Actions from Previous RPSC Meetings

Meeting 19 March 2015

Today's Topics

- Black Mica – Add-on?
- Refresher Report on Endocrine-Analogues in Discharge
- UV Disinfection
- Reverse Osmosis
- Report on Chemical Analysis of Current Discharge
- Graphical Representation of short-listed treatment options – estimated costs and nutrient discharge loads

Additional Topics

- TAG Update for RPSC (Jim)
- Investigation Projects Update (Greg)

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Black Mica

- "Black Mica" is one name for the geological term Biotite, also called "Iron Mica"
- Biotite is a common phyllosilicate mineral within the mica group. Contains iron, magnesium, aluminium, silicon, oxygen and hydrogen. Found in igneous and metaphoric rocks
- A Black Mica extract is promoted to purify water that is then drunk to re-mineralise and detoxify the body. The claims are that drinking this re-mineralised water optimises the enzymatic processes in the body and delivers a wide array of healing benefits. There are claims and counter-claims and independent testing on the web.
- There are demonstrated claims on how it can transform contaminated ponds and lakes to pristine, crystal clear and potable water
- Still trying to track down if it has been used on a large scale with polluted water/waste water. No evidence to date. Will report to RPSC further.

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Refresher Report on Endocrine-Analogues in Discharge – Setting the Scene

International Position- Leading Research Work in the USA:

Integrating Nutrient and Trace Organic Removal in Wastewater Treatment WERF CEC4R08

9th IWA Leading-Edge Conference, June 3-7

Tanja Rauch-Williams et al

Trace Organic Challenge

- Numerous and diverse known and unknown chemicals used in high quantities
- Adverse effects of trace organic compounds (TOrC) on aquatic life in receiving waters
- Sewage systems not specifically designed for TOrC removal Regulatory requirements world-wide in development

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Regulatory Developments Related to TOrC

Region/Country	Regulatory Development
United States	• Contaminant Candidate List 3 (2009, every 5 years): 10 pharmaceuticals, 9 hormones • Unregulated Contaminant Monitoring Regulation (UCMR3) (2012): Screening for 7 hormones
Oregon	SB737 - Municipal Persistent Pollutant Reduction Plans
California	Recycled Water Policy: Monitoring Strategy for Water Reuse (2012)
Massachusetts	Emerging Contaminant Screening Process
European Union	• REACH Directive (2007) • Compound-specific bans (e.g., Phtalates, nonylphenol) • Proposed change of 'Directive on priority substances in the field of water quality' (2012): 17 alpha-ethinylestradiol (EE2), 17 beta-estradiol (E2), Diclofenac. • Watershed specific strategies (2007, 2011): Rhine, Lake Geneva
Switzerland	• Regulation Proposal to Finance WWTP Upgrades for TOrC Removal (2012)

Categorizing Selected TOrC Indicators

The two methods of removal in WWTP's

Biotransformation	Sorption
Biotransformation Rate	Sorption Coefficient

$$\frac{dC_{ToRC}}{dt} = -K_b C_{TOrC}$$

$$K_d = \frac{C_{TOrC,solid}}{C_{TOrC,liquid}}$$

Indicator Matrix to Benchmark Treatment Performance

Faster transformation during secondary treatment

Higher sorption during secondary treatment

Sorption (log K_d)		Biotransformation (K_b, L/g-d) Recalcitrant <0.1	Moderate Slow 0.1-10	Rapid >10
Low	<2.5	Carbamazepine Meprobamate Primidone TCEP Sucralose	DEET Sulfamethoxazole Gemfibrozil Iopromide	Acetaminophen Caffeine Naproxen Ibuprofen Atenolol
Sorptive	2.5-3	TCPP	Cimetidine Trimethoprim	Benzophenone Diphenhydramine Bisphenol A
Effective	>3	Triclocarban		Triclosan Fluoxetine

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Cawthron Report EDC's

- RDC contracted Cawthron in 2013 to estimate efficacy of two wastewater treatment plant technologies to remove endocrine disrupting chemicals (EDC's).
- There are a wide range of international and some New Zealand studies on removal of EDC's and micropollutents in wastewater treatment processes.
- Other New Zealand studies show for secondary treatment plants, particularly those with long sludge age, they remove up to 99% of estrogenic and androgenic products in the influent.
- Cawthron specifically tested for a range of Alkylphenols, Pararben preservatives, Phenolic antimicrobials, Bisphenol A(BPA), Estrongenic steroid hormones, Androgenic steroid hormones. A total of 30 compounds tested.

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Cawthron Report Conclusions

- Most EDC concentrations detected in the MBR and Bardenpho treatment stage treated wastewater were below the Europeans Union's Predicted No Effect Concentration for aquatic organisms.
- Concentration of the treated wastewater compounds will be further reduced by dilution within the Puarenga Stream and therefore unlikely to cause harm to aquatic organisms in the receiving waterways.
- Both MBR and Bardenpho effluent samples contained estrogenic activities, but the levels in the Puarenga and Waipa Forest reference stream waters were all below the detection limits of the bioassays.
- Overall, the results suggest that the risk of the RDC WWTP treated wastewater to cause endocrine disruption within receiving waterways is negligible.

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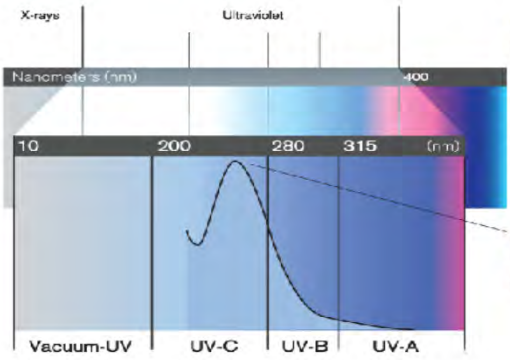
UV Disinfection - Further Background Information

What Is UV Light?



Ultraviolet (UV) light is invisible to the human eye

UV is comprised of electromagnetic radiation of wavelengths ranging from 10 - 400 nanometers (nm)

Certain wavelengths of UV light are germicidal – meaning they can inactive microorganisms

TROJAN UV

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UV Disinfection - Further Background Information

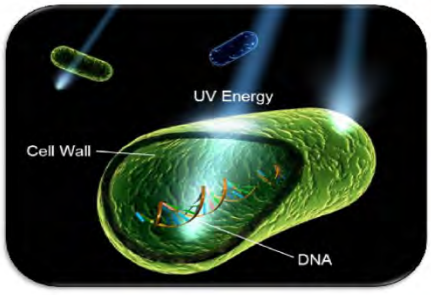
How UV Works

UV light penetrates the cell wall

The UV energy permanently alters DNA of the microorganism

Microorganisms are "inactivated" and unable to reproduce to infect human

The amount of cell damage depends on the dose of UV energy absorbed by the microorganisms and their resistance to UV.



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Disinfection vs. Sterilization

Disinfection is the reduction of pathogens (disease causing microorganisms) to noninfectious levels, whereas sterilisation is the total inactivation of all living cells and viruses.

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UV Disinfection - Further Background Information

Factors Affecting UV Disinfection

The UV dose delivered by a disinfection system is a product of UV intensity (milliwatts per square centimeter) and retention (exposure) time in seconds

UV Dose = Intensity X Time

The units of dose are milliwatt seconds per square centimetre (mW.s/cm2) or millijoules per square centimetre (mJ/cm2).

"UV intensity" is affected by:

- wastewater quality, microbial inactivation kinetics, equipment/lamp configuration, and lamp age and sleeve fouling.
- Temperature and pH do not affect UV disinfection.

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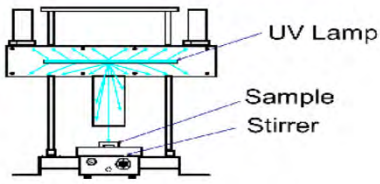
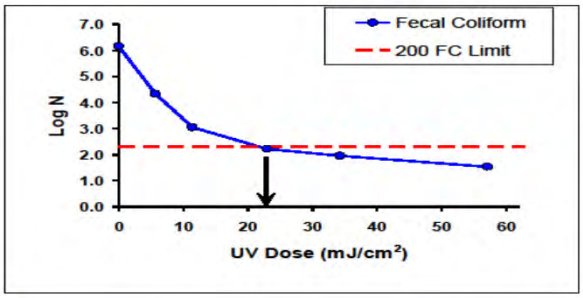
Step 1: What UV dose is required?

- Do Collimated Beam testing on effluent
- Collect and test samples over events
- Testing provides dose-response data





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UV Disinfection - Further Background Information

The RPSC and RRSC equally observed UV Disinfection Plants at Chapel Street in Tauranga (an early NZ plant) and Te Puke (a very new small plant)

Small UV disinfection - many

Large UV System at Mangere WWTP

UV disinfection now installed at many NZ wastewater Treatment Plants

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Acknowledge Trojan's slides shown herewith Trojan are one of a number of international UV plant suppliers

Trojan Technologies Inc.

TROJAN UV4000™ PLUS

OPERATION AND MAINTENANCE MANUAL

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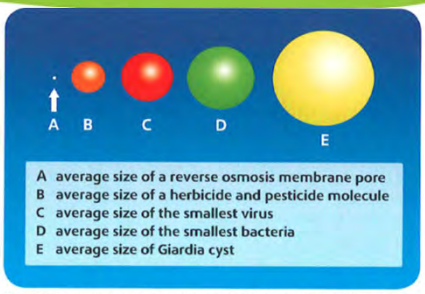
Reverse Osmosis Background

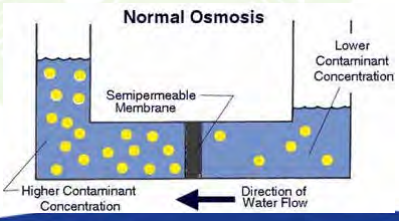
What is reverse osmosis?

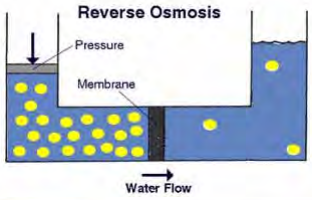
Reverse osmosis is a common process to remove salt and other dissolved substances from water.

Reverse osmosis works by forcing water through a special plastic, semi-permeable membrane sheet to remove compounds such as dissolved salt, dissolved organic compounds, micro-organisms and viruses. Reverse osmosis is used to purify water and to desalinate seawater.



The diagram above shows the relative sizes of contaminants. Mineral salts, dissolved metals, some organic molecules, bacteria and even viruses are repelled by the membrane surface based on their atomic weight, size, shape and charge.





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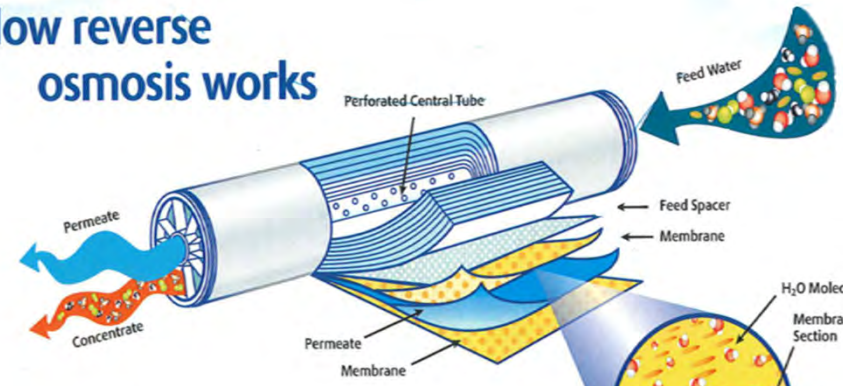
How reverse osmosis works



- Used in advanced wastewater treatment/reclaimed water e.g. Orange County, Singapore, Brisbane plants. RPSC has been informed of.- proposed for Ruakaka wastewater reuse at NZ Refinery Marsden Point
- Used in desalination for water supply e.g. the four? large Australian plants

Two streams of water are produced – a 'concentrate' stream (rejected water) containing waste materials which do no pass through the membrane, and the 'permeate' stream (cleaned water) which has filtered through the membrane.

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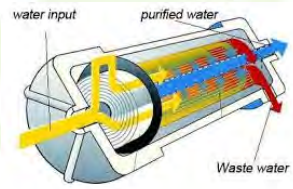
Reverse Osmosis Plants



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Rotorua's WWTP Incoming Sewage and Treated Wastewater Analysis – Typical Results Slide 1 of 2

- An extensive testing regime
- Effects Study will look at key contaminants related to accepted guidelines and requirements. These will be shown on comparison tables along the lines previously presented to RPSC

		Sewage	treated discharge		
		Sewage	Bardenpho	MBR	discharge
DRP	g/m3	3.8	2.5	1.7	2.2
Particulate-P	g/m3	2.3	0.8	0	0.5
Total P	g/m3	6.1	3.3	1.7	2.7
NH4-N	g/m3	37	0.5	1.6	0.67
NO3-N	g/m3	0	3.1	1.8	2.7
Organic-N	g/m3	15	2.6	1.0	2
Total-N	g/m3	52	6.1	4.0	5.4
Suspended solids	g/m3	514	22	<1	15
pH	pH units	7.3	7.4	7.2	7.3
COD	g/m3	670	44	18	34
alkalinity	g/m3 as CaCO3	206	78	87	81
UV transmissivity			60	60	60
E. coli				<1	4300
Chloride	g/m3	49			49
Total Aluminium	g/m3	1.04			0.068
Total Antimony	g/m3	0.0042			0.0042
Total Arsenic	g/m3	0.021			0.021
Total Barium	g/m3	0.04			0.0061

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Rotorua's WWTP Incoming Sewage and Treated Wastewater Analysis – Typical Results Slide 2 of 2

- Metals results are from 8 November 2012
- Remainder of Compounds are weekly tests Jan 2013 – Feb 2014
- This information was used in the last Wastewater Consent Condition Change

		Sewage	treated discharge		
		Sewage	Bardenpho	MBR	discharge
Total Bismuth	g/m3	0.0021			0.0021
Total Boron	g/m3	0.22			0.16
Total Cadmium	g/m3	0.0011			0.0011
Total Caesium	g/m3	0.0111			0.0105
Total Calcium	g/m3	10.3			9
Total Chromium	g/m3	0.011			0.011
Total Cobalt	g/m3	0.0042			0.0042
Total Copper	g/m3	0.091			0.011
Total Iron	g/m3	0.68			0.42
Total Lanthanum	g/m3	0.0021			0.0021
Total Lead	g/m3	0.0045			0.0021
Total Lithium	g/m3	0.084			0.083
Total Magnesium	g/m3	3.1			2
Total Manganese	g/m3	0.071			0.052
Total Molybdenum	g/m3	0.0064			0.0042
Total Nickel	g/m3	0.011			0.011
Total Phosphorus	g/m3	6.53			1.53
Total Potassium	g/m3	17.8			16.1
Total Rubidium	g/m3	0.038			0.035
Total Selenium	g/m3	0.021			0.021
Total Silver	g/m3	0.0022			0.0022
Total Sodium	g/m3	66			63
Total Strontium	g/m3	0.051			0.039
Total Thallium	g/m3	0.0011			0.0011
Total Tin	g/m3	0.011			0.011
Total Uranium	g/m3	0.00042			0.00042
Total Vanadium	g/m3	0.021			0.021
Total Zinc	g/m3	0.16			0.035

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Shortlisted Options - Refresher

Wastewater Inputs Management Options

- Water conservation
- Wet weather flow and infiltration management
- Trade-waste management and pre-treatment
- New Infrastructure types and standards

Note:
Also refer TAG "Add-Ons" further being considered. This includes the technically feasible 'Best for Lake' option and TAG's request to RPSC about the cultural considerations relating to it.

Core Treatment Options (Based on Rotorua WWTP)

Option 1 Base Upgrade	Option 2 Base Upgrade + Filtration	Option 3 Base Upgrade + Nitrate Removal	Option 4 Dual Discharge	Option 5 New Land Treatment System
- Dissolved-Phosphorous Removal - UV to kill pathogens	- Phosphorous Removal - UV to kill pathogens - Filtration (particulate removal)	- Phosphorous Removal - UV to kill pathogens - Denitrifying Process (nitrate removal)	- MBR discharge to water - New Land Treatment System for Bardenpho	- Land Treatment System

MBR

Bardenpho

Ecosystem Re-Entry (Treated Wastewater Discharge / Disposal)

Water Discharge Options

Direct discharge to water	Discharge to water via ecosystem
• Open Pipe • Rock passage to direct discharge	• Wetland • Rapid infiltration beds • Riparian / Gabions • Natural monitoring Pond

Land Discharge

Treated wastewater discharged to land with potential to modify soils with biochar

Wastewater Strategy which underpins the future Consent (Roadmap)

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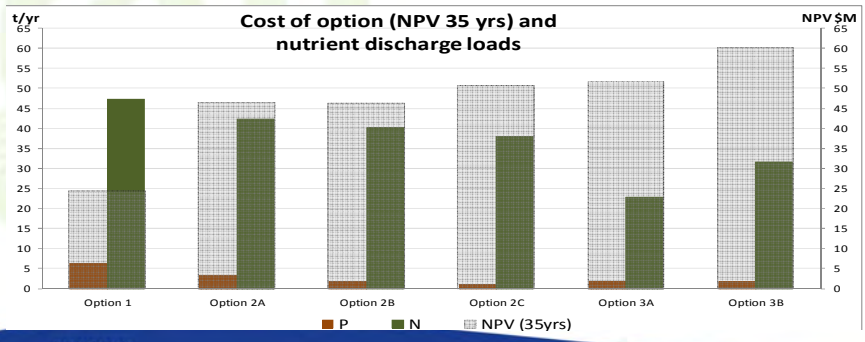
GRAPHICAL REPRESENTATION OF SHORT-LISTED TREATMENT OPTIONS FROM MOTT MCDONALD REPORT (Sheet 1 of 2)

Table 6.1 (Mott McDonald's Report): Summary of Capital Costs, Operational Costs and NPV for Treatment Plant Upgrade Options

Option Option	TP (Load) P	TN (Load) N	Capex Capex $M	Addt'l Opex Opex $M	NPV (35yrs) NPV (35yrs)	Description
Option 1	6.29	47.35	14.4	0.47	24.3	Bardenpho/MBR + FB + UV + P Removal
Option 2A	3.22	42.29	19.8	0.58	46.5	Bardenpho/MBR + Base Option + Disc Filter
Option 2B	1.71	40.18	19.5	0.59	46.4	Bardenpho/MBR + Base Option + Sand Filter
Option 2C	0.87	38.01	22.3	0.65	50.6	Bardenpho/MBR + Base Option + Membrane filters
Option 3A	1.71	22.85	22	0.72	51.6	Bardenpho/MBR + Base Option + Denitrifying snd filters
Option 3B	1.71	31.54	28.8	0.6	60.2	Bardenpho/MBR + Base Option + Carbon beds



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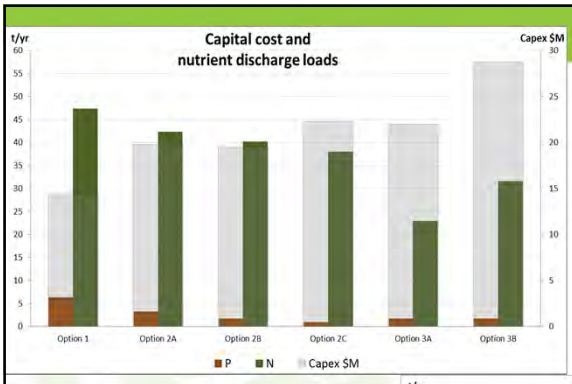
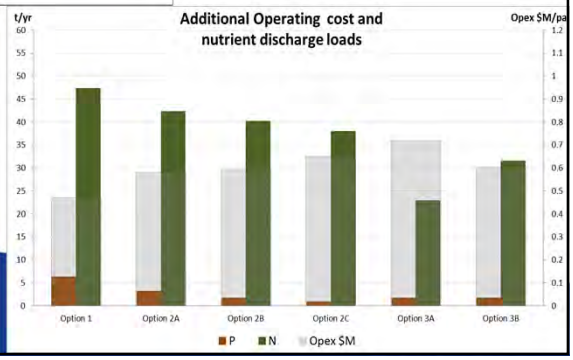


GRAPHICAL REPRESENTATION OF SHORT-LISTED TREATMENT OPTIONS FROM MOTT MCDONALD REPORT (Sheet 2 of 2)



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TAG Update for RPSC

Meeting 19 March 2015

- Next TAG Meeting 8th April 2015. Key Topics will include:
  - Add-Ons summarising and reporting to next RPSC
  - Update on land treatment system options investigation
  - Update on TERAX interaction with short-listed options
  - Discharge siting investigations update
  - Effects study update
- Following TAG Meetings will be 22nd May & 16th June 2015
  - 16th June – key meeting to consider effects study findings and development of TAG preferred option

Discharge Location and Effects Study Update (University of Waikato)

- Data collection and analysis is well underway
- The data will be used in numerical modelling to support the effects study.
- Jonathan Abell - specialist expert in environmental assessment and numerical modelling is getting familiarised with all relevant information related to the project.
- Still on track to deliver the Final Reporting late May 2015.

Alternative Land Disposal Site Investigation

- Contract with Mott McDonald has been let
- Design criteria/ site selection criteria being developed
- On Track to complete in early June 2015.