Lowe Environmental Impact

Incorporating Biosolids and Wastewater as a Soil Amendment into Nutrient Budgets and the Associated Environmental Management Considerations

Brian Ellwood, Britt Paton, Hamish Lowe & Sian Cass

February 2019

Outline

- Nature of wastewater vs biosolids
- Mineralisation Rates
- Example Fertiliser value equitant
- Regional Plans in relation to Biosolids and Wastewater
- Management Considerations
- Future Approach

Biosolids and Wastewater

- Can be used as a fertiliser/soil amendment to add nutrients onto the land
- Management considerations need to be understood by farmers as different from fertiliser
- Biosolids - A high percentage of the nitrogen is in an organic form, with very little nitrate or ammoniacal nitrogen
- Wastewater – Nitrogen is more likely to be in the nitrate or ammoniacal form
- Organic nutrients are not readily available to plants and are required to be mineralised to be plant available.
- Inorganic forms of nutrients are readily available post application.

Mineralisation Rates

- Complex nature – nutrients bound within the material
- Only a percentage of the nutrients may be initially available for plant uptake
- Requires mineralisation before nutrients become soluble and mobile.
- Prior treatment processes impact on ultimate nutrient availability

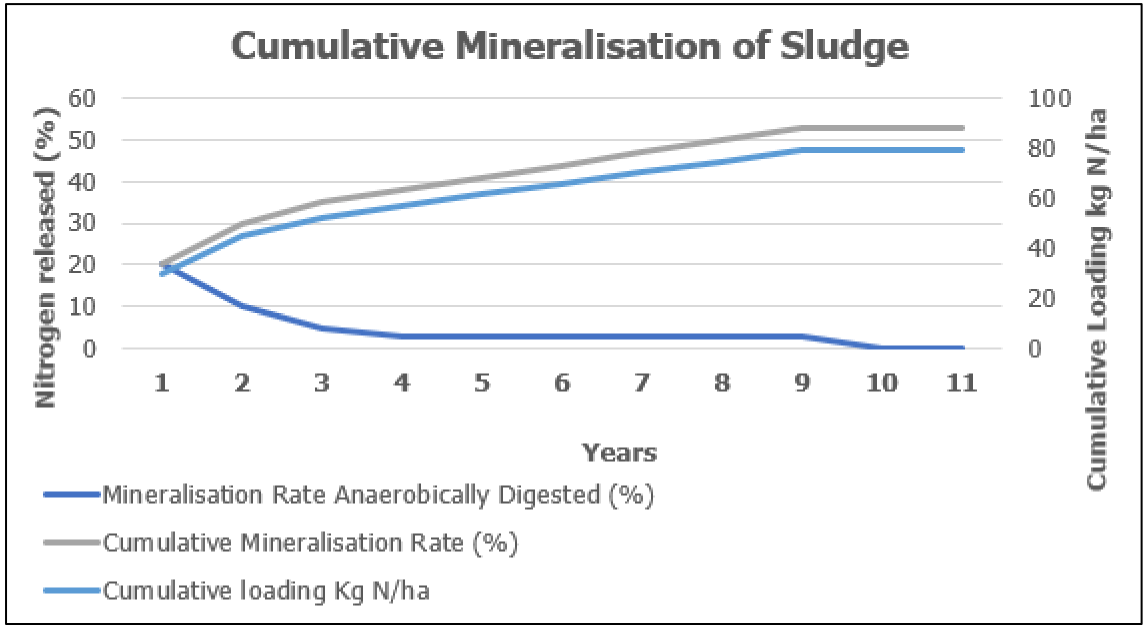
Time after Sludge Application (yr)	Mineralisation Rate Anaerobically Digested (%)	Mineralisation Rate Raw sludge (%)
1	20	40
2	10	20
3	5	10
4	3	5
5 to 10	3	3

Source: Metcalf and Eddy

Mineralisation of Biosolids

LOWE Environmental Impact

Mineralisation example showing Nitrogen availability for an anaerobically digested sludge applied annually @150 kg TN/ha/year



Equivalent Fertiliser value

Approximate NPK value of Waste Activated Sludge based on Balance Agri Nutrients 2017 published trade prices

Nutrient	Proposed Application Rates (kg/ha/yr)	Fertiliser Prices			Equivalent WAS value $/ha/yr
		Type	$/tonne	$/kg nutrient	
Nitrogen	150	Urea (46%)	588	1.28	$192
Phosphorus	50	DAP Sulphur Super (14.8%)	613	4.14	$208
Potassium	25	Muriate of potash (50% K)	588	1.18	$30
NPK					**$430**

Actual fertiliser value is likely to be much lower in the initial years

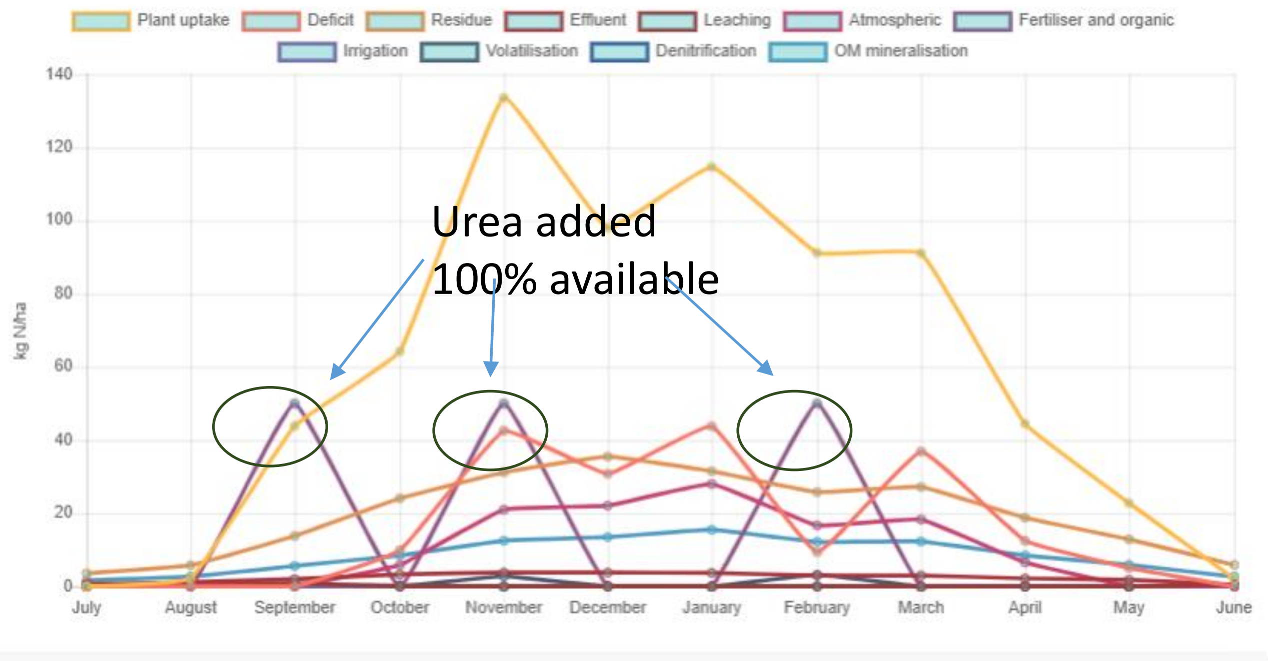
Example: WAS compared to Urea

- Waste Activated Sludge (WAS)
- Options for modelling N Loss: Could add as Urea or as Organic N
- An OVERSEER© model was created to assess the difference in effects of adding WAS as Organic N at a rate of 150 kg N/ha/yr vs Urea at 150 kg N/ha/yr.
- Modelled four 50 ha blocks based on two common Southland soil types: a Wyndham and Makarewa soil.
- 600 cow dairy unit
- Nitrogen was applied in 50 Kg N applications in September, November and March in the form of dilute <16 % organic dairy factory waste to two blocks
- Urea was applied to the others two blocks.
- The same nitrogen loss was modelled for both nitrogen forms

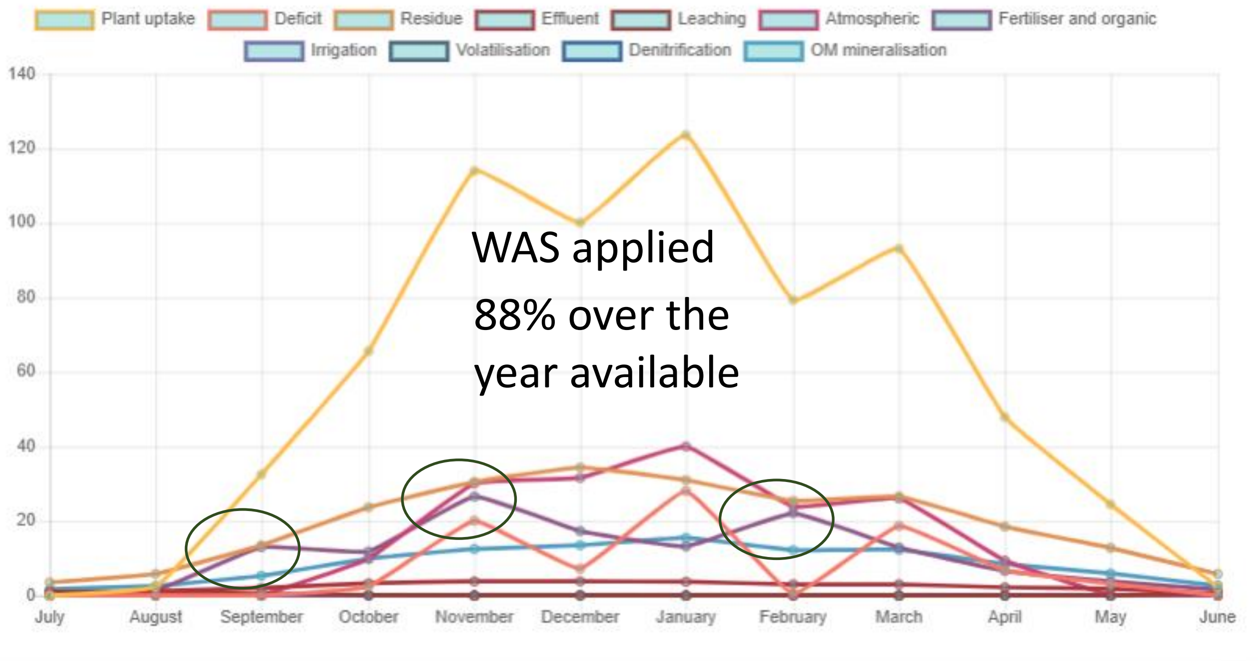
WAS compared to Urea Leaching Losses

BLOCK DETAILS	WYNDHAM FERT	MAKAREWA FERT	WYNDHAM WAS	MAKAREWA WAS
NITROGEN SUMMARY				
Total N loss (kg/yr)	1279	1389	1340	1458
N loss per ha (kg/ha/yr)	26	28	27	29
N in drainage (ppm)	10	10	10	11
N surplus (kg/ha/yr)	185	189	184	189
N added (kg/ha/yr)	180	180	180	180

N Pool Graphs



Urea



Waste Activated Sludge

The long term equilibrium nature of OVERSEER assumes 88% of the added Organic nitrogen will be available over the year. However, mineralisation rates are likely to be only 30- 40% over the first year and only this amount plant available initially over full 12 months.

Wastewater considerations

- Higher proportion of the nitrogen is plant available either as Nitrate or Ammoniacal nitrogen depending on the upstream treatment system than biosolids.
- Ponds systems are likely to have higher ammoniacal nitrogen than an activated sludge system
- This has implication for land treatment system and direct water discharges.
- Ammoniacal nitrogen potentially toxic to aquatic organisms but it less leachable than Nitrate when applied to land.

Regional Plans – Provisions

- Conservative approach to application is often taken in regional plans
- Loading rates based on total nitrogen content and not the available nitrate and ammonium.
- The same loading rates often used for both liquid and solid wastes (eg Southland Water Plan, Proposed Marlborough Regional Plan)
- Plans limit the total amount of N that can be applied (e.g. 150 or 200 kg/ha) via straight forward consenting pathway.
- Misunderstanding can occur if the nitrogen loading rate is thought of as an equivalent of urea fertilizer.

Management Considerations - Biosoilds

- Over time a high percentage of the nutrients can be released
- Implications for both nutrient budgeting, environmental management and nitrogen leaching mitigation regimes to limit overall N losses.
- An additional consideration when using Overseer to assess the leaching potential is the cumulative impact of mineralisation beyond the application month and reporting year.
- Land user may not initially see the plant responses that they were hoping for.
- Communication of fertilizer form and benefits to all stakeholders needs to factor in the expected plant availability of the nutrients

Future Approach?

LOWE Environmental Impact

- Plans could provide a differentiated approach based on the form of nitrogen allowing for short and long term application rates.
- Reduced regulatory hurdles for application of organic nitrogen could improve beneficial use of nutrients in waste sources.
- Nutrient modelling protocols for inputting slow release fertiliser need to be developed.
- The nutrient modeling approach’s are needed to predict transitional system nutrient losses from organic fertiliser are needed.

LOWE Environmental Impact

Advice AEE Agricultural Analysis Application Approachable Assessments Assimilation Assistance Biosolids Capability Client Communications Communities Compliance Compost Consents Consultation Contamination Coordinate Council Cultural Current Data Degradation Design Detention Developments Discharges Documentation Drafting E. coli Ecosystems Effects Engagement Environment Equipment Evidence Excellence Experienced Expert Facilitating Farming Feasibility Fieldwork First-flush Fit-for-purpose Flooding Fun Geology Graphs Greywater Groundwater Guidelines Handbag Hazardous Hydraulics Innovation Interpretation Investigation Irrigation Land Landfills Landscape Land-treatment Leaching Lodge Management Metals Microbiology Modelling Monitoring NES Nitrogen Nutrients Onsite Optimisation Organics Overseer Papers Pathogens Phosphorus Plain-english Plans Preparation Presentations Project Quality Relevant Remediation Reports Research Review Sampling Scientific Septage Sludge Soil Solutions Spreadsheets Standpipes Stormwater Strategy Support Surface Water Sustainability Systems Team Testing Timely Treatment Validation Wastewater Water Water-balance Waterways

www.lei.co.nz | Palmerston North Christchurch Wellington | office@lei.co.nz