM Monitoring - 2007 to 2014

No. of Samples	No. of Samples > 100µg/L	Average concentration (µg/L)	Max. concentration (µg/L)
81	57	159	312



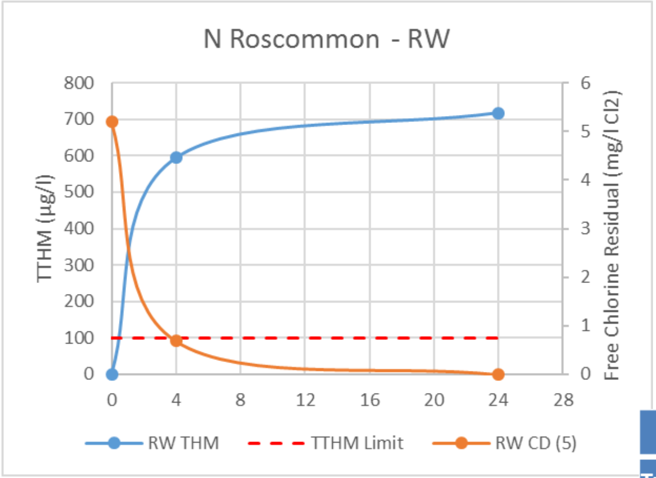
	RW
Turbidity (NTU)	0.53
TOC (mg/l)	7.87
UVT (%)	52.8



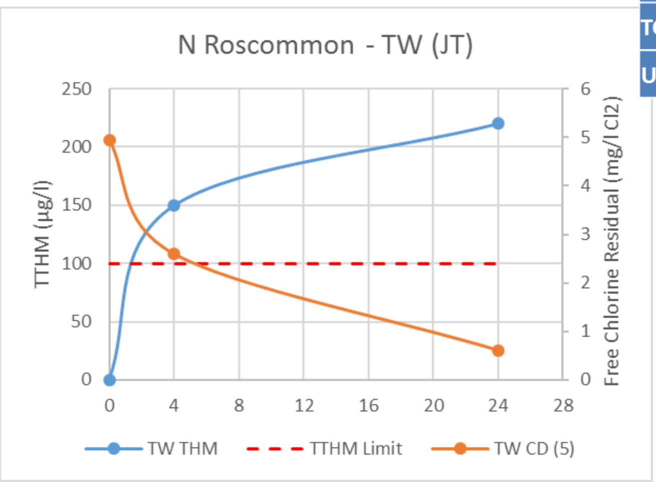
RH. EPS 2016

TTHM Monitoring - 2007 to 2014

No. of Samples	No. of Samples > 100µg/L	Average concentration (µg/L)	Max. concentration (µg/L)
32	6	69	132

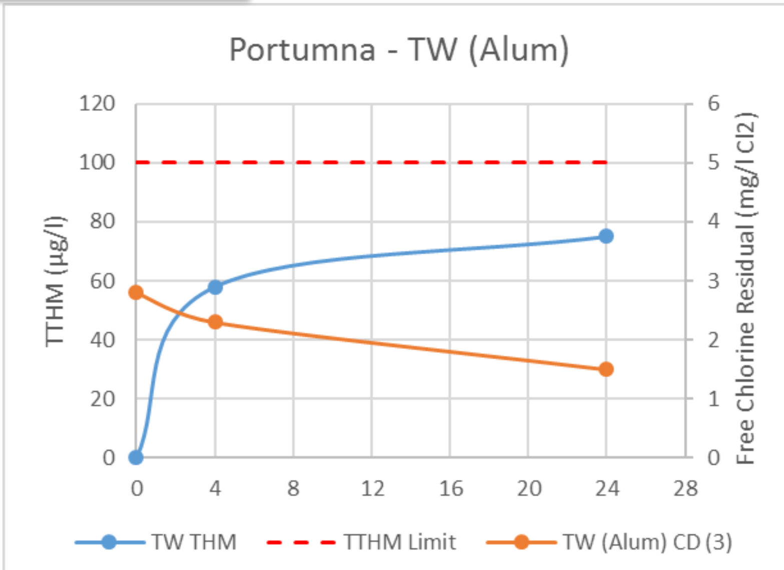


	RW
Turbidity (NTU)	0.45
TOC (mg/l)	13.76
UVT (%)	24.4



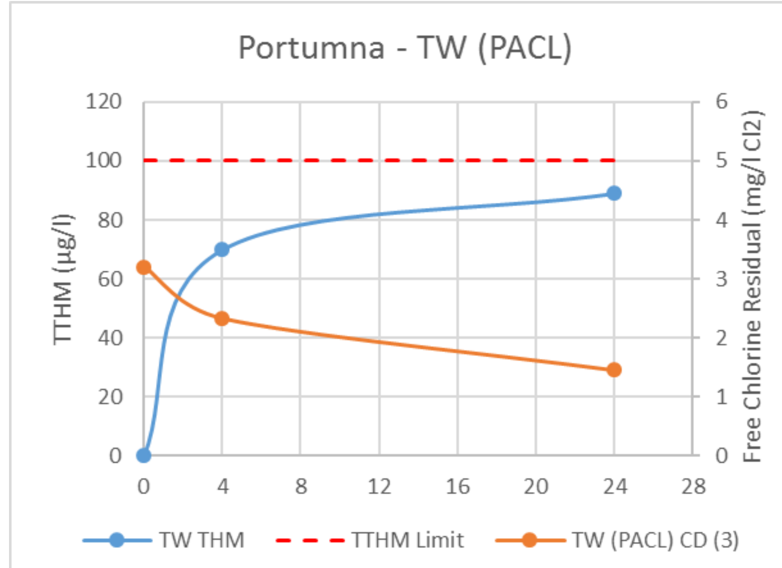
RH. EPS 2016

Portumna WSS – Jar Test THMFP



	RW	TW (JT)	% Improvement
Turbidity (NTU)	0.53	0.13	75%
TOC (mg/l)	7.87	4.43	44%
UVT (%)	52.8	87.6	66%

RH, EPS 2016



	RW	TW (JT)	% Improvement
Turbidity (NTU)	0.53	0.18	66%
TOC (mg/l)	7.87	3.77	52%
UVT (%)	52.8	87.6	66%

RH, EPS 2016

- PACL removes more TOC;
- Alum removes more THM precursors.

RW – Raw water, TW (JT) – Treated water jar test, CD – Chlorine demand

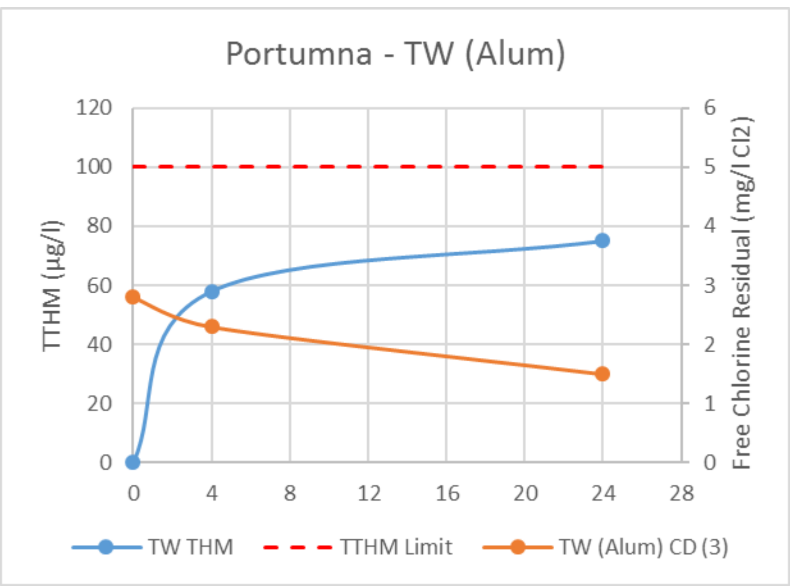
Portumna WSS – CFC Upgrade

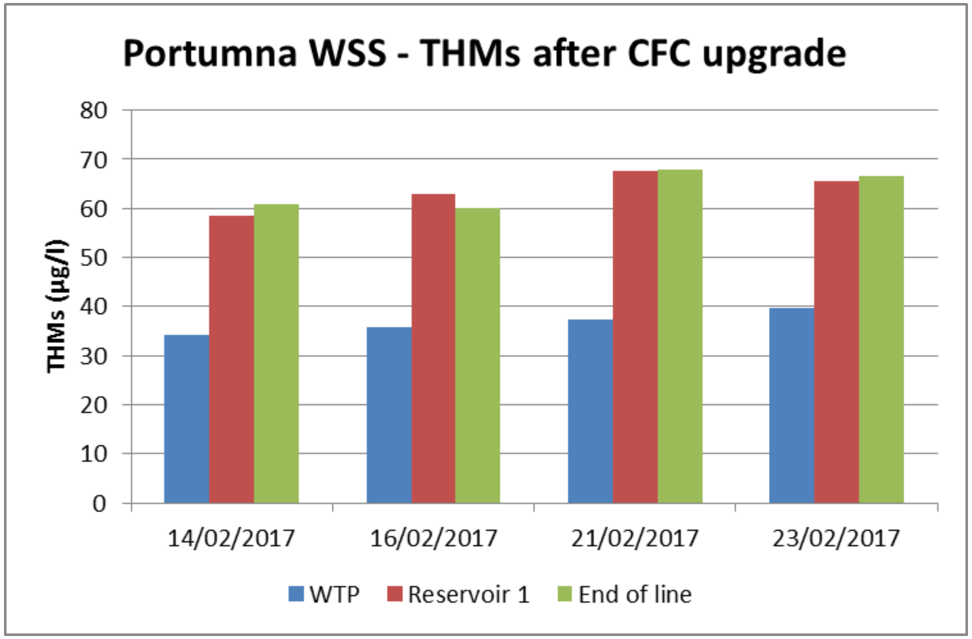
TTHM Monitoring - 2007 to 2014

No. of Samples	No. of Samples > 100µg/L	Average concentration (µg/L)	Max. concentration (µg/L)
81	57	**159**	**312**

	RW	TW (JT)	% Improvement
Turbidity (NTU)	0.53	0.13	75%
TOC (mg/l)	7.87	4.43	44%
UVT (%)	52.8	87.6	66%

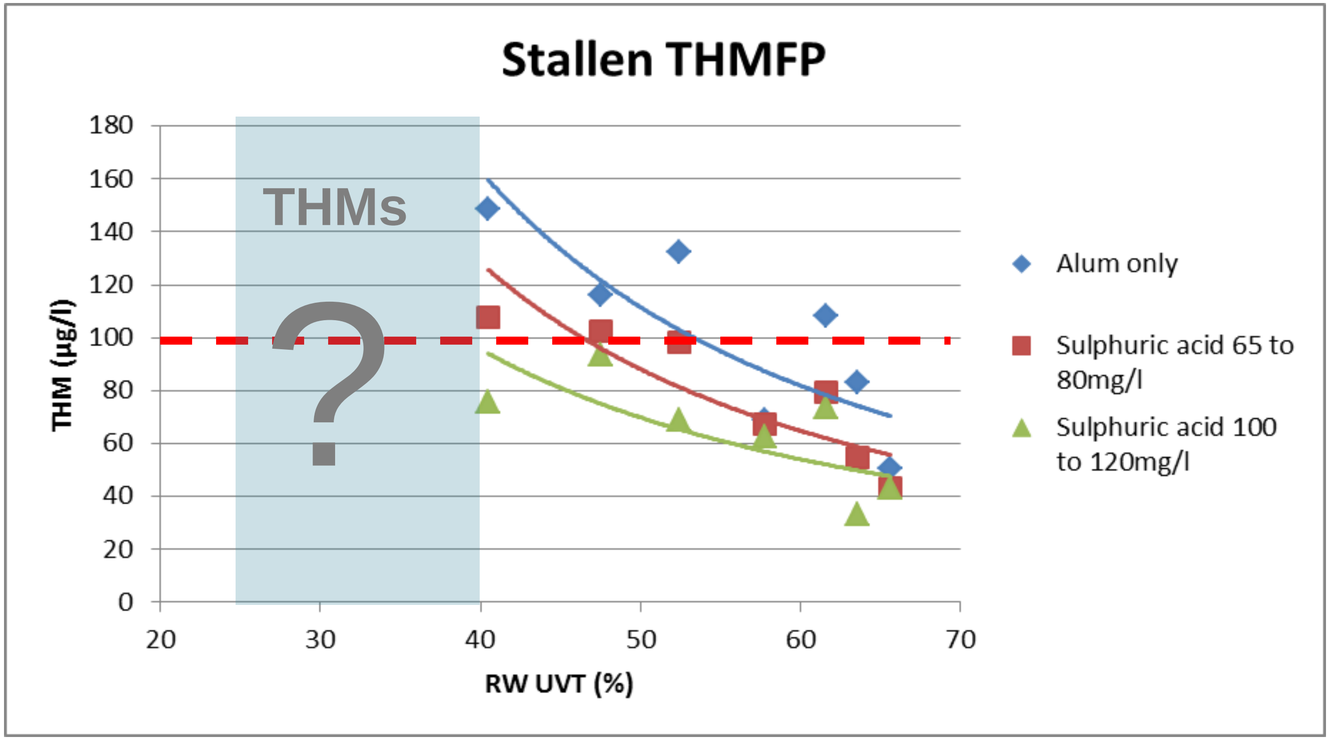
	RW TOC (mg/l)	TW TOC (mg/l)	% improvement
14/02/2017	8.06	3.67	55%
16/02/2017	9.00	4.05	55%





Risk Assessment

Jar Testing and THMFP



RW UVT	Alum dose	Sulphuric acid dose	THM (µg/l)	Alum + acid chemical unit OPEX/m3	Alum + acid chemical OPEX/day	Alum + acid chemical OPEX/yr
63.6	160	0	83.3	€0.02	€504	€183,960
61.6	160	70	79.46	€0.02	€725	€264,443
57.8	200	0	68.76	€0.02	€630	€229,950
52.7	220	70	68.7	€0.03	€914	€333,428
47.5	160	110	93.8	€0.03	€851	€310,433
40.5	260	100	75.75	€0.04	€1,134	€413,910

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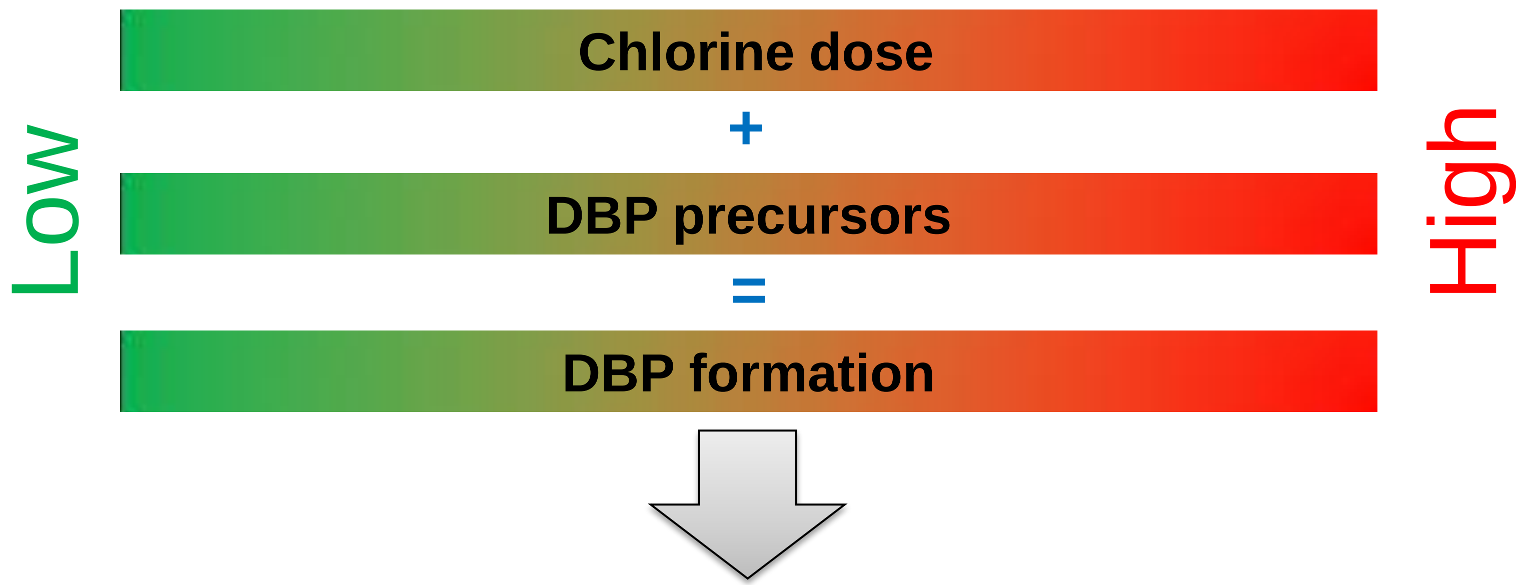
WTP Upgrade Solutions



Chlorine dose	<3.0mg/l	> 3.0mg/l	
Max TTHMs	< 160µg/l	> 160µg/l	
TOC			>12mg/l
CFC+RGF		Permanent	Permanent
In-tank aeration	Permanent	Interim	Interim
PAC+CFC+RGF			Permanent

IW Coagulation Control Guidelines

Coagulation Control Upgrade Rollout

1. Upgrading works (improvements to coagulation control) must pass the following business test:
    a. *Reduce DWSP risk (i.e. effect Barriers 4 and 6); and/or*
    b. *Economic (payback < 5-years)*
2. In addition, Process Ops team will carryout a review of proposed upgrading works and make a recommendation, before AS approval.

Example – AMP business test

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WTP 1

Barrier		RA - 25	RA - 20	RA -16	OM
1	B + V	1	1		● 2
2	Tap				● 2
3	UV				n/a
4	CFC+RGF	7	3		● 2
5	Supply				● 3
14	Pollution				● 4

AMP1

AMP2

WTP 2

Barrier		RA - 25	RA - 20	RA -16	OM
1	B + V	1	1		● 2
2	Tap				● 2
3	UV				n/a
4	CFC+RGF	1		1	● 5
5	Supply				● 4
14	Pollution				● 2

AMP1

SCM - Design

1. SCM correlates with turbidity/organic removal, especially when charge neutralization is the dominant coagulation mechanism.

   Key benefit – provides information more rapidly than a jar test and under most conditions will inform Operator in which direction the coagulation dose should be adjusted.

   Increasing negative signal indicates excess of negatively charged particles, {i.e. deterioration in raw water.}

2. Proper function of SCM is dependent on proper installation, in particular, location of sampling point. A sample point free of abrasive grit and resistant to clogging must be assured.

SCM – Design cont.

3. The design of SCMs under the following conditions must be referred to Asset Strategy(Process Optimisation) for prior approval:

   a. Stable raw waters conditions (lakes) [less likely to save appreciable amounts of chemicals, chemical reduction low (average 15%) – high payback period];
   b. High coagulant dose (alum dose >150mg/l);
   c. High alkalinity (>100mg/l);
   d. Very low pH and turbidity (i.e. sweep flocculation coagulation is required);
   e. UVA/UVT for forward feed control (raw water turbidity > 8.0NTU);
   f. Use of lime for pH adjustment;
   g. Recirculation of liquid residuals (filter backwash, etc.). Residual metal hydroxides are positively charged;
   h. Occasional use of powdered activated carbon (PAC); and
   i. Control of dose rates for high molecular weight polymers (coagulant aids or flocculants).

An evaluation of streaming current detectors, (AWWRF)

SCM - Installation and commissioning

1. Manufacturer's assistance is required in installation and establishment of correct sampling point, (i.e. evaluation of 3 or more sampling locations may be required to find best sampling point);
2. Manufacturer's assistance is required during commissioning period (min. 12 months). Commissioning period should cover periods when coagulation difficulties will be encountered, (i.e. high/low – turbidity, organics, temperature, etc.);
3. SCM set point should be established by initial use of jar tests, followed by observation of plant performance as a function of SCM reading, (i.e. increasing/reducing coagulant dose vs settled water quality [turbidity, true colour or UVA/UVT]); and
4. Manufacturer to provide cost/benefit analysis and performance assessment report (before and after SCM installation):
   a. *Plant operational data for stable and transient conditions (flow, chemical use, raw and settled water quality [pH, temperature, turbidity, true colour and/or UVA/UVT]); and*
   b. *Plant and equipment failure and out of service.*

An evaluation of streaming current detectors, (AWWRF)

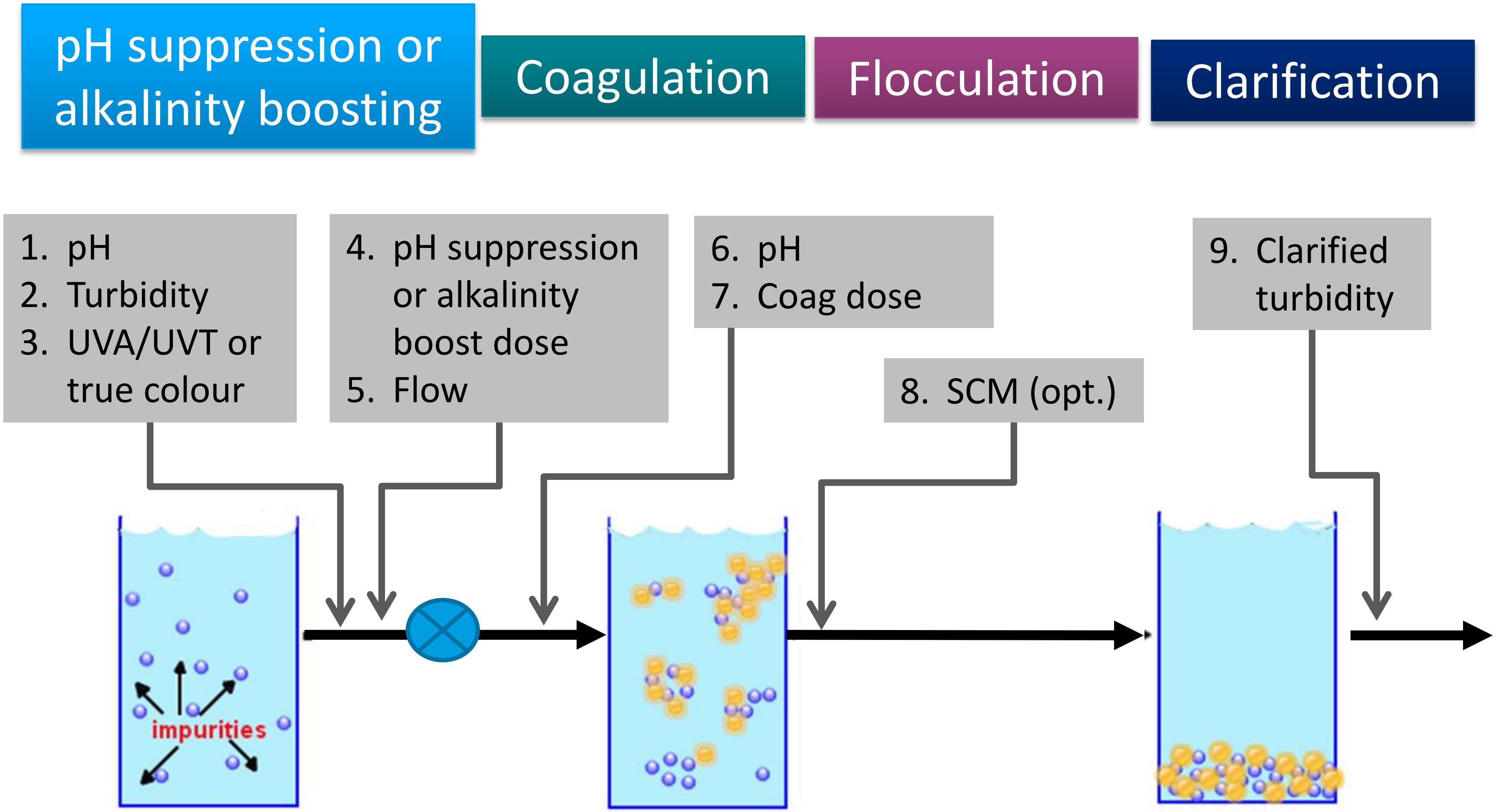
SCM - Operation and maintenance

1. SCM is not a substitute for good operation and maintenance. Periodic comparison with jar tests is essential. The set point should be re-evaluated periodically to ensure optimum settled water quality (turbidity, true colour or UVA/UVT.) Set points will become less accurate with large variations in temperature, turbidity, organics, colour, pH, etc. Set points may vary monthly, day and night, etc.;
2. Establishment of preventative maintenance schedule is key to performance. Waiting for signs that instrument is dirty may result in the production of poor water quality. Experience indicates that cleaning requirements could vary from 2 days to 3 months, depending on concentration of raw water contaminants and type of coagulant used;
3. High iron or manganese in raw water may increase operational difficulties; and
4. Lime addition may increase operational difficulties.

An evaluation of streaming current detectors, (AWWRF)

Draft CFC Specification amendments

1. CFC control process –



Draft CFC Specification amendments cont.

2. Pg 79: Control mechanism:
   a) *Manual or automatic (preferred option);*
   b) *Feed forward – turbidity, UVA/UVT (or true colour)*
   c) *Feedback – SCM (optional)*
   d) *Tables 31 to 33:*

Coagulation Control	Turbidity	TOC	Coagulation pH	Alkalinity
Turbidity →	> 8ntu	<2		
UVA/UVT →	< 8ntu	>2		
SCM ←			< 7.5	> 100mg/l

3. Pg 80+: Replace SUVA with UVA/UVT

Draft CFC Specification amendments cont.

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4. Protozoa log credit compliance criteria - CFC:

- To obtain protozoa log credits for CFC + RGF used as a coagulation, clarification and filtration process, the following requirements must be met during periods when treated water is being produced:

  a) *All water must pass through the full CFC and filtration process (no bypass or mixing of water without CFC + RFG);*

  b) *The clarifiers must be operated at a steady flow rate;*

  c) *Measurement of turbidity of the clarified water must satisfy the following conditions:*

     i. Shall be less than or equal to 2.0 NTU for at least 95% of each 24-hour period.

- Protozoal compliance monitoring requirements for CFC process (part of CFC+RGF) are as follows (separation between data records must be less than 1-minute):

Parameter	Location	Frequency	Critical Control Point	Alarm	Compliance duration
Turbidity	Raw water	Continuous	>8.0NTU	>7.0NTU	Any 15-minute period
	Clarified water	Continuous	>2.0NTU	>1.5NTU	Any 15-minute period
pH	Before coagulation	Continuous	>Target pH	>0.8 Target pH	Any 15-minute period
UVT/UVA	Raw water	Continuous	< Coag design limit	< 1.2 Coag design limit	Any 15-minute period
SCM (optional)	After coagulation	Continuous	< SCM set-point	< 1.2 SCM set-point	Any 15-minute period
Flow	Raw water	Continuous	>maximum design flow m^3/hr	>maximum design flow m3/hr	Any 15-minute period

CFC Control Summary

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CFC Control

RW UVT/UVA, turbidity or true colour

Clarified turbidity and SCM (optional)

Coagulation recipe

RW pH and alkalinity

SUVA

TOC/ DOC

TOC/ DOC

SUVA

For info only

Jar test + THMFP

TOC = 1.04 + 22.8 UVA254