## AMMONIA - WATER TREATMENT CHALLENGES

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Urban

https://www.lawa.org.nz/explore-data/river-quality/national-picture/nutrients/nitrate-nitrogen/

### **AMMONIA IN RAW WATER**



# HUMAN FACTORS





## NATURAL PROCESSES



1. Ashleigh Collis (2017), "Cows in water supply shock town" retrieved from <u>www.nzherald.co.nz</u> accessed on 13 August 2019

2. Cedrick May (https://commons.wikimedia.org/wiki/File:Decomposition\_and\_New\_Life\_1.JPG), https://creativecommons.org/licenses/by-sa/4.0/legalcode

### **AMMONIA - TREATMENT CHALLENGES**



### TASTE & ODOUR



### CHLORINATION EFFICIENCY



### **OXIDATION OF AMMONIA**

### **TREATMENT PROCESSES**

### **AMMONIA REMOVAL**



### **ALTERNATIVE DISINFECTION**



CHLORINE DIOXIDE

Reverse Osmosis - Hold my ARK, https://www.pexels.com/photo/piping-reverse-osmosis-water-treatment-1287878/ Chlorine Dioxide - CCoil (https://commons.wikimedia.org/wiki/File:Chlorine-dioxide-CPK.png), "Chlorine-dioxide-CPK", https://creativecommons.org/licenses/by-sa/3.0/legalcode Biological Ammonia Removal - Professor William Hickey (https://commons.wikimedia.org/wiki/File:TEM\_Image\_of\_Nitrobacter\_winogradskyi\_str.\_Nb-255.jpg), "TEM Image of Nitrobacter winogradskyi str. Nb-255", https://creativecommons.org/licenses/by-sa/2.0/legalcode

### **TREATMENT PROCESSES**

### **AMMONIA REMOVAL**







Reverse Osmosis - Hold my ARK, https://www.pexels.com/photo/piping-reverse-osmosis-water-treatment-1287878/

Chlorine Dioxide - CCoil (https://commons.wikimedia.org/wiki/File:Chlorine-dioxide-CPK.png), "Chlorine-dioxide-CPK", https://creativecommons.org/licenses/by-sa/3.0/legalcode

Biological Ammonia Removal - Professor William Hickey (https://commons.wikimedia.org/wiki/File:TEM\_Image\_of\_Nitrobacter\_winogradskyi\_str.\_Nb-255.jpg), "TEM Image of Nitrobacter winogradskyi str. Nb-255", https://creativecommons.org/licenses/by-sa/2.0/legalcode

### **AMMONIA REMOVAL - ION EXCHANGE & REVERSE OSMOSIS**

- Common WTP processes
- Proven Technologies
- High capital and operating costs
- Affected by Hardness
- Increased waste streams





### **BIOLOGICAL AMMONIA REMOVAL**

#### Ammonia Oxidising Bacteria (AOB)

 $2NH_3 + 3O_2 + (AOB) \rightarrow 2NO_2 + H_2O + 2H^+$ 

#### Nitrogen Oxidising Bacteria (NOB)

 $2NO_2^- + O_2^- + (NOB) \rightarrow 2NO_3^-$ 





## **Shopping List** - Bacteria AOB NOB - Oxygen -Bacteria Food (Phosphate) - pH 7-9 -Cold Temperatures

### **BIOLOGICAL AMMONIA REMOVAL**

Ammonia Oxidising Bacteria (AOB)

 $2NH_3 + 3O_2 + (AOB) \rightarrow 2NO_2^- + H_2O + 2H^+$ 

Nitrogen Oxidising Bacteria (NOB)

 $2NO_2^- + O_2^- + (NOB) \rightarrow 2NO_3^-$ 



### **BIOLOGICAL AMMONIA REMOVAL - PALO IOWA**



Wapcaplet (https://commons.wikimedia.org/wiki/File:Map\_of\_USA\_IA.svg), "Map of USA IA", https://creativecommons.org/licenses/by/2.0/legalcode

HR Green, "Treatment Plants" Retrieved on 13 August 2019 from https://www.hrgreen.com/markets-projects/water/potable/treatment-plant/

Lytle, D.A. Williams, D. Muhlen, C. Pham, M. Kelty, K. Wildman, M. Lang, G. Wilcox, M. Kohne, M. (2014), 'Engineering Design and Operation Report: Biological Treatment Process for the Removal of Ammonia from a

Small Drinking Water System in Iowa: Pilot to Full-Scale', United States Environmental Protection Agency, Issue 600/R-14/336

### **BIOLOGICAL AMMONIA REMOVAL - TAI PO, HONG KONG**



 $\boxed{1}$  400 → 800 → 1,200MLD

#### DAF

- Primary Biological Filters
- Secondary Rapid Gravity Filters
- **80-90%** ammonia removal
- **75%** manganese removal

### **ALTERNATIVE DISINFECTION**







### **BREAKPOINT CHLORINATION**



### **BREAKPOINT CHLORINATION - ISSUES**



### **CHLORAMINATION**



Cang Li (2011), "Trends and Effects of Chloramine in Drinking Water", Water Conditioning and Purification Magazine, Selecto Scientific, Inc., Suwanee, GA retrieved on 13 August 2019 from http://www.wcponline.com/2011/10/05/trends-effects-chloramine-drinking-water/

### **CHLORAMINATION - ISSUES**



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### **CHLORINE DIOXIDE**



### **CHLORINE DIOXIDE - ISSUES**

Highly Unstable

**Generated onsite** 

Chlorites – 0.8 mg/L MAV

Chlorates – 0.8 mg/L MAV



### **TREATMENT SUMMARY**

	ION EXCHANGE	REVERSE OSMOSIS	BIOLOGICAL FILTERS	BREAKPOINT CHLORINATION	CHLORAMINATION	CHLORINE DIOXIDE
AMMONIA	$\bigcirc$	$\bigcirc$	$\bigcirc$	×	$\bigcirc$	$\bigcirc$
DISINFECTION BY- PRODUCTS	$\checkmark$	$\bigcirc$	$\bigcirc$	×	$\bigcirc$	Ξ
DWSNZ COMPLIANCE	Ξ	$\bigcirc$		$\bigcirc$	×	$\bigcirc$
CAPITAL COST	×	×	Ξ	$\bigcirc$	Ξ	Ξ
OPERATING COSTS	×	×	$\bigcirc$	Ξ	$\bigcirc$	$\bigcirc$
TASTE AND ODOUR	$\bigcirc$	$\bigcirc$	$\checkmark$	×	$\bigcirc$	$\bigcirc$

### NZ CASE STUDY - PATEA WTP - CHLORINE DIOXIDE



### **THOUGHTS FOR NEW ZEALAND**



