

STRATEGIC SCIENCE INVESTMENT FUNDING (SSIF)- FINAL PROJECT REPORT FOR FY2018

ESR is fully accountable for Strategic Science Investment Funding (SSIF). Information in this report will be used to demonstrate the value of ESR SSIF and to quantify the benefit from the investment. It will also inform future investment of SSIF.

Your Final Report will be used to populate the Board Science Report for FY2018. Please remember if you don't inform the Research Office we can't inform MBIE or the Board and your work will not have the impact it deserves.

- Please answer every question.
- Please complete and email, in document form, to *[Withheld under section 9(2)(a) of the OIA] @esr.cri.nz* by Friday 20th July 2018.

Project title:

Centre for Integrated Biowaste Research

Project leader(s):

Maria J Gutierrez-Gines

Duration: (e.g. "Continuing, Year 2 of 3")

Year 1 of 3

Budget (amount allocated per year and total spent)

Allocated: \$1,161,669 + \$297,000

Spent: \$1,045,338 + \$297,000

List the 1) capabilities and 2) new collaborations developed in the project and by whom (include students)

New capabilities:

- Proteomic capability has been established for identification of enzymes capable of virus inactivation (Amanda Inglis, PhD).
- Generate environmental fate, transport and effects data for viruses and emerging contaminants (Louise Weaver, Judith Webber, Amanda Inglis, Maria Jesus Gutierrez-Gines).
- Optimised methods for analysing Laccase activity, tyrosinase activity, lignin peroxidase activity and manganese peroxidase activity in aqueous samples, including wastewater (Maria Gutierrez Gines, Judith Webber, and Louise Weaver).
- A new ICP-MS that will be able to analyse isotopes of trace elements in biowastes, allowing a better understanding of their fluxes in the soil – plant system (Brett Robinson).
- Optimised method for enumerating *Campylobacter* spp. in soil, biowaste and complex samples (Izzie Alderton).
- Gas chromatography mass spectrometry method to analyse multiple classes of alkylphosphate

and polybrominated flame retardants. Establishment of passive sampling device (PSD) sampling capability to enable time integrated sampling of EOCs and other organic contaminants from aqueous samples (Grant Northcott).

- Jianming Xue, through collaboration with Prof Zhaojun Li and his team at the Chinese Academy of Agricultural Sciences (CAAS), developed an enhanced antibiotic degradation manure composting system by using novel fungal strains or bacterial consortia and incorporating biochar or other functional materials. This will encourage the beneficial use of animal manures or biosolids in agriculture and forestry land and effectively reduce the point-source and non-point source pollution of residual antibiotics, which causes the spread and impact of antibiotic resistance.

- Development of the Comet assay in the copepod model to assess genotoxicity in complex mixtures. The method has been validated using contaminated estuarine sediment samples and the results published. We have developed and validated the use of the copepod model for multigenerational exposure experiments as it responds well to DNA-methylation. A manuscript has been submitted (Louis Tremblay).

- Mārie McCarthy (Ngati Whakaue, Te Whanau-a-Ruataupare, Ngati Whitikaupeka, Ngati Tamakopiri) has joined the social and cultural team and brings capability in education and kaupapa Māori research. Marie's previous role was lecturer at Te Whare Wananga o Awanuirangi (Lisa Langer).

- Development of a monitoring system for assessing the success of riparian plantings. Maria Gutierrez Gines, Robyn Simcock, Brett Robinson, in collaboration with EcoQuest.

New collaborations:

- Ecotoxicology team has initiated a collaboration with Dr. Bradley Clark of RMIT University in Melbourne to develop a survey of polyfluorinated alkyl substances (PFAS, PFOS, PFOA) in biosolids from NZ wastewater treatment plants (Grant Northcott & Louis Tremblay).

- Grant Northcott is continuing discussions with Tonkin + Taylor to identify and pursue future collaboration opportunities with CIBR, particularly with the future application of newly developed PSD capability.

- New collaboration has been built between Jianming Xue at CIBR and Prof Baisuo Zhao at the Chinese Academy of Agricultural Sciences for the 2018 MBIE Catalyst Strategic Fund bidding.

- Grant Northcott and Louis Tremblay are on the organising committee of the What's in Our Water Symposium in Canberra (www.wiow.com.au) where Jinny Baker will give a keynote address. *[Withheld under section 9(2)(a) of the OIA]* (Environment Southland) will coordinate a small by invitation only workshop on the last day of the symposium to develop the Australasian Directive Framework. We are working closely with colleagues *[Withheld under section 9(2)(a) of the OIA]* (CSIRO, Adelaide) to generate opportunities for Australasian scientists to work more closely together and maximise capability and expertise.

- A collaboration between the CIBR Social and Cultural and the University of Canterbury Māori Research teams has enabled a successful bid (\$60k) to Ngā Pae o Te Māramatanga that will scope a further bid to the Marsden Fund and/or National Science Challenge 1 and 11 on Kaitiakitanga and decolonizing methodologies for Māori succeeding as Māori in education. Five hui (1 @ ESR, 3 @ UC, 1 @ Rapaki) have been held this year refining the goals to look into educational outcomes for a sustainable urban pā wānanga which has an emphasis on kaitiakitanga and eco-literacy.

- Robyn Simcock and Bathurst Resources. First, Met BT mining environmental & planning *[Withheld under section 9(2)(a) of the OIA]* to discuss biosolids 2016/26 research application to the new owner of Solid Energy's Waikato coal mine assets, with the objective of helping assessment of business case to re-activate biosolids use for mine rehabilitation, with extension to native ecosystems (previously limited to pasture and radiata pine). The biosolids case needs to be

activated before the consent lapsed. Second, met *[Withheld under section 9(2)(a) of the OIA]* of Bathurst Resources; the latter two are responsible for rehabilitation at NZ's largest export coal mine (some 800 ha requiring rehabilitation), Stockton. Solid Energy are also NZ's largest user of municipal biosolids for rehabilitation. We reviewed biosolids trials and practice on site since 2012, and explored research to meet future needs.

- *[Withheld under section 9(2)(a) of the OIA]*, GHD approached Robyn Simcock in June 2017 by to supply desk top evaluation of plants and hydromulching method suitable to trial to revegetate Te Awamutu oxidation ponds as part of decommissioning. We developed ideas with Jacqui Horswell and Brett Robinson into July 2017 but the trial did not go ahead.

- Robyn Simcock approached by Brian Smith in September 2017, to develop a WasteMinz or Auckland Council application to trial separation and reuse of the organic component of road sweepings (which have elevated Zn) to reduce landfill costs and provide a useful organic soil amendment using an Inverell Composting System. Landfill currently costs \$150/Tonne.

- Query on use of biowastes – organic mulches for use in rain gardens and swales (Boffa Miskell/Stevensons – testing (Robyn Simcock).

- Rob Tinholt, Watercare. Jacqui Horswell brought Rob to meet researchers at Lake Waikare workshop. Followed up by Robyn and Brett in Auckland late 2017, and again by Robyn in early 2018 and June 2018.

- Australian CRC for High-performance soils – Jo Cavanagh attended a scoping workshop for programme 3 of the CRC, which includes a focus on developing new fertilisers derived from waste, primarily organic waste. The CRC has only just commenced and Jo and Robyn will maintain connection to identify opportunities for joint research.

- Three field sites with 150,000 native trees are planted or are being currently planted in Lake Waikare, Lake Wairarapa and Levin, and will be kept in perpetuity for further investigation of nutrient and pathogen movement in soil and in plant root systems, and effects of land-application of biowaste. CIBR team at ESR, University of Canterbury, LEI, with the help of all CIBR collaborators.

Successful students:

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Current students:

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Provide a maximum 200-word summary of Vision Matauranga activities, actions, collaborations in the project as a result of this SSIF investment.

The Social and cultural team research has dual aims:

- a. To provide Te Pā o Rākaihautū school’s Board of Trustees with feedback and analysis to help capture the dynamics of the Pā Wānanga model. This will enable the school to build a viable evaluation framework to help them identify the significant changes being seen in pononga (students) and their whānau, and to capture and measure these changes for the purpose of the schools self-assessment and development.
- b. With Te Pa’s guidance the data will extend insights on how a Pā Wānanga model of education and community engagement can support sustainable transformation and leadership in local environmental management. The insights from the Pā Wānanga model will help identify culturally informed theories of sustainable change, and will identify points of leverage and changes needed in the wider institutional system that will better support the new forms of sustainable environmental change and leadership being sought within the Pā Wānanga model.

List the external research or grant proposals submitted (include \$ value) and any research funding obtained that have been made possible as a result of SSIF investment in the project; include proposals awaiting funding decisions:

Funding body	Project title	Funding requested	Successful/declined/pending
[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]	Pending
Ngā Pae o te Māramatanga	Te Pā o Rākaihautū – Wetekia kia rere: Kaitiakitanga and decolonizing methodologies for Māori succeeding as Māori in education.	\$60,000	Successful
MBIE Endeavour Fund - Research Programmes	Emerging organic contaminants – managing risk for a safer NZ environment and economy	\$5,607,675	Successful (CAWX1708)
BRANZ + ESR SSIF	Greywater quality from residential and non-residential sources	\$84,000 ½ BRANZ ½ ESR SSIF	ESR successful BRANZ successful

Envirolink medium advice grant with Environment Southland	National strategy for managing emerging organic contaminants	\$ 20,000	Successful (1785-ESRC284)
<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	Unsuccessful
ESR SSIF Fund	Centre for Integrated Biowaste Research - continuation	\$1,413,085	Successful
<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	Unsuccessful
<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	Pending
<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	Pending
<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	Unsuccessful
ESR-Pioneer fund	30 years of effluent land-application	\$30,000	Successful
ESR-Pioneer fund	Enzyme discovery	\$120,000	Successful
Young Innovator Award - KiwiNet.	Wastewater enzymes for virus removal	<i>[Withheld under section 9(2)(a) of the OIA]</i>	Successful
<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	Not successful
<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	Pending

- Louis and Grant are exploring options with CSIRO colleagues to fund Australasian research projects on micro-pollutants. This involves the revision of the Black Mountain Declaration to develop the Australasian Framework to manage micro-pollutants and explore opportunities to attract funding from Australia and NZ (e.g. Australian Research Council/MBIE).

- Te Pā o Rākaihautū has applied to TPK for funding with advice from the CIBR social and cultural team to build a novel circular vermicomposting unit. A prototype has been designed and made and received support from Te Pā staff and Board. The unit, when operational will be a working biowaste composter, an educational tool and will display kaitiakitanga in practice.

List all external research revenue obtained seeded by this SSIF project:

Other contracts and non-contestable research funds

Funding type	Organisation name	Title	Amount
Contract	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]
Research co-fund	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]
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Contract	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]
Subcontract	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]	[Withheld under section 9(2)(b)(ii) of the OIA]
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	<i>9(2)(b)(ii) of the OIA]</i>		<i>9(2)(b)(ii) of the OIA]</i>
Contract	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>
Research Contract	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>
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Research co-fund	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>	<i>[Withheld under section 9(2)(b)(ii) of the OIA]</i>

List the 1) peer reviewed publications, 2) conference presentations (oral) 3) conference presentations (poster), 3) external presentations other than conference that were developed from this SSIF project.

1. Peer reviewed publications

Park, J.B.K., **Weaver, L.**, Davies-Colley, R.J., Stott, R., Williamson, W., Mackenzie, M., McGill, E., Lin, S., **Webber, J.**, Craggs, R.J. Comparative removal of faecal indicators and viral pathogens in wastewater treatment pond mesocosms. Submitted to Water Research June 2018.

Yao, R.T., **Langer, E.R.** and Leckie, A.B. Household preferences on the choice of handwashing soap: Are emerging contaminants considered? Manuscript under external review for submission to Science of the Total Environment.

Cavanagh JE, Trought K, Mitchell C, **Northcott G**, **Tremblay LA**. 2018. Assessment of endocrine disruption and oxidative potential of bisphenol-A, triclosan, nonylphenol, diethylhexyl phthalate, galaxolide, and carbamazepine, common contaminants of municipal biosolids. Toxicology In Vitro 48:342-349, DOI 10.1016/j.tiv.2018.02.003.

Welikala D, Hucker C, Hartland A, **Robinson BH**, Lehto NJ. 2018. Trace metal mobilization by organic soil amendments: insights gained from analyses of solid and solution phase complexation of cadmium, nickel and zinc. Chemosphere, 199: 684-693. DOI <https://doi.org/10.1016/j.chemosphere.2018.02.069>.

Robinson BH, Yalamanchali R, Reiser R, Dickinson NM (2018). Lithium as an emerging environmental contaminant: Mobility in the soil-plant system. *Chemosphere* 197, 1-6.

Zhong H, Kim YN, Smith C, **Robinson BH**, Dickinson NM (2017). Seabird guano and phosphorus fractionation in a rhizosphere with earthworms. *Applied Soil Ecology* 120, 197-205.

Gutierrez-Gines MJ, **Robinson BH**, Esperschuetz J, Madejon E, **Horswell J**, McLenaghan R (2017). Potential use of biosolids to reforest degraded areas with New Zealand native vegetation. *Journal of Environmental Quality* 46(4), 906-914.

Al Mamun S, Lehto NJ, Cavanagh J, McDowell R, Ak tar M, Benyas E, **Robinson BH** (2017). Effects of lime and organic amendments derived from varied source materials on cadmium uptake by potato. *Journal of Environmental Quality* 46(4), 836-844.

Paramashivam D, Dickinson NM, Clough TJ, **Horswell J**, **Robinson BH** (2017). Potential environmental benefits from blending biosolids with other organic amendments before application to land. *Journal of Environmental Quality* 46(3), 481-489.

Esperschuetz J, Balaine N, Clough T, Bulman S, Dickinson NM, **Horswell J**, **Robinson BH** (2017). The potential of *L. scoparium*, *K. robusta* and *P. radiata* to mitigate N-losses in silvopastoral systems. *Environmental Pollution* 225, 12-19.

Esperschuetz J, Anderson C, Bulman S, Katamian O, Horswell J, Dickinson NM, **Robinson BH** (2017). Response of *Leptospermum scoparium*, *Kunzea robusta* and *Pinus radiata* to contrasting biowastes. *Science of the Total Environment* 587-588, 258-265.

Kim YN, **Robinson BH**, **Horswell JH**, Boyer S, Dickinson NM (2017). Impacts of endemic Maoridrilus earthworms (Megascolecidae) in biosolids-amended soil. *Journal of Environmental Quality* 46, 177-184.

Wang, M., **Xue, J.**, **Horswell, J.**, Kimberley, M.O. and Huang, Z., 2017. Long-term biosolids application alters the composition of soil microbial groups and nutrient status in a pine plantation. *Biology and Fertility of Soils*, 53 (7), 799–809 (Rabbit Island work)

Scott PD, Coleman HM, Khan S, Lim R, McDonald JA, Mondon J, Neale PA, Prochazka E, **Tremblay LA**, Warne MSt.J, and Leusch FDL. 2018. Histopathology, vitellogenin and chemical body burden in mosquitofish (*Gambusia holbrooki*) sampled from six river sites receiving a gradient of stressors. *Science of the Total Environment* 616–617: 1638–1648.

Tremblay LA, Gadd JB, **Northcott GL**. 2018. Steroid estrogens and estrogenic activity are ubiquitous in dairy farm watersheds regardless of effluent management practices. *Agriculture, Ecosystems and Environment* 253: 48–54.

Charry MP, Keesing V, Costello M, Tremblay LA. 2018. Assessment of the ecotoxicity of urban estuarine sediment using benthic and pelagic copepod bioassays. *PeerJ* 6:e4936 <https://doi.org/10.7717/peerj.4936>.

Gooneratne, R., Saleeb, N., **Robinson, B.**, **Cavanagh, J.**, Ross, J., Lasching, A., Wellby, M., 2017.

Biochemical- and neuro-toxicity of silver nanoparticle and silver nitrate in soil to *Aporrectodea caliginosa* earthworms. *Toxicology Letters* 280, S203-S203

Leusch, F.D.L, Aneck-Hahn, N.H., **Cavanagh, J.E.**, Du Pasquier, D., Hamers, T., Hebert, A., Neale, P.A., Scheurer, M., Simmons, S.O., Schriks, M., 2018. Comparison of in vitro and in vivo bioassays to measure thyroid hormone disrupting activity in water extracts. *Chemosphere*, <https://doi.org/10.1016/j.chemosphere.2017.10.109>

2. Conference Presentations

Xue J, Bakker M. 2017. Effect of vermicomposted biosolids on seedling growth and nutrient uptake by exotic and native tree species. In: Proceedings of the 18th Plant Nutrition Colloquium in Copenhagen, Denmark on 21-24 August 2017.

Tremblay L, Northcott G, Sevicke-Jones G, Ataria J. 2017. Development of a National Strategy to manage emerging contaminants in New Zealand. In: SETAC Australasia Conference - The role of environmental toxicology and chemistry in a changing environment, Gold Coast, Australia, 4-6 September.

Tremblay L. 2017. Micro-contaminants- risk and solutions. In: CSIRO Land and Water, Adelaide, Australia, 8 September.

Gutierrez Gines MJ, Nikau T, Horswell J, Robinson B, Tupuhi G, Taylor M, Moana T, Hopkins A. 2017. Manuka-dominated ecosystems to improve water quality and provide economic and social return to the Lake Waikare catchment. In: Integrating multiple aquatic values. 5th biennial symposium.

Xue J, Bakker M. 2017. Effect of vermicomposted biosolids on seedling growth and nutrient uptake by exotic and native tree species. In: Proceedings of the 18th Plant Nutrition Colloquium in Copenhagen, Denmark on 21-24 August 2017.

Sitz C, Gutierrez-Gines MJ, Halford S, Alderton I, Ambrose V, Horswell J, Cass S, Lowe H, Saidy G, Robinson B. 2018. Native Vegetation For The Land-Application Of Treated Municipal Wastewater. In: New Zealand Land Treatment Collective Annual Conference on 7 – 9 March 2018 in Rotorua.

Clemens, H. 2018. Virus transport through soil from on-site wastewater treatment systems. In: New Zealand Land Treatment Collective Annual Conference on 7 – 9 March 2018 in Rotorua.

Xue, J. 2018. Benefits and risks of forest-based land application of biosolids. In: New Zealand Land Treatment Collective Annual Conference on 7 – 9 March 2018 in Rotorua.

Guyon A, Smith K, Charry M, **Champeau O, Tremblay L.** 2018. Chronic exposure to sub-lethal concentrations of benzophenone and diclofenac influence DNA methylation levels and reproductive success in a marine copepod. A poster presented at the Marine Evolution 2018 conference, Strömstad, Sweden, 15-17 May.

Guyon A, Smith KF, Charry M, **Champeau O, Tremblay LA.** 2018. «L'exposition chronique à des concentrations sous-létales de benzophénone et diclofénac influence la méthylation d'ADN et la reproduction d'un copépode marin. In : Colloque EcoBIM, Bordeaux, France, 22-25 May.

Jinny Baker presented a paper at the NZ Environmental Education Conference, 18-20 April 2018, Wellington - V.E. Baker, J. Ataria, J. Horswell, E.R. Langer, A. Leckie (2018) Schools and community engagement in science: Expanding a sustainable focus.

Jinny Baker - Abstract accepted for 4S Society for Social Studies of Science conference: Transdisciplinary theme, Sydney 2018. Re-configuring relationships and practice for sustainable change.

CIBR Newsletter articles:

Alan Leckie, Jamie Ataria, Lisa Langer, Joanna Goven, Jinny Baker (2018). Social and Cultural team update, CIBR newsletter Issue No. 17, February 2018. P3.

Leckie, A., Langer, L., Ataria, J., Goven, J., Baker, J., McCarthy, M. (2018). Social and Cultural team update, CIBR newsletter Issue No. 18, June 2018. P7-8.

3. External Presentations

Ambrose V, Alderton I, Villanueva S. Reuse of greywater and microbial testing. May 2018. Wanganui City College visit to ESR at Kenepuru Science Centre.

Gutierrez-Gines M, McIntyre C, Lense O, Mishra M, Seyedalikhani S, McLenaghan R, **Robinson B.** 2017. A lysimeter experiment and field trial to determine options for the beneficial reuse of wastewater from Duvauchelle and Akaroa, Banks Peninsula.

Report prepared for Christchurch City Council by Lincoln university -

<https://www.ccc.govt.nz/assets/Documents/Services/Wastewater/A-lysimeter-experiment-and-field-trial-to-determine-options-for-the-beneficial-reuse-of-wastewater-from-Duvauchelle-and-Akaroa-Banks-Peninsula-Brett-Robinson-Lincoln-University-June-2017.pdf>

Gutierrez Gines MJ, Robinson B, Prosser J, Esperschuetz J, Mishra M, **Horswell J.** 2017. Manuka planting for water quality. Water New Zealand, Nov Dec 2017, pp 63-66.

Alderton, I, Villianueva S. Stream Health and Contaminants. May 2018. Hataitai School visit at Kenepuru stream, Porirua.

Ambrose V, Alderton I, Villanueva S. Up the Pipe. May 2018. BioBlitz day at Hampton Hill School, Tawa.

Ambrose V, Alderton I. May 2018. Environmental Science. Careers evening at Tawa college.

Ambrose V, Alderton I, Villanueva S. Mānuka properties & possums. July 2018. Aotea College school visit to ESR at Kenepuru Science Centre.

Grant Northcott and Louis Tremblay. 2018. Sources and risks of PFAS chemicals in New Zealand. WasteMiNZ Live Webinar subscribers on 1/05/18.

Grant Northcott. 2018. A summary of the MBIE EOC research program and application of passive sampling devices to assess the concentration and risk of EOCs in aquatic ecosystems. Presentation to Tonkin and Taylor, Head Office Auckland, live streamed to nationwide offices.

Paul Evans, CEO of WMinZ, has asked Grant Northcott and Louis Tremblay to prepare a piece on PFAS chemicals for a forthcoming issue of the WMinZ magazine.

Xue, J; Wakelin, S A; Clinton, P W; Langer, E R. Understanding the risks of repeated applications of biosolids to a managed forest. A presentation to Nelson Tasman District Council, Nelson City Council, Nelson Regional Sewage Business Unit, and PF Olsen on 13 Jul 2017. Presentation of work to council members.

Xue, J; Kimberley, M; Gielen, G J H; Tremblay, L; Ross, C; Horswell, J. 2018. Ecological and environmental impacts of long-term biosolids application in a pine forest in New Zealand. A Presentation given at Zhejiang University in Hangzhou, China on 18 April 2018.

Xue, J; Kimberley, M; Gielen, G J H; Tremblay, L; Ross, C; Horswell, J. 2018. Ecological and environmental impacts of long-term biosolids application in a pine forest in New Zealand. A Presentation given at Shaoxing University in Shaoxing, China on 19 April 2018.

Tremblay L. Micro-contaminants- risk and solutions. 2017. CSIRO Land and Water, Adelaide, Australia, 8 September.

Xue, J; Wakelin, S A; Clinton, P W; **Langer, E R** (2017). Understanding the risks of repeated applications of biosolids to a managed forest. Presentation to Tasman District Council, Nelson Regional Sewage Business Unit and PF Olsen, Nelson, 13 July 2017.

For this project's SSIF investment, list the resulting:

1. **Commercial benefits**
2. **New products or services made possible (both actual and potential)**
3. **Estimated revenue, new clients and timeframe for achieving these**

[Withheld under section 9(2)(b)(ii) of the OIA]

Our goal for SSIF investments for FY2018 was to increase ESR capabilities. Please provide details on how your SSIF funded project contributed to the following areas:

1. Developing our capability in **Genomics and Informatics**
2. Developing our capability in **One Health**
3. Developing our capability in **Data to Wisdom**
4. Developing our capability in **Evidence-based Policing**

1. The CIBR team is continuing to use new and novel methods for identification of the microbial diversity present in soil and wastewater and their role in removal of contaminants – both biological and chemical. In this we are developing proteomic and transcriptomic approaches to identify function. The CIBR group has developed expertise in metabarcoding methodologies and validated the approach for oils and gas, resulting in four scientific publications.
2. We are investigating sustainable and viable approaches for wastewater treatment to remove pathogens and emerging organic contaminants. The objective of our research is to investigate safe and culturally acceptable solutions for the land application of biowaste, without affecting the public or the environmental health. We are also continuing research in low economic areas in the Pacific to optimise wastewater treatment.
3. The main strength of CIBR is the ability to investigate in a multidisciplinary and holistic way the treatment, management, and reuse options for NZ biowaste. This collaboration is generating a large set of complex qualitative and quantitative data, which will support scientifically informed decisions on treatment of contaminants in biowaste, and the potential beneficial reuse. The CIBR team is aware of the complexity in managing such complex data set, and future research will be focused in improving our capabilities in this field.
4. Not applicable to our research.

List the Opportunities arising that can further demonstrate value from this SSIF investment:

- Development of an mānukit decision support tool (DST) that calculates the costs and environmental benefits of having mānuka or kānuka based ecosystems when placed next to a waterbody. The DST available on - <http://www.kiwiscience.com/manukit/index.php> (Brett Robinson).
- The CIBR expertise platform has been key to generate multiple opportunities. In the area of micro-pollutants, the extended networks of the members have enable CIBR to secure a large MBIE programme on emerging organic contaminants. CIBR members gave the range of expertise required to tackle such a challenging environmental issue. We also have established or continued to build strong international linkages with colleagues in Australia, USA, EU and Asia that complement our expertise. CIBR enabled the group to address new emerging issues like the risk of microplastics.
- Social and cultural team – Interview questions to capture Maori worldviews and current

cultural practices of the Board and staff of Te Pā have been prepared. Questions will focus on place based learning, environmental sustainability and the future achievements of the pā wānanga. A project information sheet has also been compiled that introduces CIBR staff.

- Social and cultural team – Chemical cleaners at Te Pā have been documented in terms of usage, storage, waste residuals and efficacy. This inventory will provide data to write future testing protocols for current operational cleaners and alternative “green” cleaners. Organic wastes will be documented to provide data on amounts to enable both open air and vermicomposting practices to continue to meet school kaitiakitanga sustainability philosophy.

- Social and cultural team – Te Pā learning village has received the green light to create a purpose built pā wānanga in Otautahi starting in 2019-20. Concepts of environmental architecture, onsite energy production, total biowaste reuse, green cleaning products, sustainable education will be incorporated into the education curriculum and sustainable practices followed. CIBR Social & Cultural will contribute to sustainable options for reusing biowaste and reducing dependence on chemicals by researching Maori worldviews of kaitiakitanga through a community engagement process that will lead to transformational changes and place-based understanding.

- Social and cultural team – A previous successful CIBR case-study of community engagement in Kaikōura that focussed on the reuse of 1500 tonnes of aged biosolids was completed in 2014. The report which provided community based solutions for the reuse was tabled and accepted at a meeting of the Kaikōura District Council. Recommendations were deferred and hence not acted upon by the Council. Post November 2016 earthquake Council staff have indicated their wish to revisit the decisions of the community and proceed with the recommendations.

- Bathurst Resources have mines all over NZ, but specifically at Stockton have a contract to receive biosolids ex Christchurch for beneficial reuse; have been doing 10 to 30 ha of revegetation using biosolids p.a. and this will increase over the net 10 years to a total likely to be over 400 ha).

Executive summary – Three to four sentences giving an overview of your project and the results obtained. This will be used for the Board Report so keep in mind that not everyone is an expert in your field.

The Centre of Integrated Biowaste Research (CIBR) is a virtual research centre with multi-disciplinary expertise, led by ESR, and composed of Landcare Research, Scion, Cawthron Institute, University of Canterbury, Northcott Research Consultants, Kukupa Research, and Lowe Environmental Impact.

The goal of CIBR is to investigate about unique and holistic solutions for the sustainable management of biowastes (organic waste), by delivering value-added science that improves human well-being and protects the environment.

CIBR is a long term collaboration which has proved its value over the past ten years. In the past year (July 2017 - June 2018), CIBR has demonstrated its success by delivering internationally recognized research, attracting external funding, and increasing the overall capabilities of the group, which in return, will increase the reputation and opportunities of CIBR in the future. In this year, CIBR has:

- published **16 papers** in international peer reviewed scientific journals, given **10 presentations** in national and international conferences, and being invited to give 14 presentations, publications and outreach activities.
- published **three newsletters**.
- attracted **\$6,168,895** in research funds and contracts.

- had **13 successful students**: six master students and seven hD students.
- developed and optimized **seven new chemical and biological methods** for the analysis and/or remediation of microbial and chemical contaminants in waste, water, soil and plants, and the assessment of ecotoxicity of those contaminants.
- investigated **Māori worldviews of kaitiakitanga**/guardianship, and values of whānau (family), whakapapa (genealogy), and tikanga (tradition) in designing opportunities to reuse and minimise biowastes.
- been acknowledged its expertise by participating in the revision of the **national guidelines for the land application of organic waste**.

Project report – *Make this a stand-alone final report suitable to include in a consolidated report to the ESR Board. Include brief background, what you did, what you found, conclusions (max 2-3 pages). This is the opportunity to tell a success story that ESR can use in Impact Case Studies, Briefing and other communications.*

The CIBR group has continued to deliver valuable science that informs environmental and public health decision making in New Zealand. The group has continued existing successful research topics, particularly developing methods for analysing emerging contaminants, and their ecotoxicity, investigating beneficial reuse of biosolids, greywater, the long-term Rabbit Island Field trial, mānuka and native plants for reducing the impacts of biowaste land application, and a robust social and cultural program. These projects span multiple research streams within CIBR (Soil Science, Microbiology, Ecotoxicology, Social and Cultural). Several research projects are emerging that have strong future potential with significant collaborative opportunities and high likelihood of bringing in more revenue for the group.

Mānuka and native species

A field trial at Duvauchelle, Banks Peninsula has demonstrated that some NZ-native plants respond positively to the application of Treated Municipal Wastewater (TMW) and can provide both economic and environmental benefits of applying TMW to land instead of into surface waters. Land application of TMW onto NZ native plants is now being considered nationwide and the Banks Peninsula field trial has resulted in a second CIBR field trial at “The Pot”, Levin. The beneficial role of NZ native plants extends beyond TMW and may reduce contaminant fluxes from agricultural systems. This is now being tested in a CIBR trial near Lake Waikare, in the Waikato, and in Lake Wairarapa. A recent collaboration between CIBR and the CAREX group has resulted in an MBIE bid (currently under consideration) where the role of NZ native plants will be assessed at 15 sites around New Zealand.

The CIBR team has also performed a field experiment in Taupo to investigate the potential of mānuka root systems to reduce pathogens and nitrate movement in the soil from cowpats. This experiment enhanced the collaboration with other scientists in ESR – *[Withheld under section 9(2)(a) of the OIA]*, for using genomic analysis in the study of movement of *E. coli* in the soil.

A current greenhouse experiment is investigating if other native plants – rata and horopito – also present potential for enhancing pathogen die-off in soil and reducing nitrate leaching from farming activities and biowaste treated soils.

Rabbit Island Long-term field trial

The biosolids research trial at Rabbit Island is unique both nationally and internationally due to the comprehensive and long-term assessment. Built on our 20 year-long data and

previous findings, the proposed research for 2017-20 will further quantify the benefits-risks at the ecosystem level and on a crop rotation basis (typically about 30 years) to ensure that 'biowastes to land reuse' can be implemented in an informed and sustainable way to maximise the beneficial reuse and sustainability of biosolids land application in forests. This year our research has been focussed on the residual effects of biosolids-derived nutrients and contaminants on tree health, nutrition and growth, and the soil and groundwater quality. This information is required to develop decision support tools for assisting Tasman District Council to monitor and manage land application of biosolids in a way that minimises the risks and maximise the benefits. Our research will facilitate the implementation of sustainable biosolids management practices for enhancing soil fertility and functions (e.g. carbon sequestration), forest productivity and ecosystem service, reducing the impact of biosolids application on environmental quality (soil, surface water and groundwater), and maintaining the ecological, recreational and cultural values of Rabbit Island.

Ecotoxicology

The recently funded 5-year MBIE Endeavour Emerging Organic Contaminants (EOCS) project is a great example of the strength of the multi-disciplinary CIBR team to address new issues. Our expertise in ecotoxicology, environmental chemistry, microbiology, social science and mātauranga Māori was key to develop the successful proposal. The CIBR member's track records and extended network of contacts with regional councils, industry, central government agencies and international experts enabled us to develop a sound strategy required to successfully secure MBIE funding. We continue to work with our existing Ngāi Tahu partners in Southland, one of the study sites and built a new partnership with Te Kawerau-ā-Maki in Auckland. That provides us with sites that cover the main land use activities. The structure of the project includes the successful development of a National Strategy to manage EOCs funded by an Envirolink Medium Advice grant and a National Advisory Panel, with members from Regional Councils, MfE, MPI, EPA, iwi and industry. This sound structure also helped us with other initiatives to address the topical issue of microplastics in the environment. That assisted the completion of an ESR-led MBIE Endeavour proposal to characterise and manage the risk of microplastics in New Zealand.

Social & Cultural Research

Waste production at Te Pā has been documented and achievable outcomes of reuse, recycling, and recovery have been discussed with school staff. Examples of composting (open air and vermicomposting) operate within the school and a novel approach to vermicomposting has been outlined to staff with very favourable responses. Staff have been at the forefront of the development of green cleaning products for the whole learning village to reduce the use of chemical cleaners and to replace them with lower polluting residuals whilst retaining efficacy.

A previous successful CIBR case-study of community engagement in Kaikoura that focussed on the reuse of 1500 tonnes of aged biosolids was completed. The report was tabled and accepted at a meeting of the Kaikoura District Council. The report which provided community based solutions for the reuse was to be acted upon by the council but this never occurred. Recent employment changes in the council owing to the effects of the November 2015 earthquake have seen the council wishing to revisit the decisions of the community and proceed with their wishes.

Reuse of Greywater and Solid biowaste

The CIBR team at LEI and ESR is undertaking a project to investigate collaborative and

sustainable solutions for the biosolids generated by small communities of the lower North Island. The biggest challenge of this work resides in the engagement with multiple councils, community and iwi groups, and stakeholders. The project is advancing in the next weeks a first trial to test the potential use of biowaste for growing native plants in nurseries will be set up.

ESR and BRANZ has collaborated in a project to study microbial water quality of greywater in residential and commercial buildings, and potential reuse options. Results are highly variable, so not strong conclusions can be arisen for comparing the greywater quality in residential versus commercial buildings.

Virus and organic contaminants removal in wastewater

We are focused on optimising virus removal in wastewater systems through a sustainable and low cost approach. Within this remit we are enhancing the understanding of the complex mechanisms existing in wastewater that have the potential for virus and organic contaminants removal. Our work has investigated virus removal efficiencies of wastewater, particularly the effect of controlled pH and dissolved oxygen (DO) on virus removal, in the presence and absence of sunlight. By maintaining waste stabilization ponds (WSP) with high pH and DO levels efficient removal of virus can be achieved using these sustainable, economic treatment methods.

We are currently investigating the efficacy of high rate algal ponds, HRAP (collaboration with NIWA, Rupert Craggs and Jason Park) for pathogen removal. While the research is ongoing at present we have found, when combining summer and winter data so far collected, that indicator *E. coli* showed at least 2 Log removal through HRAP but most removal occurred in the maturation ponds following the HRAP. Viral indicator, f-RNA bacteriophage showed over 2 Log removal but again most occurred in the maturation ponds. When looking at the pathogens themselves there was little removal by either HRAP or maturation ponds with < 1 Log removal occurring. The results generated so far need to be investigated further, including variation between summer and winter and loading rate differences. Overall, however, it does again point to the risk of relying on traditional bacterial (or bacteriophage) for predicting pathogen removal efficiencies in wastewater.

Another highlight from this year has been the completion of two masters' theses. The first investigated the use of coral sands as a low cost option for treatment of septic tank effluent in the Pacific. The other master's thesis successfully submitted this year was an investigation of the virus transport and removal potential from septic tanks through disposal fields in New Zealand. Finally, [Withheld under section 9(2)(a) of the OIA] is in the final stages of her PhD thesis which has discovered enzymes capable of virus reduction in wastewater. [Withheld under section 9(2)(b)(ii) of the OIA].