

A photograph of two seals resting on a sandy beach at sunset. The sun is low on the horizon, creating a bright glow and reflecting on the water. In the background, there are some buildings and a rocky shoreline. The seals are in the foreground, with one slightly to the left of the other, both looking towards the water. The overall scene is peaceful and scenic.

A new wastewater treatment plant for Davis

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Australian Government

Department of the Environment, Water, Heritage and the Arts



Big stink brews in Antarctica

ANDREW DARBY, HOBART

September 3, 2009, The Age online



Emperor penguins are at risk from untreated human waste. *Photo: Ross Knights*

Antarctica, the most pristine continent on Earth, has a dirty secret. Human waste is being dumped there as governments turn a blind eye to normal standards.

More than half of 71 Antarctic scientific stations surveyed lack any kind of sewage treatment system, a Swedish study has found.

Survey of waste water disposal practices at Antarctic research stations

Fredrik Gröndahl et al. Polar Research 2009



Davis tarn (where water comes from)



Joe at wastewater discharge site

Bristol Stool Chart

Type 1		Separate hard lumps, like nuts (hard to pass)
Type 2		Sausage-shaped but lumpy
Type 3		Like a sausage but with cracks on its surface
Type 4		Like a sausage or snake, smooth and soft
Type 5		Soft blobs with clear-cut edges (passed easily)
Type 6		Fluffy pieces with ragged edges, a mushy stool
Type 7		Watery, no solid pieces. Entirely Liquid



Background

- Australia first with secondary wastewater treatment
- Rotating biological contactors (RBC)
- Installed 1985 at Mawson, 1989 Casey & 1991 Davis
- Well before Madrid Protocol (1991)
- McMurdo didn't install plant until 2003



Mawson Rotating biological contactor



Background

- Davis plant removed 2005
- Wastewater macerated & discharged at shoreline
- Meets minimum requirements of Madrid protocol
- Discharge at site with initial dilution and rapid dispersal?





Background

- Minimum of treating wastewater to secondary level agreed
 - Majority of permanent stations have 2ndary (63%)
 - Some of these have tertiary treatment (at least 5)
 - What level of treatment should Davis have?
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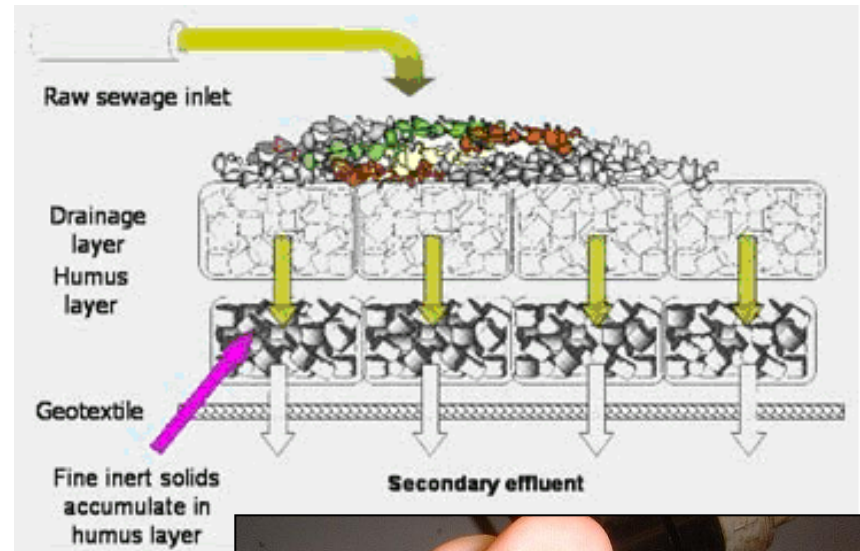
Secondary treatment

- Often known as biological treatment
 - Removal of biodegradable organic content by bacterial growth processes
 - Rotary Biological Contactors are most common
 - Robust, simple to operate and proven in Antarctica
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Another simpler secondary option...

- Biolytix composting, system
- Decomposition by a range of living critters
- Takes kitchen waste as well as sewage!
- Extremely low energy consumption
- No moving parts, low cost
- Minimal byproducts



Non-compliance with Annex II prohibition on introducing non-native species



Tertiary treatment

- Additional treatment to further clean WW and/or remove particular substances
 - Bacteria, pathogens and other microorganisms, nutrients & pharmaceuticals
 - Tertiary in Antarctica increasing, membrane filtration systems most common (pore size 0.1 – 0.01 microns)
 - Works like the human kidney. Depending on pore size v. high quality water produced even drinking water
 - High maintenance requirements & high electricity use
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Secondary or tertiary treatment?

- Provisions of the Madrid Protocol not onerous
 - No explicit standards (besides maceration) of water quality for wastewater discharged in Antarctica!
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Davis WWTP design considerations

■ Environmental

- Characteristics and volume of wastewater
- Sensitivity of receiving environment
 - To be resolved by research done by dive team at Davis 09/10

■ Operational

- Simple, little maintenance, trade based workforce
- Robust and highly dependable
- Cost effectiveness

■ Policy

- At least meets requirements of Madrid protocol
 - Meets expectations of ATS community
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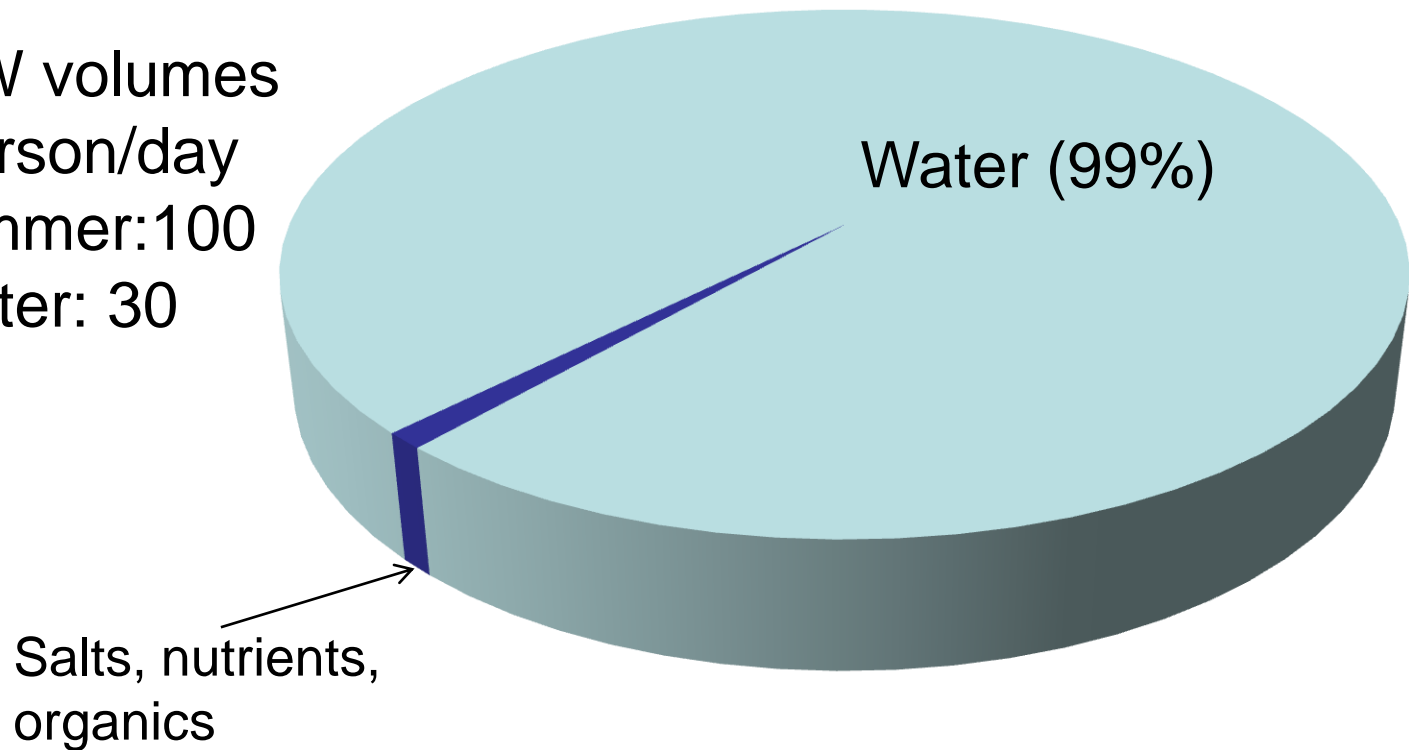


What is (in) wastewater ?

Wastewater: laundry, showers, kitchen, toilets

Davis WW volumes

- 160L/person/day
- Max summer: 100
- Max winter: 30





What's in wastewater that could cause harm?

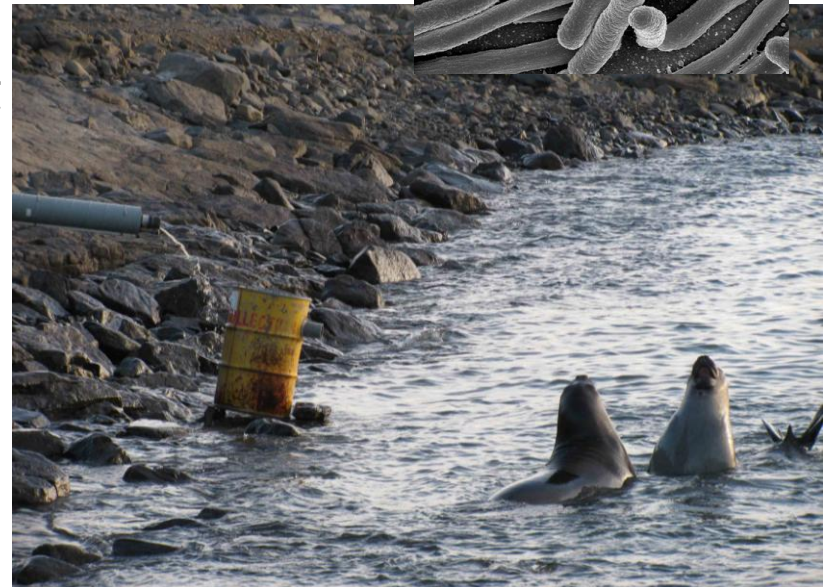
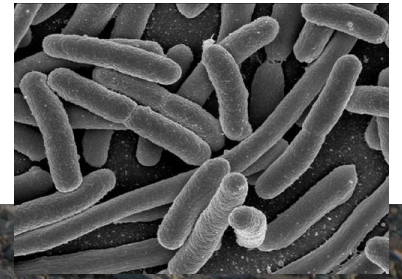
- Biological content from food and toilets – potential for anoxia
 - But low volume and seawater has high dissolved oxygen
- Nutrients (nitrogen and phosphorous) – potential for algal bloom
 - But impact negligible compared to discharge by wildlife
- Pathogens and other organisms pose greatest threat
- Trace chemicals (e.g. pharmaceuticals) ?





Sewage microorganisms

- Some sewage microorganisms are pathogenic (cause disease)
- No evidence that sewage has yet caused disease in Antarctic wildlife
- But it is a known pathway for of non-native species to enter the ecosystem





Disinfection

- Destroys, inactivates or removes microorganisms
 - Usually the final process of wastewater treatment and is commonly achieved by:
 - Chemical – e.g. chlorination
 - Physical – UV radiation and membrane treatment
 - Chlorine residual toxic to aquatic life
 - UV radiation achieves 99.99% reduction
 - Membrane treatment achieves 99.9999%
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The options

- Secondary system using RBC (or similar) with ultraviolet light disinfection
- Tertiary system with disinfection via membrane filtration



or





The perspectives

- **Operational – Secondary**
 - Simple, reliable and proven in Antarctica
 - Avoid high ongoing operating costs of tertiary
- **Policy – Secondary OK, Tertiary preferred**
 - Secondary meets expectation of ATS community
 - But tertiary promotes World's Best Practice within ATS
- **Scientific and environmental – Tertiary**
 - Higher environmental protection
 - Allows opportunity to move toward water reuse & zero discharge





Pros and cons

Low operational risk and cost with reasonable - good environmental outcomes

Operational considerations					Environmental and policy considerations				
Type	Specialist required	Maintenance \$/yr	Energy kWh/d	Proven down south?	Water re-use potential	Pathogen reduction	Policy	Nutrient removal	Effluent quality
Secondary	No	28K	15	Yes	No	99.9%	No change	Limited	Good
Tertiary	Yes	190K	105	Not yet	Yes	99.9999%	Worlds best practice	Excellent	Excellent (A or A+)

High operational risk and cost with excellent environmental outcomes



The winner is...

■ Environment: 🐛 🐛 🐛

■ Environment: 🐛 🐛 🐛 🐛 🐛

■ Operational: 🐛 🐛 🐛 🐛 🐛

■ Operational: 🐛 🐛 🐛

Secondary treatment



or

Tertiary treatment





The outcome

- Balance between the cost and operational risks, and the environmental and policy benefits
- Decision deferred until analysis and reporting 09/10 dive program investigating the environmental impacts of the effluent

