CORE FUND PROJECT - FINAL REPORT FOR 2015/16

Please complete and email to ESR.research@esr.cri.nz by Friday 15th July 2016.
ESR is fully accountable for Core Funding. Information in this report will be used to demonstrate what ESR Core Funding has been invested in, and to quantify the benefit from the investment in e.g. the Board Report. It will also inform future investment of Core Funding.

Project title:

Centre for Integrated Biowaste Research (CIBR)

Project leader(s):

Dr Jacqui Horswell

Duration:

Until 2017. Report covers period of 01st July 2015 – 30th June 2016.

Budget (amount allocated per year and total spent)

Allocated: $1,254,086	**Spent: $1,754,646**

List the capabilities developed and by whom (include students)

CIBR core capabilities

The CIBR is a virtual centre, combining the expertise of 9 New Zealand research institutes, universities and research partners. Led by ESR, it brings together a multi-disciplinary team of scientists and researchers from ESR, Scion, Cawthron Institute, Landcare Research, NIWA, Lincoln University, Lowe Environmental Impact, Northcott Research Consultants Ltd., and Kukupa Research.

Four teams, one aim: The CIBR combines researchers with over 20 years' experience in Soil Science, Micro and Molecular biology, Ecotoxicology, and Social and Cultural Research.

The CIBR has core capabilities and innovation to support biowaste beneficial reuse/resource recovery; this includes:

- The development of transdisciplinary solutions (technical/social/cultural/economic) for beneficial reuse of biowaste .
- Providing NZ's leading capabilities in utilising field trials, laboratory data and cutting edge experimental science to assess:
    - environmental fate and effects of contaminants in different waste streams;
    - waste processing technologies for reducing harm (e.g. reduction in environmental impacts) and economic potential;
    - technologies and systems to mitigate the environmental and public health impacts of recycling waste to land;
    - risks of new and emerging contaminants (biophysical/social/cultural science).

Capability development - students and postdocs

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

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

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

Grant proposals submitted

Funding body	Project title	Funding requested	Successful/declined/pending
Royal Society of NZ Catalyst: Seeding General grant	Managing the risk of emerging organic contaminants in New Zealand through an international science partnership	$52,230	Successful
[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
[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
[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]*	declined
[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]*	declined
[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]*	Declined

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

Co-funding and subcontracting

Funding type	Organisation name	Amount
Industry external	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Industry External	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
External	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
External	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
External	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Industry External	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Internal Investment Fund (IIF)	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Industry External	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co funding	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Sub-contract	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Sub-contract	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*

Co-funding	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Sub-contract	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*

Show commercial benefits from the investment, list any new products or services made possible by CF, both actual and potential (*be realistic, not far fetched*) and estimate revenue, clients and timeframe for achieving this:

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

Explain how your research contributes to ESR's IMPACT/s? (don't just list the impacts)

The CIBR programme contributes specifically to the **Water and Environment Outcome 4** of the outcomes and impacts in the Statement of Corporate Intent (2015-2020). "Improve the safety of freshwater and groundwater resources for human use and the safer use of biowastes"

Our work contributes to the ESR impacts:

New Zealanders have assurance that drinking water is safe
Land use and water resources are inextricably linked. This is illustrated in many Regional plans where certain activities such as on-site wastewater treatment is restricted in drinking water catchments. Our research into greywater and on-site wastewater is improving the quality of treated effluent by reducing microbial and chemical contaminants that could potentially end-up in drinking water catchments.

Improvements in rivers, streams and groundwater quality are informed by scientific analysis
Water pollution in NZ is an increasing concern for regulatory bodies and environmentalists. Nutrient loss from agricultural areas and wastewater treatment plant effluent are major sources of pollution for freshwater systems. CIBR research is contributing to the improvement of water quality by:

- *increasing our knowledge of viruses present in wastewater and methods to enhance their removal;*
- *using bioactive/antimicrobial compounds produced by myrtaceaeous plants, especially Manuka (Leptospermum scoparium), to inhibit the conversion of ammonia into nitrate and nitrous oxide, and enhance the die-off of pathogenic organisms in the wastes that pass through their root systems.*
- *determining which emerging organic contaminants are of the most concern in terms of environmental impact and investigating ways to reduce them (e.g., behaviour change) or which waste processing technologies remove them.*

Safer use of biowastes
CIBR aims to facilitate the safer use of biowastes by providing holistic fully integrated solutions that take due cognisance of the environmental, social, cultural and economic aspects of re-use as well as the regulatory environment in NZ (The Resource Management Act, RMA). We have characterised chemical and microbial levels and collected fate, transport and effects data in a variety of organic wastes. We can combine this data with our research on waste processing technologies, our community and Iwi engagement expertise and our site management to ensure that the impacts of biowaste re-use is "less than minimal" as required under the RMA. We can provide mitigation tools to reduce environmental contamination risks associated with agricultural wastes such as

dairy shed effluent and to manage pollution run-off from farms ultimately leading to the safer use of biowastes.

CIBR continues to provide the science that underpins the development of national guidelines and is jointly leading a review of the NZ Biosolids Guidelines. Programme leader Jacqui Horswell is a member of the steering group supported by CIBR team members (Tremblay, Gielen, Northcott, Horswell, Robinson and Esperschuetz). Jacqui Horswell also represents the Australia/NZ Biosolids partnership on the new international ISO standard for biosolids application to land. CIBR provides advice for resource consent applications and district planning, with respect to land application of wastes and works in partnership with environmental engineers to provide the science expertise where required.

Environmental threats to human health from chemicals, microbes and physical contaminant are mitigated.

CIBR has extensive expertise in the detection of biological and chemical contaminants in waste – this is an incredibly difficult medium to work in and often traditional techniques are not applicable to this complex waste stream. Our extensive emerging organic chemical analysis capability coupled with our ecotoxicology platform allows us to characterise the range of contaminants commonly detected in biowastes including mixtures of chemicals. Our experience in isolating microbiological contaminants allows us to reliably detect and enumerate bacteria and viruses present in wastewater and solid wastes. Using these techniques we can improve knowledge on the effectiveness of waste treatment and use this enhanced knowledge to improve the effectiveness of treatment of waste for the future. We are developing methods to detect and identify pharmaceuticals, and enzymes present in wastewater, which will have a direct use for response to contamination in the environment in the future.

List anything else that can demonstrate value from this CF investment:

Science Quality:

Indicator	Number
Accepted Peer-reviewed journal publications	18
Completed masters or doctorate theses	6
Conference presentations	23
Book Chapters	1
Commissioned or CIBR Reports:	7
Workshop/hui presentations	3
Awards for science achievement	10
Travel grants awarded for conference attendance	$9,500
Newsletters	2
Science education/outreach	20

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.*

CIBR provides unique and holistic solutions for the sustainable management of biowastes (organic waste). We deliver value-added science that improves human well-being and protects the environment.

CIBR is a virtual research centre with multi-disciplinary expertise within 9 research organisations. Integrating our research skills enables us to offer a full range of biowaste solutions backed up by cutting edge science and innovation. Not only do we solve today's problems, but we are working to solve the tomorrow's issues today.

New Zealand produces nearly 700,000 tonnes of solid biowaste each year, of which 62% goes to landfill. Landfilling is not a viable long-term management option and is becoming more difficult due to increased levies, lack of space and transportation distance, and a general community expectation of a need to develop sustainable use options. In addition, landfilling creates a significant regional economic and environmental issue and runs contrary to central government policy.

Unlike many other waste streams, there are good prospects for alternative, economical and beneficial end-use options for organic wastes, and in an agricultural context, re-use of biowaste may offset the cost of inorganic fertilizers, while improving soil quality.

CIBR has been working on finding sustainable solutions for the management of

biowastes, centred on land application. We have developed systems for mitigating and minimising environmental impacts; and developed frameworks to support and aid the community and iwi engagement often required.

CIBR also provides the science behind the development of policy and guidelines for biowastes re-use in New Zealand and much of our research is focused on future proofing by gaining an understand of the new challenges the industry may face, for example the fate and effects of new and emerging contaminants. We have also broadened our historical focus on biosolids to encompass other waste streams including greywater, municipal effluent, dairy shed effluent, green waste and construction plasterboard.

We work jointly with the wastewater industry and have many examples of partnership-co-funded projects which will make our core-funded programme self-sustaining in the future.

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 (**2-3 pages**). This is the opportunity to tell a success story that ESR can use in 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 beneficial reuse of biosolids, greywater, the long-term Rabbit Island Field trial 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 likely hood of bringing in more revenue for the group. This year we have increased our mining bioremediation research at Rotowaro, and a clear picture of significant, long term potential for Mānuka research is developing. A summary of key projects and developments within the CIBR group for 2015-2016 is presented below.

Ecotoxicological research has continued to provide a greater understanding of the potential negative environmental effects associated with the application of biosolids to land. This year the focus has been to identify contaminants of concern using an effect-directed approach. In this approach, a solvent extract from a sample, which contains a complex mix of chemicals, undergoes an initial fractionation to broadly separate different chemical groups. Biological/toxicological testing is then undertaken on the different fractions, enabling chemical analysis to be targeted to fractions that elicit

biological responses and thus identifying compounds that are likely to be eliciting the responses observed. This builds on previous research using *in vitro* cellular and acellular assays to assess toxicological effects associated with individual chemicals associated with biosolids, and organic solvent extracts, containing a mixture of contaminants, of biosolids collected from 10 different waste-water treatments plants across New Zealand. The outcome of this research will be a Toxicity Identification Evaluation (TIE) that will determine the actual causes/chemicals responsible for toxicity. This information enables us to target the removal or remediation of chemicals of concern.

Mine rehabilitation. Collaborative work between Solid Energy and CIBR researchers at Rotowaro - Waipuna coal mine will contribute data to underpin an updated, accurate value case for spreading biowaste on mined (or degraded) land by providing data on the medium-term benefits of biowaste for pasture, pine and soil quality.

Enhancing ecosystem services in cities. In urban areas, trials are helping identify the potential uses/values of organic biowastes such as arborist (tree-pruning) mulch, composted organic materials (green waste / food waste) to enhance performance of urban green areas. These urban biowastes are used as amendments to earth-worked natural soils. This has potential to 'close the loop', i.e. from kerbside collection to placement (after composting) to enhance plant and soil function. Specific biowastes are being tested as components of specialist media/mulches in devices treating stormwater (bioretention devices).

Greywater. This has continued to be research of interest to councils and the wastewater industry. Trials conducted to investigate pathogen regrowth in various mulches that could be used to cover greywater sub-surface irrigated areas were valuable. This data was disseminated to councils and end-users via conference and council presentations. Greywater research is gaining traction with industry, and our expertise in this area has led to increased revenue by participation in a BRANZ funded research project investigating greywater and rainwater use in non-residential buildings.

Pathogen removal in wastewater. Our research has focused this year on the adsorption and settlement of viruses in waste stabilisation ponds as there is a lack of knowledge on the transport of viruses in and through WSPs. The research was well received at both national and international conferences and we were runners up in the best poster presentation at a leading industry conference in NZ (WaterNZ). The work on enzyme activity in wastewater and its efficacy on virus inactivation is a developing area of expertise for the programme (Amanda Inglis PhD) we have found the presence of enzyme families present in wastewater and are testing their efficacy on a range of viruses. We have established a lab scale WSP series to model removal in the controlled lab environment. Our sub-contractors NIWA have been working on the data we are generating to provide a model of virus removal. We have leveraged off the research to expand our capabilities in the Pacific region, continuing our overarching aim at low cost sustainable waste solutions. In this project Bronwyn Humphries has investigated the attenuation (and thus removal) capability of coral sands for faecal indicator and viral pathogens. Our research is gaining more interest from both regional and local councils

and the wastewater industry. We have an on-going project assisting Waimakariri District Council on their WSP and ocean outfall efficiencies and are continuing to work with Parklink on their enzyme desludging product.

Mānuka. The CIBR team have been exploring the benefits of native plants. At Lincoln University the team have been looking at the potential of biosolids being used to establish native plants in disturbed or degraded environments - thereby resulting in significant revenue. ESR and Lincoln University have been combining their microbiology and chemistry expertise to investigate processes in the root zones of native plants. They have found in laboratory, lysimeters and small field trials that bioactive/antimicrobial compounds produced by myrtaceaeous plants, especially Manuka (Leptospermum scoparium), may inhibit the conversion of ammonia into nitrate and nitrous oxide, and also enhance the die-off of pathogenic organisms in the wastes that pass through their root systems. This exciting discovery has the potential to improve water quality, incorporating manuka into bio-diverse riparian planting schemes has the potential to help both filter and inactivate pollutants from intensive agriculture. Our research is now at a stage where systems can be installed in an operational environment such as in tributaries of the Waikato River. Measuring the performance of these areas will enable us to optimise the system. *[Withheld under section 9(2)(b)(ii) of the OIA]*

Rabbit Island Long-term field trial. Our long-term field trial has been investigating the sustainability of biosolids land application in plantation forests through assessing the environmental, ecological and economic impacts. Biosolids from Nelson have been applied to a radiata pine forest on Rabbit Island since 1996. Research has focussed on the effects on tree nutrition and growth, wood quality, and the soil and ecosystem environmental quality. This trial is unique both nationally and internationally and is providing important information on the sustainability of land treatment of biowastes and its economic outcomes, resulting in improved soil fertility and stand productivity (by 25% in 2016). Long-term biosolids land application has transformed the forest site from relatively low to moderately high productivity without causing significant adverse effect on the environment. The research findings from this long-term forest field trial have supported and informed management practices for sustainable land application of biosolids for the Nelson community, and provided direct evidence for Tasman District Council to make informed decisions during the resource consent application process. It also provides indicative research findings for land application of biosolids throughout New Zealand.

Community Engagement Framework The CIBR Social and Cultural team have worked with an industry collaborator, Lowe Environmental Impact (LEI) to develop a Community Engagement Framework to assist waste producers and regulators (regional, district and city councils) to more effectively undertake community consultation with respect to the discharge of biowastes to land in New Zealand. This framework is the summation of the last 5 years of research undertaken with a number of communities around New Zealand. Working with an industry collaborator has enabled us to ensure a “pathway to uptake” of the research and ensures the framework is well targeted to the end-users. The

framework provides a pathway to meet the requirements of the Resource Management Act, Local Government Act and the Treaty of Waitangi. The framework utilises the quadruple bottom line (QBL) approach to decision-making where environmental, social, cultural and economic factors are thoroughly considered and outlines how two-way communication can be facilitated by interactive stakeholder workshops, hui or public meetings. Importantly the process helps build shared understanding between different stakeholders, strengthens council and community relationships, builds greater trust and confidence in the decision-making process and is showing improved buy-in by communities. The CIBR Social and Cultural team also launched a report on tapu and noa (tapu is often understood to mean forbidden or restricted and noa ordinary or free from restriction) this year. It is also a summation of many years of work with communities around New Zealand and is intended to guide non-Māori towards knowing how to ask the right questions in their conversations and engagement with local hapū and Iwi regarding biowaste and biosolids issues. The report is designed to support local government staff and engineers in better understanding and incorporating Māori worldviews into biowaste management negotiations and solutions.

A greater awareness and deeper understanding of cultural values and frameworks will help support more respectful and meaningful conversations about how to best design and manage local biowaste systems, including biosolids and wastewater discharge impacts. Therefore these frameworks will ably support long-term solutions and co-management approaches for enhanced environmental and biowaste management. Importantly, the framework and Tapu to Noa report are examples of how the social/cultural and biophysical research are fully integrated to provide solutions to sustainable biowaste management that manage the practical as well community values and concerns.

Science education/outreach CIBR has continued to play a leading role in ESR's outreach programme by hosting multiple school visits, providing professional development in the science space for teachers and supporting career and science fairs.

In conclusion, CIBR actively works in the multi-disciplinary space with multiple research partners including Universities and the public sector as recommended by key Government officials and policy *[Withheld under section 9(2)(a) of the OIA]* A recent external review of ESR's Food, Water and Biowaste activities strongly supported the collaborative approach developed by CIBR and the research and the approach that the programme undertakes were flagged as having potential for revenue growth. Our challenge this year is to focus on key projects and turn them into commercial revenue so that the CIBR can become less reliant on Core Funding and self-sustaining in the future.

Please attach a copy of your final full year financial report with commentary.

Commentary on budget:
External expenses were on target with a slight overspend of $8,680. This was due to local travel being higher than expected due to the set-up of a vermicomposting field trial in Otaki and associated expenses.

Total labour costs were significantly over budget. This was due to underestimation of the number of billable hours in a year by the previous group manager who did last years budget.

Profit and Loss	YTD Actual	YTD Plan	Variance	Total Plan	% Used	Commitmts
Commercial Domestic	14,208-		14,208			
CRI Capability Fund	1,643,569-	1,626,667-	16,902	1,626,667-	101	
Other Govt Depts						
External Income	1,657,777-	1,626,667-	31,110	1,626,667-	102	
Grants/Scholarships						
Contract Personnel						
Training/Conferences	1,217	5,000	3,783	5,000	24	
Other Staff Expenses	1,046	2,000	954	2,000	52	
Material/Consumables	23,641	22,086	1,555-	22,086	107	12
Equipmnt Maintenance	1,673		1,673-			
Equipment Hire	120		120-			
Sub Contracted Work	1,055,674	1,068,012	12,338	1,068,012	99	1,308,734
Freight & Courier	904	500	404-	500	181	
Postage		500	500	500		
Tolls/Local/Fax	35		35-			
Maintenance IT	20		20-			
Network Charges	159		159-			
Software						
Rental Other Equip						
Vehicle Expenses	2,273		2,273-			
Maintenance Plant	634		634-			
Building Services	130		130-			
Travel Local	10,742	8,000	2,742-	8,000	134	
Travel Overseas	3,446	3,000	446-	3,000	115	
Travel Allowances	820	1,000	180	1,000	82	
Advertising & PR	583	1,500	917	1,500	39	
Donations/Sponsorshi						
Entertainment	43		43-			
Entertainment Non De	43		43-			
Information Supply	39		39-			

General Expenses	456	3,500	3,044	3,500	13	
Printing/Stationery	1,846	1,000	846-	1,000	185	
Memberships etc	1,874		1,874-			
Legal Fees						
Consulting Fees						
External Expense	1,107,418	1,116,098	8,680	1,116,098	99	1,308,746
Labour Bands	173,055	137,988	35,067-	137,988	125	
Corp O/head Alloc	249,893		249,893-			
Program O/head Alloc	196,160		196,160-			
Alloc RC O/h Prog	18,286		18,286-			
Internal Cost	9,834		9,834-			
Internal Expenses	647,227	137,988	509,240-	137,988	469	
Expenditure	1,754,646	1,254,086	500,560-	1,254,086	140	1,308,746
Margin	**96,869**	**372,581-**	**469,450-**	**372,581-**	**26-**	**1,308,746**

LABAST LABAST	138		138-	
SCNLDR SCNLDR	498	443	55-	443
SCNTST SCNTST	309	323	15	323
SNRSCN SNRSCN	823	816	7-	816
SNRTEC SNRTEC	33		33-	
TECHN TECHN	2,606	1,736	870-	1,736
*** Hours**	**4,405**	**3,318**	**1,087-**	**3,318**

% Margin	6-	23	29-	23
%Mgn ex Subcontracts	159	258	99-	258
% Consumables to Rev	2	1	0-	1
Band Multiplier	0	4	3-	4
Annual Rev per FTE	632	824	191-	824