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Putting waste to work

A CENTRE FOR INTEGRATED BIOWASTE RESEARCH PUBLICATION

INSIDE THIS ISSUE

Centre for Integrated Biowaste Research

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UPDATE FROM THE PROGRAMME MANAGER

Kia ora and welcome to the first newsletter of 2017.

The beginning of the year always involves a lot of grant proposal writing, the CIBR team have been hard at work submitting large collaborative project proposals. More and more of these proposals require active support and input from end-users. A huge thank you to all of you involved in the Cawthron led project (Louis Tremblay) "Emerging organic contaminants – managing the risk for a safer New Zealand environment and economy" that was submitted to the MBIE Endeavour fund earlier this month.

This year we had our first ever Māori summer studentship. We were lucky enough to find Sky Halford (Ngāti Kahungunu ki Wairarapa and Rangitane), you can read about her project with Branz on page 2. Sky did an amazing job and although she is escaping CIBR to do her Masters' at Victoria this year, she will be back in year two to undertake her research project with us.

The Landcare team have been leading the research project into the use of biosolids to rehabilitate post-mining land – in this issue we hear about the benefits to establishing pine plantations (page 4).

By the time this newsletter is in print the annual Land Treatment Collective conference will have been and gone. In June last year an ESR/CIBR/Lowe Environmental Impact team took over management of the LTC including organisation of the conference. Thanks to the team for all their efforts. The conference is in Christchurch this year and CIBR will be giving ten presentations – there will be a synopsis in the next issue!

There have been a few changes of staff in the ESR CIBR team. After 15 years at ESR and working with biosolids Jennifer Prosser left the team to spend more time with her young family; and this newsletter is the last one our wonderful editor Sarah Quaife will work on. Sarah is off on her OE and will start as a NZ ambassador in Japan in July – what an adventure – we wish both Jen and Sarah all the best.

Jacqui Horswell

Sky Halford (Ngāti Kahungunu ki Wairarapa, Rangitane), working on project with BRANZ

Jen Prosser in the field

Sarah Quaife, left with Jacqui Horswell

SKY HALFORD'S PART IN THE BRANZ 'FLOODIT' PROJECT

Sky Halford has been working with Alma Siggins on a BRANZ-funded summer project at ESR. This project is part of the larger BRANZ "FloodIt" project, managed by Kathryn Stokes and Patricia Shaw.

In this larger project, they have been flooding small scale test houses, which are small single room houses built using typical house construction methods. By monitoring the temperature, humidity and timber moisture content, they are aiming to provide the building industry with advice for carrying out repairs following a flood event.

FloodIt small scale test houses

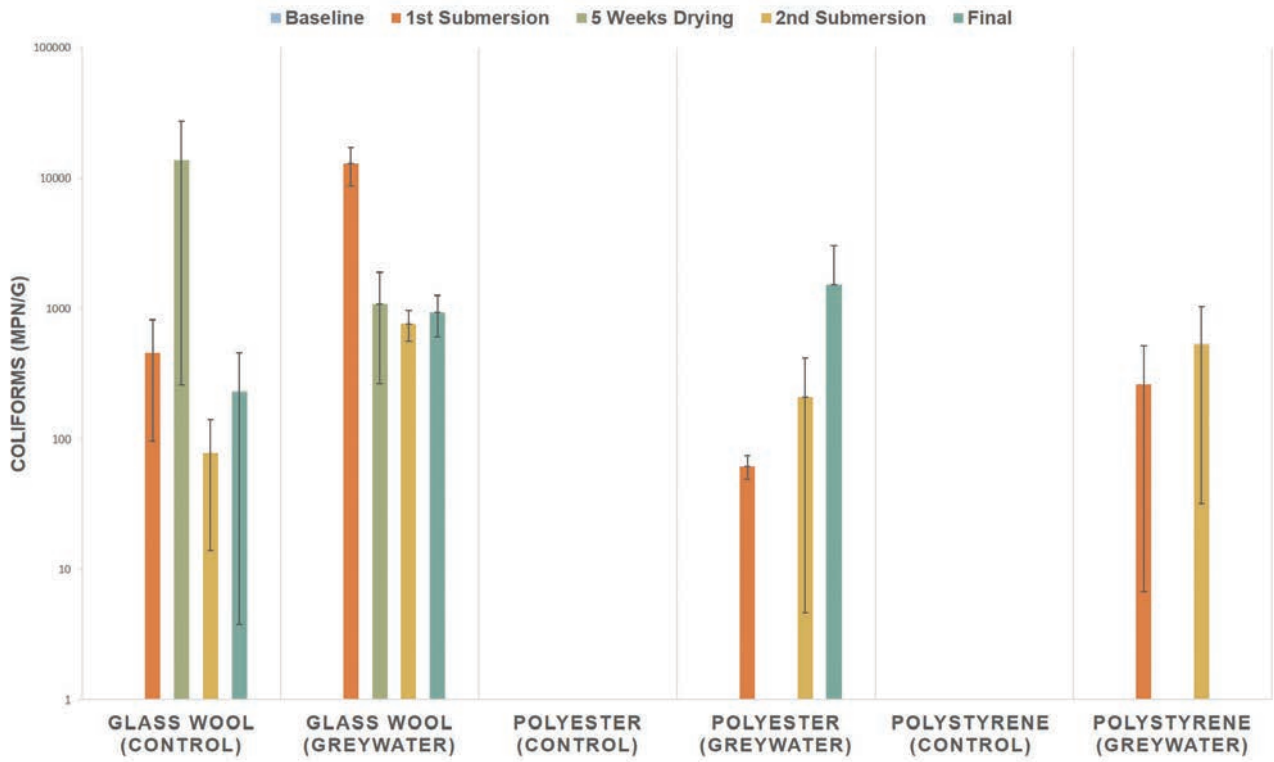
Flooding of the small scale test houses

Insulation wall panel testing set up

At ESR, Sky has been submerging wall panels in "flood waters" – either clean tap water or synthetic greywater, and monitoring the insulation for signs of microbial contamination. She has been comparing three different insulation types, all of which are commonly used in the building industry. Sky has also been investigating the effect of drying time on the insulation as part of this project, with two flood events followed by 5 weeks and 3 weeks drying time, respectively.

The results have been really interesting and show clear differences between the three investigated insulation types. Glass wool insulation tested positive for coliforms following submersion in both tap water and greywater, for up to 5 weeks after the flood event. Polyester insulation tested positive for coliforms following an initial submersion in greywater, but no coliforms were detected after drying the insulation for 5 weeks. When the insulation was submerged a second time coliforms reappeared and remained even after drying for a further 3 weeks. The final insulation tested was polystyrene. For this insulation, coliforms were detected one week after each submersion but not after the panels were dried.

At the end of the experiment we used agar contact plates to determine if any fungi were present in the insulation. All insulation types showed the presence of fungi, for both tap water and greywater treated samples. Work is ongoing in association with the Auckland District Health Board Microbiology Laboratory to identify the fungi present.



UP-DATE FROM THE ECOTOX TEAM *Louis Tremblay*

The Whau River, Auckland

Louis Tremblay, Grant Northcott, Jamie Ataria and Graham Sevicke-Jones (Director, Science & Information, Environment Southland) attended the 7th SETAC World Congress/SETAC North America 37th Annual meeting in Orlando, Florida, 6–10 November.

The Society of Environment Toxicology and Chemistry (SETAC) is a worldwide professional organisation that hosts regular conferences and publishes scientific manuscripts and books.

One of the key events was the final symposium of the Global Horizon Scanning Research Prioritisation Project: a SETAC World initiative that aims to collect and prioritise the most important future research questions as recognised by scientists from around the globe working in government, academia and business. The process involved a call for people to submit research questions they believed were important and then those were presented and ranked at workshops.

The Australasia workshop was held in Nelson at the 2015 SETAC conference. The outcomes from each of the geographic units were presented in Orlando. The four NZ representatives and Vin Pettigrove from the Centre for Aquatic Pollution Identification and Management in Melbourne, presented the outcomes of the Australasia workshop. They are now working on the completion of a manuscript for publication in the scientific journal *Integrated Environmental Assessment and Management*. We will provide updates on progress in future newsletters.

Closer to home, Louis Tremblay, Grant Northcott, Jamie Ataria, Jacqui Horswell and Jinny Baker from CIBR were key participants at the Royal Society Catalyst: Seeding General project: "Managing the risk of emerging organic contaminants (EOCs) in New Zealand through an international science partnership" held at the West Plaza Hotel in Wellington on 1, 2 December 2016. Contributors to the workshop were from regional councils, MfE, MPI, EPA, DoC, industry and international experts from Australia, USA and Europe. The objective was to discuss the steps required to develop a National Strategy to assess and manage the risk that EOCs pose to our taonga and people.

ME student Anna Lewis sampling a berm where glyphosate was applied.

A first draft of the document was put together and Louis and Graham Sevicke-Jones are coordinating the completion of the document by Chris Arbuckle and Karen Bell with financial support from Envirolink. The Strategy will identify the knowledge gaps required to develop regulations and policy to protect NZ from the risk of EOCs.

Lastly, graduate student Anna Lewis (Master of Engineering at the University of Auckland) was hosted at Cawthron to conduct ecotoxicity testing on samples she collected in Auckland as part of her project. Anna is looking at the fate and transport of glyphosate in the Whau catchment and is utilising CIBR testing methods for this application. She took a series of samples from berms where glyphosate products are applied down to estuary. That will provide useful information on the presence and potential impacts of this herbicide for which there is a strong perception that it is safe to use.

BIOSOLIDS ASSIST MINE REHABILITATION TO PLANTATION FORESTRY

Robyn Simcock and Jianming Xue

Pine plantations have been a productive, post-mining land use in New Zealand since the 1970s/80s. At this time forest research scientists worked out how to convert dredge tailings left by alluvial (river gravel) gold miners into productive plantations[1] by underplanting pines with vigorous legumes. This process supplied nitrogen to trees which overcame deficiencies that limited tree growth.

Aerial photo showing areas with biosolids sampling locations (red dots) and two control plots (blue dots in areas with no lanes cut to allow spreading)

Dredge tailings occupy the extreme end of soil nitrogen deficits that are inherent in any mined land where topsoil is not replaced, or is mixed with subsoils or overburden. Biosolids, being rich in nitrogen and organic matter, have been used to enhance rehabilitation internationally for decades.

Biosolids are a valuable amendment for mined lands where root zones are typically deficient in the macro-nutrients found in biowaste. Mine sites also have the advantages of having water management systems that direct mine runoff to ponds, which allows monitoring of nitrogen (N) concentrations in discharges, one of the main monitoring concerns for land application of biosolids. Further, mine sites exclude public while active and are typically well buffered from neighbours – allowing easy mitigation of air pollution (odour) required by consenting processes.

In Issue 12 (May 2016) of the CIBR newsletter, we reported pasture trials established in 2007/2008 by Solid Energy at Rotowaro Mine.

Pine establishment without biosolids showing erosion risk

Initial monitoring focused on nitrogen leaching and soil contaminant concentrations after incorporating a one-off rate of 0, 50, 100, 200 or 400 dry tonnes/hectare (t/ha) of biosolids into the subsoil (biosolids had an average 3% N, 2% P w/w (wet weight) and 20% dry matter).

There was a short-lived "nitrogen pulse" in the beginning and then nitrogen leaching rates lowered, in part because nitrogen release was moderated by the rate of organic decomposition of the biosolids. Seven years later, pasture in the trial plots that had received 100 dry t/ha (N = X Tonnes/ha) or greater had maintained much higher plant biomass and height than control areas (plots with no biosolids applied). This increased resistance to both surface erosion and invasion by weeds.

The biosolids trial was not implemented operationally for two reasons. Firstly, the source of biosolids changed from a 10-year-old stockpile (with moderate moisture content) to relatively fresh biosolids with a higher moisture content. It was difficult to mix high rates of the new, higher-moisture content biosolids into the subsoil. Secondly, mixing needed timely (inflexible) coordination between different contractors and therefore exposure of many more people to the biosolids.

A solution was to use a 'muck spreader' to spray biosolids over rehabilitated areas in summer, i.e. once sown in with pasture and planted with pine trees. Every eighth row of pines was removed to create access for the spreader: the characteristic strips define the areas where biosolids were spread (see photograph above).

The biosolids had an average 5. 6 % w/w N and 1.9% P. In summer 2010/2011, about 3 dry tonnes Tonnes/ha was spread. This increased to 6 dry tonnes/ha in 2011, reflecting the resource consent Nitrogen cap increasing from 200 to 400 kg N/ha as monitoring showed about 5.5 kg N / ha / annum was leaving the small to catchment containing 40 ha of 'biosolids land' under the lower application rate.

Solid Energy applied about 600 kg N/ha over two summers to 1 to 3 year-old GF19 pines planted at 1330 stems/ha. Photos taken before and after the first spreading of biosolids show a strong positive pasture response, and reduction in erosion potential (see photographs above and opposite).

Early last autumn, the CIBR team measured soil and pine tree quality in areas rehabilitated with or without biosolids (see photograph 4). We wanted to quantify the results of the early applications to very young trees, now that the seven and eight-year-old trees had reached canopy closure. At this stage most of the initial pasture groundcover was eliminated, releasing nutrients back into soils and trees.

Pine establishment after biosolids spreading. Pasture responded vigorously, reducing erosion risk

Measuring trees, Autumn 2016

Information from the intensive Rabbit Island biosolids trials, also on nitrogen deficient soils, have shown 7-year-old to mid-rotation pines benefit significantly from biosolids application rates of 300 and 600 kg N/ha every 3 years (CIBR newsletter issue 13, Spring 2016). The 20 to 30% basal area volume increase has been economically beneficial.

As a comparison, we measured tree survival, nutrition and form on the Rotowaru site. We thought applying biosolids to very young trees might make the trees top-heavy, increasing poor form through toppling and butt-sweep. Alternatively, it was possible the vigorous pasture sown underneath could have used excess nutrients and helped to mitigate against poor form.

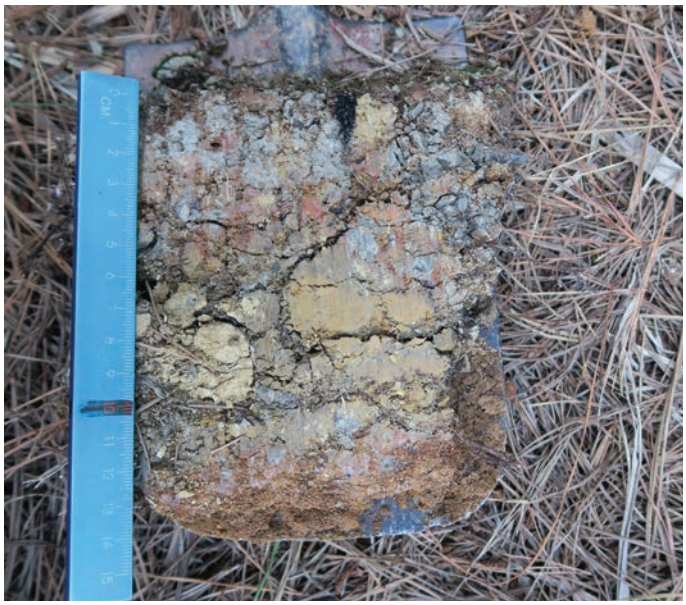
RESULTS

As in the earlier pasture trial, soils in 'control' areas without biosolids had low levels of available and total phosphorus, nitrogen and organic carbon, but were able to store any applied nutrients. Biosolids applications had the greatest effect on all forms of phosphorus: total phosphorus approximately doubled and plant-available phosphorus was six-fold higher on average (Olsen P was 19 ± 12 mg/L in biosolids plots vs. 3 ± 1 mg/L in control plots).

Up to 600 kg/ha of additional nitrogen over two years was reflected in only a minor increase in soil N% of 0.17 ± 0.02 in biosolids plots vs. 0.13 ± 0.03 in control plots. Areas of similar age that were established in permanent pasture without biosolids also had low available P (Olsen P 6 mg/L), but developed higher nitrogen and organic carbon concentrations. Total and Olsen P concentrations were less than half that achieved in 50T/ha of dry biosolids in the early pasture trial.

Tree foliar chemistry reflected higher phosphorus nutrition in biosolids treatment (0.17 ± 0.1%P vs. 0.14 ± 0.1 %P in controls). This response was not seen in Rabbit Island, where the recent soils have very low phosphate retention. The amount of biosolids applied at Rotowaro has probably not met nitrogen requirements, as mean foliar %N was 1.40 ± 0.08. Trees in only one of the six replicate plots exceeded 1.5% N, which is regarded as a threshold value below which radiata pine may benefit from fertilisation.

Mean foliar N for control plots was 1.30 ± 0.16 and as low as 1.17%. This indicates the site is more deficient than the Raw Sands of Rabbit Island where Foliar N in controls in 2015 was 1.40% w/w. Despite foliar differences, eight-year-old trees had similar average height (13.8 m) and mortality. Mean DBH was marginally higher and less variable where biosolids had been applied (172 ± 8 mm compared



Rehabilitated upper soil profile showing mixture of subsoils (grey, fawn, brown and rust-coloured

with 159 ± 19 mm). Soils at Rotowaro have the capacity for large basal doses in excess of 400 kg N/ha/annum that may be based on 'standard' fertiliser rates to farmland. Rates in excess of 600 kg N/ha over 2 years are needed to overcome N deficiency and to achieve tree growth benefits; such rates may also provide economic 'gate fees' (received for disposal).

The study highlights the importance of creating suitable physical conditions for pine plantations. Applying biosolids probably improved soil aeration by boosting biomass (and hence evapotranspiration) of pasture grasses, but this was not adequate to ensure pine seedling survival in all rehabilitated areas. Some parts of rehabilitated areas had high mortality due to inadequate drainage for pine tree establishment. Inadequate drainage occurred in places with gentle slope and/or inadequate ripped width and where water from steeper slopes accumulated on lower sloped land.

[1] *Modern dredging now separates fines from gravels, allowing rehabilitation to high quality pasture.*

WORKING ON BIOWASTE STRATEGIES FOR A SUSTAINABLE LEARNING VILLAGE: UNDERSTANDING UPTAKE OF KAITIAKITANGA

James Ataria, E.R. (Lisa) Langer, Virginia Baker, Alan Leckie, & Joanna Goven

Te Pā o Rākaihautū (Te Pā), is a designated special character school in Christchurch that is the first school of its kind in New Zealand. By combining traditional Māori education teaching methods and cultural philosophy with modern teaching methods, the creators of this initiative have created a Pā Wānanga, or learning village.

In issue 14 of the CIBR newsletter, the social and cultural team reported on our initial engagement with Te Pā and Te Taurinui (the establishment Board of Trustees) and this article provides an update on our collaboration to date.

A high level Te Taiao strategy has been created that outlines key pou (anchor points) (Figure 1). This provides focus points for work that Te Pā is currently carrying out or will be considered for the infrastructure build at Te Pā's new permanent site. Te Taurinui is currently exploring options to secure a permanent site within Christchurch City on which to commission a purpose-built Pā wānanga.

A number of Taiao (environmental) sustainability goals have been created for Te Pā that are a key element of Te Pā's quadruple bottom-line approach . These goals are guiding thinking and practice at the current temporary site and will be instrumental during the development of the new Pā wānanga facility.

Te Pā's sustainability goals fit with CIBR's Community Engagement Framework research. With this alignment, CIBR is excited to work in partnership with Te Taurinui and encourage shared learning that can be applied to both our research and realising Te Pā's goals.

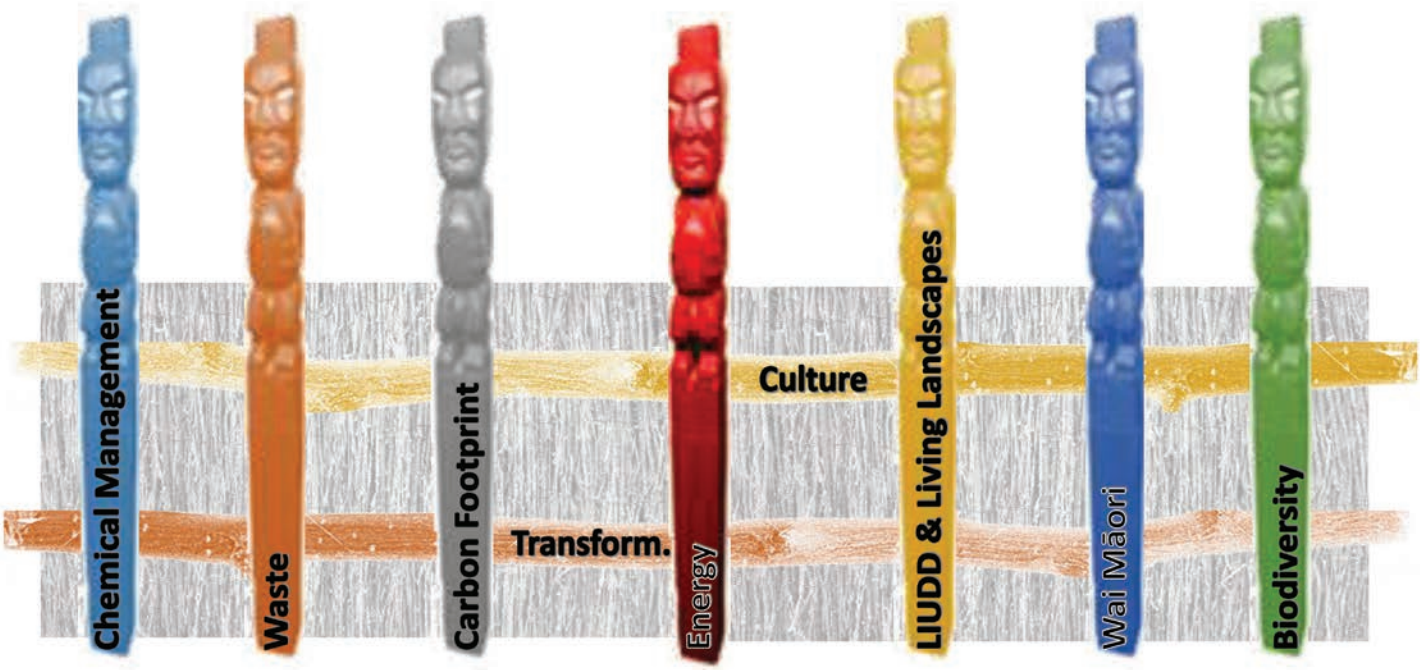


Figure 1. Key pou (anchor points) outlined in Te Pā's high level Te Taiao strategy

TE PĀ LOOKS TO THE FOLLOWING GOALS:

Strategic Pou	Description of goal
Waste	**Goal:** To minimise waste to landfill by committing to a programme of 'Reduction, Recycling, Re-use and Composting', e.g. all green waste is composted/re-purposed, all paper and cardboard waste is composted or recycled. Within 7 years plastic use on-site or brought onto site is minimised.
Chemical management and awareness	**Goal:** Te Pā will characterise its chemicals use profile and adhere to a risk reduction strategy to phase out chemical management in favour of appropriate organic alternatives or practices, or employing chemicals that have a low risk to humans and the environment.
Wai Māori – wai ora	**Goal:** Te Pā will incorporate devices and procedures that conserve and manage potable water use; harvest, store and re-use rainwater, and explored options for grey water re-use.
Carbon footprint	**Goal:** Becoming carbon-neutral within 15 years of operation.
Energy	**Goal:** To generate all of the school's daily energy requirements (electrical and heating) at the permanent site via sustainable energy sources, and minimise energy loss and inefficiencies within the building infrastructure through materials and design.
Biodiversity	**Goal:** To become active citizens in the promotion and support of indigenous biodiversity gains on- and off-site.
Culture (cross-cutting theme)	**Goal:** To use te reo Māori me ngā tikanga Māori as a vehicle for raising the profile of ngā tikanga me ngā kawa e pā ana ki te taiao to relocate people back into the environment rather than the current process of people and the environment.
Transformative change - a better environment for better people (cross-cutting theme)	**Goal:** Challenging current neo-liberal teaching methods requires transformative change. Te Pā will create this change through a number of taiao initiatives that reflect our special character, and re-enforce identity and our values. In doing so, the school will become a local, national and global education leader that graduates leaders for the future.

POTENTIAL PARTNERSHIPS AND SUPPORT

Realising the inherent potential within these pou outlined in the Taiao Strategy will require strategic partnerships with organisations that can provide resourcing, assistance and expert advice. CIBR has engaged with Te Tautarinui and will begin working with Te Pā to assist with particular pou from the Te Taiao plan – especially the waste and chemical management and awareness pou.

Furthermore, discussions are underway with educational researchers who are interested in examining whether the Te Pā model of education is generating transformation amongst students in areas like environmental intelligence. Researchers are also interested in improvements to social and emotional learning outcomes.

In summary the CIBR research with Te Pā represents a unique opportunity to collaboratively design the learning village from the ground up, generating innovative development. The data and knowledge generated will be of immense benefit to Te Pā from the perspective of creating practical data that can be used to support how Te Pā is progressing towards and meeting its Te Taiao goals.

The worm farm built for organic waste generated by the Nōku Te Ao (Early Childhood Education unit) at Te Pā. From left Kirianna Winiata (Nōku Te Ao teacher), a pononga of Nōku Te Ao, Alan Leckie and Jamie Ataria.

UPDATE FROM THE SOIL SCIENCE GROUP

By Jianming Xue

The CIBR Soil Science Group has been conducting research on the beneficial reuse of biowaste and wastewater on agricultural and forest lands, and minimising their environmental and ecological impacts. The Group aims to create economic, environmental and social values through rebuilding degraded soils and marginal land and improving waterways by developing sustainable management solutions and practices.

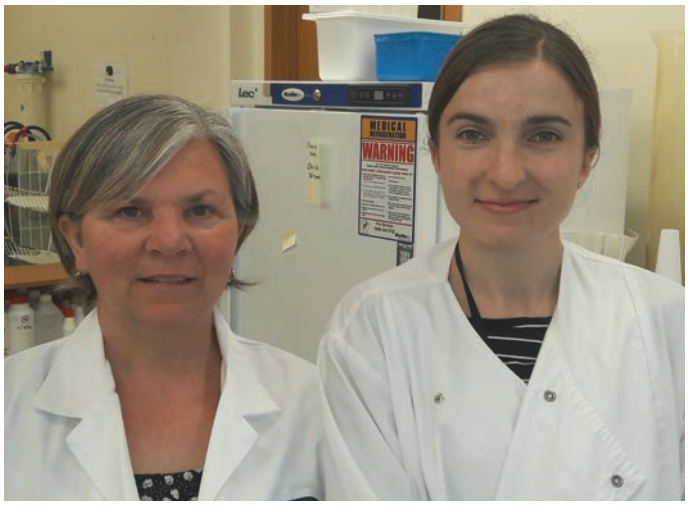
In this newsletter, Dr Robyn Simcock at Landcare Research in Auckland will summarise the results from the Rotowaro trial in Huntly, Hamilton about the beneficial use of biosolids for establishing production forestry after mining (see pages 4–5).

Dr Jianming Xue and his team at Scion have been studying the environmental, ecological and economic impacts of repeated applications of biosolids to a radiata pine plantation at Rabbit Island. They aim to develop sustainable land application of biosolids for the Nelson community, and provide indicative research findings for land application of biosolids throughout New Zealand.

Alan Leckie, David Henley and Max Novoselov recently completed another soil sampling from this trial to investigate the residual effect of repeated applications of biosolids on soil quality. The results will be presented in the next issue of newsletter.

Fig.1 Soil sampling of the field crew at the biosolids research trial at Rabbit Island in Nelson

NEW ESR CIBR STAFF ADDITIONS



Vikki Ambrose (scientist) and Izzy Alderton (senior technician).
Both Vikki and Izzy are from England. Vikki has been a previous ESR team member and is pleased to be back. In her spare time Vikki volunteers at Helping You Help Animals (HUHA) and Retired Working Dog Adoptions NZ. Izzy is new to the world of environmental science, with a background in biomedical science, but is enthusiastic to learn and has previously worked at the Wellington hospital laboratory.

Vikki Ambrose (left) and Izzy Alderton

If you would like further information on the programme or have any questions, please see our website www.cibr.esr.cri.nz or contact a member of the Science Leadership Team:

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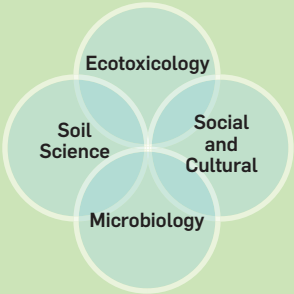

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