Ministry for the Environment
Manatū Mō Te Taiao

PO Box 10362, Wellington 6143
Website: www.mfe.govt.nz
Freephone: 0800 499 700

19-D-02522

s 9(2)(a)

NZME
s 9(2)(a) @nzme.co.nz

Dear s 9(2)(a)

Thank you for your email of 4 November 2019 requesting the following information. Due to the nature of the information and documents requested we have treated this as a request under the Official Information Act 1982 (the Act):

> *I'm taking a bit of a look at a council/private venture which appears to have flopped here in Rotorua. The project (Waste 2 Gold, also known as Terax) received Waste Minimisation Funding. I found these two grants: Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation, TERAX Waste Deconstruction Technology. Can the Ministry provide any information about these grants. I was thinking maybe the proposal the funding was given to, how much money was actually given, any reports the applicants had to complete and give back to the Ministry in exchange for funding, and anything else which might relate to the applications from 2010 and 2012.*

Additionally (email received 25 November 2019):

> *- What date the Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation grant process was completed*
> *- At what stage the Terax Waste Deconstruction Technology grant is at*
> *- What dates the applications were made and approved*
> *- What requirements had to be met after the grants were made and what requirements were / weren't adhered to*

The Ministry for the Environment has identified 20 documents in scope of your request, as listed in the attached table. Some information within these documents has been withheld under the following sections of the Act:

9(2)a	to protect the privacy of natural persons, including those deceased
9(2)(b)(ii)	to protect information where the making available of the information would likely unreasonably to prejudice the commercial position of the person who supplied or who is the subject of the information
18(e)	the document alleged to contain the information requested does not exist or, despite reasonable efforts to locate it, cannot be found.

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In terms of section 9(1) of the Act, I am satisfied that, in the circumstances, the withholding of this information is not outweighed by other considerations that render it desirable to make the information available in the public interest.

The Ministry for the Environment approved two funding grants from the Waste Minimisation Fund for the development of Rotorua waste treatment technologies in 2010 and 2012. A hold was put on funding to the second project, and the majority of the grant was not paid.

Waste 2 Gold Deconstruction Technologies for Organic Waste Utilisation project, 2010. The applicant was New Zealand Forest Research Institute (Scion). The WMF funding was for the purpose of developing a pilot plant in Rotorua to test the viability of technology for turning sewage sludge into useable end-products (the TERAX process). This pilot project was completed in 2012 having met all the funding objectives and milestone deliverables.

TERAX Waste Deconstruction Technology project, 2012. The application was Rotorua District Council. The WMF funding was for the purpose of developing a full-scale TERAX hydrothermal deconstruction processing plant in Rotorua. The Ministry paid the first five milestones of this project which were for the design phase. The project was put on hold before the construction phase, first by the Council in 2015 and then by the Ministry. The Deed of Funding expired in December 2015 and a closure letter was sent to the Council on 7 March 2016.

In response to your specific questions about the two Terax projects:

Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation project

- The total amount of WMF funding paid for this project is $999,999.79 (ex GST).
- The application for the Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation was received on 2 March 2010.
- WMF funding for this project was approved in May 2010.
- A Deed of Funding between Scion and the Ministry for the Environment was signed on 24 December 2010.
- The grant process for this project was completed in June 2012.
- The funding requirements are the project objectives and milestone deliverables. All objectives and milestone deliverables were achieved for this project.

TERAX Waste Deconstruction Technology project

- The total amount of WMF funding paid to the TERAX Waste Deconstruction Technology project is $952,000.00 (ex GST).
- The application for the TERAX Waste Deconstruction Technology project was received on 20 June 2012.
- WMF funding for this project was approved in September 2012.
- A Deed of Funding between Rotorua District Council and the Ministry for the Environment was signed on 21 December 2012.
- The Deed of Funding expired in December 2015 and a closure letter for the TERAX Waste Deconstruction Technology project was sent to the Council on 7 March 2016. The project status is "partially completed".
- The funding requirements are the project objectives and milestone deliverables. The project met the milestone deliverables for Year 1 – Milestones 1, 2, 3, 4 & 5. The project did not meet any of the project objectives.

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You have the right to seek an investigation and review by the Office of the Ombudsman of my decision to withhold information relating to this request, in accordance with section 28(3) of the Act. The relevant details can be found on their website at: www.ombudsman.parliament.nz.

Please note that due to the public interest in our work the Ministry for the Environment publishes responses to requests for official information on our OIA responses page shortly after the response has been sent.

If you have any queries about this, please feel free to contact our Executive Relations team at ministerials@mfe.govt.nz

Yours sincerely



Shauh Lewis
Director, Mana Honohono, Investments and Partnerships

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List of documents

Document no.	Document date	Content	Decisions	OIA sections applied
1	2 March 2010	WMF 00000137 Application Form – Scion 2010	Released in part	9(2)(a)
2	2 March 2010	WMF 00000137 – Supplementary Information	Released in part	9(2)(a) 9(2)(b)(ii)
3	9 May 2011	WMF 00000137 Year 1 - Milestone 2 Report	Released in part	9(2)(a) 9(2)(b)(ii)
4	14 July 2011	WMF 00000137 Year 1 - Milestone 3 Report	Released in part	9(2)(a) 9(2)(b)(ii)
5	21 October 2011	WMF 00000137 Year 2 - Milestone 1 Report	Released in part	9(2)(a) 9(2)(b)(ii)
6	21 January 2012	WMF 00000137 Year 2 - Milestone 2 Report	Released in part	9(2)(a) 9(2)(b)(ii)
7	20 April 2012	WMF 00000137 Year 2 - Milestone 3 Report	Released in part	9(2)(a) 9(2)(b)(ii)
8	1 July 2012	WMF 00000137 Year 2 - Milestone 4 Report	Released in part	9(2)(a) 9(2)(b)(ii)
9	01 July 2012	WMF 00000137 Final Technical Report – Year 2 - Milestone 4	Released in Full	
10	20 June 2012	WMF 00000559 Application For – Rotorua District Council 2012	Released in part	9(2)(a)
11	20 June 2012	WMF 00000559 Business Plan	Released in part	9(2)(a)
12	20 June 2012	WMF 00000559 Feasibility Study	Released in part	9(2)(a)
13	20 June 2012	WMF 00000559 Background Information	Released in part	9(2)(a)
14	20 June 2012	WMF 00000559 Project Capability Statement	Released in part	9(2)(a)

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Document no.	Document date	Content	Decisions	OIA sections applied
15	19 June 2012	WMF 00000559 Letter of Support	Released in part	9(2)(a)
16	1 March 2013	WMF 00000559 Milestone 1 Report	Released in part	9(2)(a) 9(2)(b)(ii)
17	20 June 2013	WMF 00000559 Milestone 2 Report	Released in part	9(2)(a) 9(2)(b)(ii)
18	30 September 2013	WMF 00000559 Milestone 3 Report	Released in part	9(2)(a) 9(2)(b)(ii)
19	20 December 2013	WMF 00000559 Milestone 4/5 Report	Released in part	9(2)(a) 9(2)(b)(ii)
20	March 2011	WMF 00000137 Year 1 - Milestone 1 Report	Refused in full	18(e)

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Ministry for the Environment
Manatū Mō Te Taiao

REDUCE • REUSE • RECYCLE • RECOVER

Waste Minimisation Fund

Application Form for project funding 2010

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New Zealand Government

Introduction

This application form is for project proposals to the Ministry for the Environment's Waste Minimisation Fund (WMF), for projects commencing 1 July 2010.

Please read the *Waste Minimisation Fund Guidance for Applicants for projects commencing 1 July 2010* (the guide) before completing this form.

You can download the guide from the Ministry website, or contact us on (04) 439 7400 or email wmf@mfe.govt.nz to request a copy be posted to you.

You can print a copy of this form, and complete it manually, or you can complete it electronically.

If you are completing this form electronically:

- mouse click or press the ↑ and ↓ keys on your keyboard to move between fields
- some of the funding calculations will automatically be done for you
- questions that allow for longer responses (more than 50 words) allow you to cut and paste from other documents if required.

If you want help completing the form, see the guide or press F1 for specific field help.

When your application is complete

Send your completed application to:

Email wmfapplication@mfe.govt.nz using the subject line 'WMF Application'

or

Waste Minimisation Fund
Ministry for the Environment
Environment House
23 Kate Sheppard Place
PO Box 10362
WELLINGTON 6143

Official Information

Important note: Information presented to the Minister is subject to disclosure under the Official Information Act, 1982, (OIA). Certain information may be withheld in accordance with the grounds for withholding information under the OIA. Further information on the OIA is available at www.ombudsmen.parliament.nz.

Information held by the Minister and Ministry may have to be released under the OIA in response to a request from a member of the public for that information. If applicants wish to provide sensitive information to the Minister or Ministry which they do not want released, it is recommended the applicant consults with the Ministry as to whether the information is necessary for the application and whether there may be grounds in the OIA for withholding the information. For instance, if release of the information would disclose a trade secret, or be likely to unreasonably prejudice the commercial position of the person who supplied or who is the subject of the information, then the information may be able to be withheld.

The grounds for withholding must always be balanced against public interest considerations that may justify release. Although the Ministry does not give any guarantees as to whether information can be withheld under the OIA, it may be helpful to discuss OIA issues with the Ministry in advance if information provided with an application is sensitive.

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Application for Waste Minimisation Funding 2010

SECTION 1: Applicant details

Organisation details

Organisation's legal name	New Zealand Forest Research Institute Limited
Trading name (if different)	Scion
Provide a brief description of the organisation	The New Zealand Forest Research Institute Limited, trading as Scion, is a Crown Research Institute (CRI) dedicated to improving the international competitiveness of the New Zealand forest industry and building a stronger bio-based economy for New Zealand. Scion is constituted under the Companies Act 1993 and the Crown Research Institutes Act 1992.
Organisation type *select one*	☐ Community ☐ Iwi/hapū ☐ Business ☐ Local government ☐ School ☒ Other *please specify* Crown Research Institute
Legal entity status *select one and provide evidence* *local government agencies do not need to complete this question*	☐ Incorporated Society ☒ Limited Liability or Cooperative Company ☐ Charitable Trust ☐ Limited Partnership ☐ Other *please specify*
Physical address *including post code*	Te Papa Tipu Innovation Park, 49 Sala Street Rotorua 3010
Postal address *including post code*	Private Bag 3020 Rotorua 3010
Website	www.scionresearch.com

Contact person details

Principal contact name	s 9(2)(a)
Position	Team Leader Wellington
Postal address *if different to organisation*	PO Box 10345 Wellington 6143
Email	s 9(2)(a)
Telephone	office s 9(2)(a) mobile s 9(2)(a)

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Contact fax	s 9(2)(a)

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SECTION 2: Project details

1 What are the details of your project, and what level of funding do you require?

Provide a title, type, description and location (area or region) of the project. Include an estimate as to the total cost of your project, and how much funding you require from WMF. You will need to supply further details about requested funding in Section 4 of this application.

Larger projects (those requesting over $200,000) should also attach background information about their project.

Project title	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation
Project type *select one*	☒ Infrastructure and/or services ☐ Investigative ☐ Education and awareness
Project purpose *maximum 100 words*	To optimise at pilot scale a breakthrough, patented technology for organic waste destruction (96% volume reduction) and value creation ($490/ dry tonne net benefit over landfilling). Successful completion of the Project will lead to design specifications for a full-scale reference plant at the Rotorua District Council Wastewater Treatment Plant (WWTP) that can divert 8,100 tonnes of biosolids waste annually. This is expected to catalyse an inter-regional expansion of the technology commercialisation, encompassing municipal biosolids, domestic organic wastes, and primary industry organic wastes, that could divert 340,000 tonnes per year of organic wastes within ten years.
Project location	Rotorua
Total cost of project	$ 3,600,000 (two year duration)
Amount requested	$ 1,700,000

2 How does your project directly support the Ministry's waste minimisation objectives?

Only projects that directly support one or more of the Ministry's objectives as outlined below will be eligible for funding. You should make a clear link between the main objective(s) you select, and your project.

Objective *select as many as apply*	☐ Reducing waste generation ☐ Reuse of waste ☒ Increasing recovery of resources from waste
Project contribution to objectives *maximum 250 words*	This project brings together territorial authorities, industry representatives and technical expertise to deliver a substantive advance in waste management technology. Its Waste 2 Gold platform is being developed to support national goals and legislation to divert organic solid wastes from landfills. A regional-based development plan ensures optimal success. The technology can achieve substantial solids removals from wastes through a proprietary thermal oxidative deconstruction process ("thermal deconstruction") which breaks down the physical structure of the material and generates useable by-products. Large reductions in transportation and landfill costs are achieved by solids reduction and process outputs improve overall economic efficiency by offering added-value opportunities: • Energy generation as heat, methane or electricity;

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- Novel industrial biotechnology applications to offset fossil fuel imports, such as production of biodegradable plastics and liquid biofuels;
- Fertiliser manufacture from recovered nitrogen and phosphorus side streams;
- Replacement of commercial carbon supplements used to maintain treatment performance in WWTP.

A competitive analysis suggests current alternatives do not effectively address critical waste characteristics (moisture content and hazardous constituents) or offer sufficient market value for end products.

Organic wastes amenable to the technology represent 53% of the total waste volume entering public landfills, plus wood waste currently entering cleanfills and company landfills and biosolids from wastewater treatment plants (MfE Waste Strategy Review of Progress, 2007).

The primary customers for the process are seen to be Territorial Authorities and specific primary industry operators (e.g. dairy, meat, pulp and paper, food processing) which generate large volumes of organic waste.

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3 How does your project result in new waste minimisation activity?

Projects must result in new waste minimisation activity, either by implementing new initiatives or by a significant expansion in the scope or coverage of existing activities. (maximum 250 words)

Rotorua District Council has identified biosolids as their primary waste issue due to handling issues, downstream impacts and disposal constraints. Over the past decade, the proportion of biosolids composted by RDC decreased from 90% to 10% due to product quality and market development difficulties. Incineration and drying have been discounted as alternative options.

RDC has partnered with Scion to pursue novel waste technologies that target value creation as an economic driver – a Waste 2 Gold philosophy. Our deconstruction process eliminates wastes by combining substantive volume reduction with maximum value recovery. Fermentation and chemical oxidative stages generate carbon-rich by-products and recover nitrogen and phosphorus with the following benefits:

- Landfill costs: 96% reduction;
- Greenhouse gases: 76% reduction;
- WWTP plant costs: 36% reduction;
- Eutrophication: 40% reduction;
- Ozone generation: 90% reduction.

The Project will prove the technology at pilot plant using biosolids and expand into the Bay of Plenty as an exemplar region for our target municipal and primary industry sectors (dairy, meat, horticulture and pulp).

Future commercial development will also divert putrescibles, timber (including treated), paper, nappies, sanitary products from landfills to produce higher value products.

To our knowledge, no commercial technology cost effectively processes such a broad range of organic wastes with this level of economic and environmental benefits.

We envisage a stepped growth strategy that could see 6-8 new deconstruction plants in operation in the Bay of Plenty/Auckland regions within 10 years with sufficient capacity to divert 16% of New Zealand's total organic waste flows

4 Are you aware of any similar waste minimisation activities in your region? ☐ Yes ☒ No

If yes, please give details of the existing activity, and explain how your project expands the scope or coverage of that activity. Funding is not available for projects that displace existing activity. (maximum 100 words)

This project focuses on development of a world first patented process.

5 Will your project promote waste minimisation to the wider public? ☒ Yes ☐ No

If your project will be promoting waste minimisation, please provide the details. (maximum 100 words)

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The feasibility study has generated considerable interest from the Rotorua community (e.g. newspapers, public presentations). Waste 2 Gold is also actively promoted by RDC in its ten-year plan and publicity material. A working pilot plant will provide tangible evidence for the technology's viability and profile. The later construction of a commercial facility that handles organic waste efficiently, generates products and creates new business opportunities will provide the impetus for businessses and the public to adopt and embrace a Waste 2 Gold focus. Scion currently manages a national schools programme (Science of Life) that will support educational opportunities for the Project.

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6 Has your organisation successfully completed a publicly funded project before? ☒ Yes ☐ No

If yes, provide the details of one or more publicly funded projects that your organisation has recently completed. Include project details including cost, outcomes, and a contact person from the funding organisation that we can talk to about the project. Applicants for larger projects (those requesting over $200,000) should also attach references. (maximum 100 words)

As a CRI, Scion has completed numerous publically-funded programmes across a broad range of opportunities, technologies and markets. Funding agencies have included MORST, FRST, MAF, MfE, and territorial authorities. Examples are detailed in the Supplementary Information document.

Of specific relevance to this application, Scion completed a publically-funded feasibility study for the deconstruction technology. The costs of this study were covered by Rotorua District Council ($485,000) and FRST ($200,000 PSAF) and allowed a laboratory-scale process to be developed. This lead to a favourable economic and lifecycle analysis and filing of a provisional patent.

Contact person s 9(2)(a)

Phone s 9(2)(a) Email s 9(2)(a)

7 Are you applying on behalf of a territorial authority? ☐ Yes ☒ No

If yes, please specify how this project differs from your statutory responsibilities under Section 32 of the Waste Minimisation Act 2008, and explain why this project is not funded out of the levy money received under S32 of the Act. (maximum 100 words)

This is a Scion-led project. Scion has partnered with end users who directly benefit from the technology. One partner, Rotorua District Council, will invest $848,000 to fund the capital cost of the plant including their portion of the Waste Levy funding (approximately $200,000 per annum for two years).

The proposal is in keeping with the 1999 Rotorua Solid Waste Management Plan. It includes investigation into organic waste conversion technologies (Sections 7.2.6.2 and 7.2.6.3) noting that they will "[keep] abreast of developments and if the opportunity arose even look at partnerships in either research or pilot programmes with [Scion]".

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SECTION 3: Project benefits

8 What is the waste problem or opportunity that you plan to address with the project?

To evaluate your application, the WMF assessment panel will need to understand the benefits offered by the opportunity, the extent of the problem, and whether a demonstrated need exists. You should also provide information on current tonnages and method of disposal if relevant to your project. (maximum 250 words)

New Zealand discards 1,272,000 tonnes/year of organically-based waste (organics, timber, paper, textiles, nappies and sanitary), 253,000 tonnes of municipal biosolids and 560,000 tonnes of organics disposed to company landfills.

Organic solid wastes create some of the greatest concerns regarding landfill operation:

- represent a high proportion of wastes entering landfills in New Zealand;
- high moisture content makes transport costs high;
- under landfill conditions, organic wastes generate large volumes of poorly recoverable methane, a potent greenhouse gas;
- waste leachates contribute to eutrophication in recipient waterways; and
- some organic wastes, such as wastewater treatment plant biosolids, contain hazardous pathogens or heavy metals, creating health and safety issues.

Significant diversion from landfills remains a considerable challenge, despite legislative and economic pressures and voluntary efforts. For example, available technologies for organic waste are only partially successful due to a range of factors including:

- inability to achieve required volume reductions (e.g. anaerobic digestion);
- significant land areas required (e.g. vermicomposting);
- odour generation (e.g. windrow composting);
- inadequate energy balances (e.g. incineration or drying);
- lack of sufficient quality control and markets for diverted products (e.g. compost); and
- contain contaminants that preclude substantial re-direction (e.g. heavy metal limits for land application of biosolids).

The challenge is to transform these seemingly intractable management problems into compelling economic opportunities. NZ's organic wastes are a valuable, high volume source of energy, carbon, nitrogen and phosphorus. Exploiting these resources in a sustainable manner is the opportunity addressed by this Project.

9 What is the solution you are proposing?

What specific action does your project take to seize the opportunity or address the problem? (maximum 250 words)

The Waste 2 Gold project is developing innovative technology platforms that address political and operational drivers for more efficient diversion of organics from landfills by:

- achieving substantial volume reductions;
- maximising embodied energy recovery from these low-value, carbon substrates;
- generating added value co-products wherever possible; and
- ensuring that recalcitrant contaminants are destroyed or segregated.

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Phase 1 of the project led to a laboratory-scale thermal deconstruction process for organic wastes and biosolids. Successful proof of concept for this waste management solution demonstrated superior economics and improved environmental footprints relative to competing processes.

An intermediate step on the way to commercialisation of the patented technology is the construction of a pilot plant at an end-user site (Rotorua District Council WTTP). This plant will provide the flexibility to undertake a range of testing and optimisation studies at a scale that de-risks the technology and is transferable to full-scale commercial plants.

This funding application seeks support for Phase 2 of the Project, which will allow the multi-sector Waste 2 Gold partnership to:

- demonstrate the thermal deconstruction process scale-up and repeat laboratory-scale performance;
- consolidate a robust economic case for deployment across a range of waste-producing sectors;
- produce a viable commercial full-scale design.

This technology offers the potential to divert 73% of all organic wastes in the Bay of Plenty from landfills within 10 years. At a national level, this would see 398,000 tonnes of wastes transformed from an environmental negative into an economic positive worth at least $25 million/yr.

10 Which waste type(s) is your project focusing on?

Please describe the waste type(s) you are addressing. For each waste type, estimate the quantity of waste currently being generated, and the weight that your project proposes to reduce, reuse, recycle or recover during the project.

Include any additional details in the space beneath, including estimates of any profit gained by reducing, reusing, recovering or recycling the waste type.

Press the TAB key on your keyboard to add more rows to the table, if required.

	Quantity of waste			
Waste Type	**Current**	**Reduced**	**Reused**	**Recovered/Recycled**
Pilot plant: Rotorua biosolids	8,400 tonnes annually	tonnes	tonnes	Up to 1 tonne per day
Commercial plant 1: Rotorua biosolids	8,400 tonnes annually	tonnes	tonnes	8,060 tonnes annually
Commercial plant 2: Tauranga biosolids	16,500 tonnes annually			15,800 tonnes annually
Commercial plants 3&4: Pulp and paper (Kawerau) and Watercare (Auckland)	181,000 tonnes annually			173,800 tonnes annually
Future commercial plants: Bay of Plenty organics	150,000 tonnes annually			144,000 tonnes annually

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The broader project focuses on organic waste in New Zealand with the possibility of international application. The pilot plant, however, focuses on biosolids. Financial modelling for this project has shown that the process becomes profitable when landfill costs exceed $80/tonne. The Process can achieve net benefits (in terms of cost reduction) of $490/dry tonne. Given our ten-year plan, net savings would be approximately $25 million/yr (assuming 355,000 tonnes at 15% dry weight). This analysis does not include the opportunities for nutrient recovery or re-direction of the carbon by-products from biogas and WWTP supplementation to more advanced higher value biotechnology applications, such as bioplastics and biofuels manufacture (such applications are already subject to patents by Scion).

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11 What objectives have been set for your project, and how do you intend to achieve them?

Specify the objective(s) that have been set up for your project. Your objective should be 'SMART' (specific, measurable, achievable, realistic and timely).

Provide detail about the types of activity(ies) that will be done as a part of your project, and how you will measure their effectiveness using Key Performance Indicators (KPIs). You will need to use these KPIs to answer Section 6 of this application form.

Press the TAB key on your keyboard to add more rows to the table, if required.

Objective	Activity	Key Performance Indicator
To establish a modular thermal deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	Tender, construct, install and commission Wet Oxidation module as the basis for Thermal Deconstruction process. Configure, install, and commission Biological Nutrient Removal module to simulate the full-scale RDC WWTP. Design, construct, install and commission pre-fermentation module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids.
To demonstrate viable scale up of the complete Thermal Deconstruction process by 31 December 2011.	Carry out pilot trial runs under a range of process conditions. Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated Pilot-scale demonstration of product value as a carbon source.
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to at least three alternative organic waste streams.
To produce a viable commercial scale design basis for application at the Rotorua wastewater treatment plant by 30 June 2012.	Development of a process engineering and economic model for the full scale application of the technology Produce design specifications and costings for a commercial plant.	Process model in place capable of capital and operating cost estimates for full scale plant. A viable commercial scale design is produced.

12 What are the specific benefits of the solution?

Provide details of any benefits of the solution, in terms of economic, environmental, social and/or cultural benefits. For environmental benefits, include any reduction of harm to the environment.

	Benefit	Description
☒	Economic	The reduction in landfill costs by 96% The recovery of high value resources from organic material. For example, from one tonne of dry organic waste, on a weight basis, organic products from the process have a wholesale price 37% higher than that of compost - and none of the existing market barriers (used on-site).

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☒	Environmental	Organic waste is the major contributor to greenhouse gases from landfills. This process achieves a 76% reduction in greenhouse gas formation from wastes. A 96% reduction in volume of organic matter to landfill. Removal of pollutants from the environment. For example, i) overall reduction of 40% of the eutrophication potential through a reduction in nitrate levels and the recoveryl of phosphates, ii) 90% reduction in photochemical ozone creation potential.
☒	Social	Community consultation will grow support for a sustainable solution to recover organic waste value and the broader adoption of the Waste 2 Gold brand/philosophy for comparable solutions. Creation of new employment opportunities through installation of new processing plants and utilisation of end products for new biotechnology industries. A social dialogue will provide opportunities for the discussion of risk and incomplete knowledge of impacts.
☒	Cultural	Dialogue with local iwi through Scion and RDC kaumatua will enable a sustainable solution for recovering organic waste to consider cultural aspects of waste recovery and disposal.

13 What other stakeholders are going to be included in this project?

Preference will be given to projects that operate collaboratively.
Select the stakeholder groups that will be included, and give a brief description. (maximum 50 words per group)

☒	Funding partners	Rotorua District Council - RDC has a core interest in the technology as an end user and as a potential investor for the broader commercial opportunities. We are currently in final negotiations with pulp and paper industry, other municipal WWTP operators, and environmental engineering partners.
☒	Advisory groups	The Project Governance group will have representation from each of the partners (via the Waste to Gold Alliance) and create an (international) Industrial Advisory Group to ensure it targets appropriate outcomes for all stakeholders.
☒	Community groups	The Rotorua District Council is in discussion with community and iwi groups with a view to forming possible partnerships for the project.
☒	Sector groups	The Project will seek in-kind or non-funded support from a range of special interest groups, including Bioenergy Association of New Zealand, WasteMINZ, Water NZ, Australasian Pulp and Paper Industry Technical Association, and Local Government NZ.
☒	Other	As part of the commercial strategy, the Project will keep a range of potential licensee partners, such as the large international wastewater treatment and environmental engineering companies, informed of Project progress - this will ensure that the market is well informed of this technology option when full-scale development is activated.

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14 How might your project influence, encourage or enhance other waste minimisation activities?

Preference will be given to projects that collectively give the largest net benefit over time. Explain how your project could enhance the uptake of waste minimisation or benefit other waste minimisation activities. (maximum 250 words)

New Zealand requires options for the long-term disposal of biosolid wastes that:

- overcome the current negative perceptions towards beneficial re-use of these wastes;
- minimise or eliminate waste residues;
- eliminate potential toxicity or human health issues;
- generate maximum recoverable value; and
- can be implemented at source to minimise transportation costs.

The specific technical characteristics of the Scion process help meet these criteria:

- **maximises** conversion efficiency by combining a low cost biological fermentation stage with a high performance chemical oxidative phase;
- **minimises** conversion energy in the chemical oxidative phase, lowering pressure and temperature demands of the reaction vessel and, therefore, capital costs;
- **optimises** by-product characteristics (for carbon, nitrogen and phosphorus species) to simplify recovery and re-use options and lower costs, whilst destroying harmful constituents.

Our case studies show that the process could generate landfill cost savings to Rotorua District Council of approximately $700,000 per annum. In addition, use of commercial ethanol as a carbon supplement in their wastewater treatment plant could be offset to the value of $367,000 per year.

Based on the Project's market development strategy, it is anticipated that after a 10 year period, 16% of New Zealand's total organic wastes would be diverted from municipal and company landfills – including 73% of municipal biosolids and municipal/industrial organic wastes in the Bay of Plenty.

Such benefits will help benchmark this Waste 2 Gold deconstruction approach as "Best Available Technology", setting in place improved criteria for waste management options in New Zealand.

15 How will you ensure the solution or the benefits of the project will endure, once WMF funding has ended?

A successful project is not only one that has immediate visible effects but also produces long-term sustainable outcomes. Please explain how you intend to make the solution self-funding long term, OR how you intend to ensure that any benefits are not lost once the project is complete. (maximum 200 words)

The Project strategy is to develop the process to scales where economic feasibility and operability are well defined. An alliance of industry, local government and research interests will then extrapolate this solution to the wider market.

Investment by RDC and Scion in laboratory-scale feasibility studies on biosolids has facilitated scale-up. Scion (on behalf of the Alliance) will leverage $1.7 million Waste Management Funding with $1.9 million partner funding for pilot-scale development to further affect core de-risking outcomes and speed in achieving these outcomes.

Further investment from Private Investors will be sought once the pilot plant is in operation. Such investment has not been sought to date as this would prejudice the current focus on achieving early benefit to NZ. At that point, strategies to address the bulk of the technical and business needs will see risks minimised and so raising Private Investment is not expected to be difficult. RDC has already made some financial provision in their Ten Year Plan.

The overall goal will be to provide a compelling case for long-term investment in commercial plants

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targeting municipal biosolids (>253,000 t/yr), a proportion of organics (e.g. putrescibles) and wastes from pulp and paper, food, dairy and meat processing.

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SECTION 4: Milestones and funding

16 What are the milestones in the first year of your project?

*Clearly outline **up to six** milestones for the period 1 July 2010 to 30 June 2011. All costs should be exclusive of GST. (maximum 50 words per milestone)*

Before completing this section refer to the application guide for step-by-step instructions.

Applicants for larger projects (those requesting over $200,000) should also attach a copy of their business plan and/or project plan.

Year One - 1 July 2010 to 30 June 2011				
Milestone	**Description**	**Due date**	**Estimated total cost (A)**	
1	Biological Nutrient Removal plant is installed and ready for operation	31 December 2010	$ 65,000	*excluding GST*
2	Thermal Deconstruction pilot plant constructed and commissioned	31 December 2010	$ 975,000	*excluding GST*
3	Biological Nutrient Removal plant under steady state operation and successfully simulating full-scale operation	30 June 2011	$ 110000	*excluding GST*
4	Thermal Deconstruction performance successfully proven at pilot scale	30 June 2011	$ 300,000	*excluding GST*
5	Integrated fermentation pilot plant module design complete	30 June 2011	$ 535,000	*excluding GST*
6	Process Engineering and economic model developed	30 June 2011	$ 90,000	*excluding GST*

Estimated total project cost for Year 1 (A)	$ 2,075,000	*excluding GST*

17 If you require funding for longer than one year, what is planned for the following year(s)?

If you are applying for multi-year funding, summarise what will occur during Years Two and/or Three. (maximum 50 words per year)

Years Two Three			
Year	**Description**	**Estimated total cost (A)**	
Two *1 July 2011 to 30 June 2012*	Construction and commissioning of fermentation pilot plant module Successful integration of Biological Nutrient Removal and Thermal Deconstruction pilot plants Successful integration of Pre-fermentation pilot plant Successful demonstration of complete process in long duration trials Evaluate potential application to pulp mill biosolids and other organic waste sources	$ 1,525,000	*excluding GST*

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	Process Engineering and economic model complete Viable full-scale commercial design complete		
Three *1 July 2012 to 30 June 2013*		$	*excluding GST*

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18 How much are you requesting from WMF, and how much have you obtained from other sources?

Preference will be given to projects that can demonstrate that more than 20 per cent of the required funding for the project has been obtained from sources other than the Waste Minimisation Fund. All costs must be exclusive of GST.

Refer to the application guide for more information.

Funding summary

	Year One FY 2010/2011	Year Two FY 2011/2012	Year Three FY 2012/2013
Estimated total project cost (A) *If you are completing online, this amount is taken from your answers to Q14 and 15*	$ 2,075,000	$ 1,525,000	$ 0
Funding sought from WMF (B) *The amount you require from WMF*	$ 875,000	$ 825,000	$
Balance (A-B) = (C) *If you are completing online, this amount is automatically calculated for you*	$ 1,200,000	$ 700,000	$ 0
Cash contribution *The amount your organisation and/or partners are contributing to the project*	$ 1,200,000	$ 700,000	$
Other funding *Totals for any other funding you have secured* *Please also complete the table below*	$	$	$
Total income/funding (D) *If you are completing online, this amount is automatically calculated for you*	$ 1,200,000	$ 700,000	$ 0
WMF share of costs (E) *If you are completing online, this amount is automatically calculated for you. The calculation is WMF funding sought (B) divided by estimated project cost (A) x 100*	42.17 %	54.10 %	%

Other funding sources

Complete this section if you identified 'Other funding' in the Funding Summary table. If your application is successful we may contact the person nominated as the contact person to discuss the status of the funding.

Organisation name	Amount	Status of offer	Expected Date	Contact name and number
	$	☐ Pending ☐ Confirmed		
	$	☐ Pending ☐ Confirmed		
	$	☐ Pending ☐ Confirmed		

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SECTION 5: Capability

Applicants will need to demonstrate the ability to deliver the project.
Where the amount requested is over $200,000 applicants should also attach documentation to support their answers.

19 Who is your project manager, and what skills and experience do they have?

The project manager is the person responsible for managing major project tasks, and is likely to be the person that we liaise with during the project. Provide details of the person who will have overall responsibility for delivering this project including their relevant technical skills and experience.
If this person has not yet been appointed, what skills and experience will they be required to have? (maximum 100 words)

s 9(2)(a)

20 What resources does your organisation have to ensure successful completion of this project?

It is important that your organisation has the necessary resources available to successfully complete the project. This may include office space, IT equipment, internet access as well as staff skills and experience. (maximum 100 words)

Scion has a long track record of:

- development from proof of principle to commercialisation;
- technical and scientific expertise;
- extensive technical testing facilities;
- project management skills; and
- administration skills and IT facilities.

Full details of our skills, infrastructure and management practices are provided in the Supplementary Information section.

21 What project governance is planned to be in place for the project?

Project governance defines the accountability and responsibilities for strategic decision making across the project (eg, a project management hierarchy). It may also include processes for auditing, monitoring and reviewing the project.
What roles, groups and/or processes will your project have in place to ensure that decisions are made consistently and robustly, money is spent responsibly, and risk is managed effectively? (maximum 200 words)

Scion uses internationally recognised best-practice processes for the management of technology development, contracting and tendering. A Stage-Gate™ system is fully integrated into our technology development process to provide seamless delivery from ideas conception to market roll out.

Scion's Strategic Investment Committee will work with the Project Team to ensure appropriate valuations and market strategies are completed by internal business development staff or through the services of external consultants.

Overall delivery and strategic development of the Project will be controlled by a Project Governance group:

- s 9(2)(a)
- Independent Chair (to be appointed)

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Delivery and coordination of the Project will undertaken by a Project Management team:

- s 9(2)(a)

Specific roles within the Project's technical and business support group will include:

- s 9(2)(a)

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22 Are there any partner organisations that will be involved with the project?

Partners generally share the decision making about the project, and must contribute resources to the project in terms of expertise, equipment or money. What do your partner organisations bring to the project?

Press the TAB key on your keyboard to add more rows to the table, if required.

Organisation name	Details of involvement	Contact person and number
Rotorua District Council	Core investment and pilot plant/full-scale reference site partner. Have committed capital investment to pilot plant construction. Will play a key role in Project governance/management and strategic development	s 9(2)(a)
AWT NZ Ltd	Expertise in environmental engineering and WWTP process modelling. Will provide specific market entry points for roll-out strategy	s 9(2)(a)
Norske Skog/Carter Holt Harvey Pulp and Paper	Scion has a long term partnership with these two companies as part of our Waste Minimisation Project Committee. Both companies have expressed a strong desire for involvement in the Alliance and we are currently negotiating specific contracts associated with the project.	s 9(2)(a)
Others	Currently negotiating with a number of municipal and industry partners for formal involvement. In addition to direct funding, these partners will facilitate market and economic analyses and help shape our development pathways through provision of in-kind materials and services	Unable to provide at this stage – have asked for confidentiality

SECTION 6: Project evaluation

23 How will you evaluate your project?

How will you know your project is successful?

Briefly describe how the effectiveness of your project will be monitored, evaluated and reported, based on the KPIs and answers you provided in section 3 of the application form. (maximum 250 words)

There are a number of technical, financial, social and investment risks associated with this project. These have been identified in our Risk Management Plan and will be monitored and evaluated accordingly.

The overall technical and operational risk is being managed via the Governance Group and in accordance with best practice engineering approaches. This includes staged development. Specifically, this is the managed scale up from laboratory testing to pilot-scale system and on to a full scale commercial plant. This will continue to include incorporation of testing the economic and engineering feasibility at each stage.

It is also being managed in accordance with best practice Stage Gate management (a requirement of all projects where Scion has investment) ensuring that each stage is reviewed to make sure that all levels of risk are assessed, to minimise surprises and ensure the project continues to meet the requirements of its investors.

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Scion has a formal monthly and quarterly reporting structure, which will be used for this Project to report back to all partners and the Scion Executive Management Team and Board. Financial management is also undertaken through a formal monthly accrual and quarterly forecasting system.

In addition, Scion's MfE Client Management Plan (for existing projects) includes monthly debriefs between the Scion Executive Sponsor and MfE with quarterly client reviews through our business development team, which will ensure quality and timely delivery on the milestones of our WMF contract.

SECTION 7: Additional information

24 Is there anything else we need to consider about your application?

This space is for you to provide any additional information which your organisation considers important and has not been covered in previous sections. (maximum 250 words)

The underpinning science for this Waste 2 Gold opportunity was funded by the Foundation for Research, Science and Technology, Public Good Science and Technology (PGST) fund (contract C04X0704) which concluded in 2009. This developed the technology to proof of concept stage. The PGST fund does not support the extension of research through to applied scale-up and commercial implementation.

In addition to the PGST funding, Rotorua District Council has provided prior funding for the laboratory scale development.

Overall, we consider Scion's capabilities and skills in the environmental technologies and waste management area to be well proven at regional, national and international scales. Success in this funding round will allow these skills to be well directed to specific technical and economic outcomes that fit strongly within our focus as a CRI and allow us to make a significant positive impact on regional issues and national policy in the waste area.

Please note the extensive information supplied in the Supplementary section.

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SECTION 8: Declaration

A person with the organisation's signing authority must complete this declaration.

As a duly authorised representative of the organisation as per Section 1 of *this Waste Minimisation Fund Application Form for project funding 2010*:

- I declare that I have read the *Waste Minimisation Fund Guidance for Applicants for projects commencing 1 July 2010.*
- I declare that to the best of my knowledge, the information contained in all sections of this application form, or supplied by us in support of our application is complete, true and correct.
- I declare that I have the authority to sign this application and to provide this information.
- I declare that the application is not being made by an organisation that is in receivership or liquidation, or by an undischarged bankrupt.
- I understand that information presented to the Minister is subject to disclosure under the Official Information Act, 1982.
- I agree that the Ministry for the Environment may collect information about our organisation from other parties, and may liaise with local and national organisations in respect of this application.
- I agree that the Ministry for the Environment can undertake a background check on the applicant(s).

s 9(2)(a)

Date 22 February 2010

form.

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Checklist

Send your completed application to wmfapplication@mfe.govt.nz or post to Waste Minimisation Fund, Ministry for the Environment, PO Box 10362, WELLINGTON 6143.

Use the following checklist to confirm you have included all the required information in your application. Please do not include any attachments that the Ministry has not specifically requested.

☒ Complete all sections of this form

☒ Sign the declaration

☒ Attach proof of legal entity status

Applicants requesting over $200,000 must also attach the following documents

☒ Feasibility study

☒ Business plan

☒ Background material about the project and the organisation

☒ References from successfully completed publicly funded projects (if available)

☒ Documentation to support the capability statement

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Supplementary Information

Waste 2 Gold – Deconstruction Technologies for Organic Waste Utilisation

Date: February 2010

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"Changing the way New Zealand thinks about waste"



Waste 2 Gold

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Contents

Project Background 6

Rotorua District Council Feasibility Study 17

Waste 2 Gold Business Plan 39

Scion Organisation and Capability 72

Letters of Reference 108

Released under the Official Information Act 1982

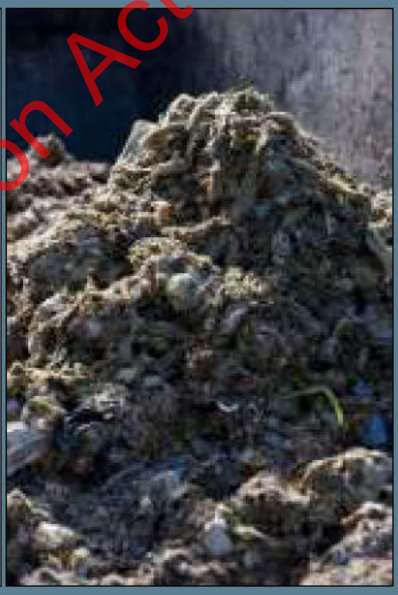
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2010 Waste Minimisation Fund Application

Scion



Project Background

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"Changing the way New Zealand thinks about waste"

Waste 2 Gold



Released under the Official Information Act 1982

Contents

Introduction....8
Objectives of the Waste 2 Gold Programme....10
Project History....10
Work to Date....12
Moving Forward....15
Conclusions....16

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Introduction

In a world of increasing demand for sustainable waste management, the drivers for reducing waste volumes to landfills have become critical. Identification of significant waste streams by the Ministry for the Environment (2009) identified a list of priority waste streams for action:

- Organics;
- Construction and demolition waste;
- Wastewater;
- Nappies;
- Packaging;
- Agrichemicals;
- Hazardous waste;
- Household lighting;
- Tyres;
- Used oil; and
- Waste electrical and electronic equipment (e-waste).



Organic solid wastes (representing organics, timber from construction & demolition waste, wastewater, nappies and packaging from the above list plus paper) create some of the greatest concerns regarding landfill operation:

- They represent a high proportion of wastes entering landfills in New Zealand.
- Their high moisture content makes transport costs high;

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- Under landfill conditions organic wastes generate large volumes of poorly recoverable methane, a potent greenhouse gas;
- Leachates from these wastes contribute to eutrophication in recipient waterways; and
- Some organic wastes, such as wastewater treatment plant biosolids, contain hazardous pathogens or heavy metals, creating health and safety issues.



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Significant diversion from landfills remains a considerable challenge, despite legislative and economic pressures and voluntary efforts. For example, available technologies for organic waste are only partially successful due to a range of factors including:

- Inability to achieve required volume reductions (e.g. anaerobic digestion);
- Significant land areas required (e.g. vermi-composting);
- Odour generation (e.g. windrow composting);
- Inadequate energy balances (e.g. incineration or drying);
- Lack of sufficient quality control and markets for diverted products (e.g. compost); and
- Contain contaminants that preclude substantial re-direction (e.g. heavy metal limits for land application of biosolids.

Objectives of the Waste 2 Gold Programme

The Waste 2 Gold programme seeks to develop technology platforms that address the needs for diversion of organic wastes by:

- Achieving substantial volume reductions;
- Maximising embodied energy recovery from these low-value carbon substrates;
- Generating added value co-products where appropriate; and
- Ensuring that recalcitrant contaminants are destroyed or segregated.



Project History

The Waste to Gold Thermal Oxidation Project is a product of approximately four years of development. From original proposition through development of research opportunities, increasing capability (both in up-skilling staff and development of laboratory infrastructure) through to engagement with industry and local government, and ultimately a feasibility study for the Thermal Oxidation Project with a territorial authority for treatment of municipal biosolids.

The original concept arose from an NZ Government FRST research programme - EcoSmart Technologies for Advanced Waste Treatment (FRST contract number C04X0201). This programme had an explicit focus on providing innovative solutions to waste issues within the NZ forest industries sector. As a concluding contract in September 2007, a significant two-year transition was proposed:

1 include solid wastes as target materials, broadening our interests from an almost exclusively wastewater base;

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2 greater inclusion of chemical/thermochemical approaches, in conjunction with our strong history in biotechnological solutions to waste problems;

3 consider broader waste management sectors, both industrial and municipal, in our technology markets.

A detailed assessment of technological approaches used internationally to manage organic waste materials was made by Scion personnel. Thermal oxidation was identified as having significant advantages, as is described in the current proposal. A funding transition programme (Waste to Gold, FRST funded over two years to September 2009) thus included Scion's initial foray into bench-scale wet oxidation (reactions at 50mL sample size) on biosolids samples from the primary industry (pulp and paper) as well as more basic work with simple model compounds, such as glucose. Also included in this work was an audit of the size of the organic solid waste opportunity within New Zealand, the results of which were presented to two WasteMINZ audiences in 2009.

Engagement with industry was undertaken as an essential part of the programme, including our traditional partnership with the pulp and paper industry, and increasing involvement with AWT NZ Ltd, an innovative environmental engineering consultancy.

Clear advantages for utilising the technology to deal with wastewater treatment plant biosolids led to interactions with the Rotorua District Council in late 2008. A feasibility study contract, running in parallel with the Government research and development programme, was signed with this territorial authority in April 2009.

The aim of the contract was to conduct a feasibility study on the efficacy of wet oxidation as an alternative to their current practice of landfilling municipal biosolids from the district's main wastewater treatment plant. As a significant outworking of this contract, Scion invested over $150,000 in commissioning a high temperature reaction engineering laboratory, specifically for the wet oxidation work. This increased our working scale to 500mL volumes (a factor of 10 enhancement on the initial work), but more importantly, it provided Scion with a world-class facility for bench-scale work in this area.

Concluding in January 2010, the contract with RDC was an outstanding success and culminated with funding commitment from RDC to further project development centred around pilot-scale demonstration of the project, as outlined in the current work proposal to MfE.

Importantly, an innovative approach to improving wet oxidation performance had been identified, which lead to submission of a provisional patent application by Scion in January 2010 (Patent No. 583082). This holds potential for intellectual property gains for the country, as New Zealand's biosolid waste problems are mirrored throughout the world.

Overall, the work has demonstrated a significant development from initial conceptualisation, proof of concept research, through to applied research contract, up to the level where significant investment is sought to prove the technology at a realistic scale.

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Work to Date



The Waste 2 Gold approach is to break down complex organic wastes into simple, short-chained organic molecules. These products can then be converted to a range of end products, including bioenergy.

Central to the Waste 2 Gold technology is a thermal deconstruction process developed by Scion that combines high pressures and temperature with oxygen to break down the physical structure of the waste material. The process leads to a substantive solids reduction (greater than 90%) but is controlled in a manner that retains a carbon fraction as a readily degradable liquid organic feedstock. Traditional thermal deconstruction processes oxidise all carbon-containing material to carbon dioxide.

The carbon-rich output can be used for a range of added-value opportunities, such as:

- Feedstocks for novel biotechnology applications, such as production of biodegradable plastics and liquid biofuels;
- Energy production as heat, methane or electricity; and
- Replacement of existing ethanol or methanol in biological nutrient removal wastewater plants.

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Targeting volume reduction

Thermal deconstruction processes were approached at laboratory-scale by separating the work into two steps:

> ***Step 1***: Process Selection, which covered a wide range of operational conditions to gain insights into the conversion process and determine the relative benefits of the Waste 2 Gold approach over existing commercial thermal processing options.
>
> ***Step 2***: Process Development, which focused on detailed investigations of thermal deconstruction with a view to directing the pilot scale concept.

Laboratory scale thermal deconstruction tests demonstrated that the best deconstruction rates were achievable under single stage wet oxidation conditions. The second phase showed that the deconstruction process was very effective at volume reduction (up to 96%).

Biological Nutrient Removal supplements, methane generation and nutrient recovery

Further work sought to determine the suitability of the carbon rich deconstruction products for:

- re-introduction as a supplement into a WWTP biological nitrogen removal process; and
- production of methane for energy recovery.

It also considered the technical opportunities for the recovery and use of segregated nitrogen and phosphorus nutrients.

The findings from laboratory scale experimentation confirmed that acetate produced from the deconstruction process was the best carbon source for nitrate removal.

The total amount of methane and the rate of production were determined for solid and liquid fractions of the supplied biosolids which had been pre-treated by thermal deconstruction processes.

The study concluded that power production from methane generated from sludge was feasible but further study is needed to determine the characteristics and application of thermal deconstruction of the solids remaining after the anaerobic digestion process.

Municipal biosolids contain considerable amounts of the nutrients nitrogen and phosphorus. Nutrient recovery from biosolids using Scion's proprietary modified zeolite product gave promising results but more work is necessary to fully scope out the possibilities.

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Economic Modelling and Life Cycle Analysis

A RDC WWTP process model has been co-developed by Scion and AWT NZ Ltd. This model has been used to complete high level process and economic analyses for the integration of a thermal deconstruction technology into the biological wastewater treatment system and the biosolids landfilling process stages appropriate for the Rotorua District Council situation.



The modelling situation was extended to describe a number of alternative scenarios.

- Wet oxidation followed by anaerobic digestion.
- Wet oxidation with reuse of the liquor as an ethanol substitute. The residual products were used for anaerobic digestion for biogas production.
- Wet oxidation with the liquor used as an ethanol substitute.
- Anaerobic digestion, followed by wet oxidation, with liquor used as an ethanol substitute.
- Anaerobic digestion only.
- The current situation – landfill operations.

The findings from the analysis were that:

- all scenarios considered provided a better long term option than landfilling;

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- the non-landfilling scenarios equally or substantially improve on the economics of the option; and
- despite the higher operating costs of wet oxidation, the reduction in waste volumes and added value benefits of the process were more than able to offset that impact.

Life cycle analyses using the LCA software GaBi 4.3 were undertaken for the scenarios covered in the economic analysis above. There are still some significant uncertainties in the LCA because the process was conducted at laboratory scale and many of the parameters were based on literature values and overseas data. However, results showed that the Scion Thermal Oxidative Process had the greatest solids reduction, and the lowest potential negative impacts on climate change, eutrophication and photochemical ozone creation potential in comparison to the Rotorua District Council landfill, an average New Zealand landfill and anaerobic digestion.

Moving Forward

The laboratory scale analysis has enabled proof of the concept to be demonstrated. The next stage is the construction of a pilot plant that permits the flexibility to permit a range of tests at a scale that is transferable to a full-scale commercial plant (e.g. assessing energy balances and inorganics build-up).

The distinguishing characteristics of a pilot plant are that its main product is data, not a large volume of physical goods. The data include engineering design information, the impact of operating parameters on process efficiency and product quality, feedstock qualification, development of safe operating procedures and the assessment of capital and operating costs.

While certain aspects of the pilot plant design will be dictated by practical constraints, the primary focus of the project is to define the range of process conditions and operating modes able to be achieved at pilot scale. The operating envelope requires:

- continuous high process temperatures (up to 260°C);
- high pressures (50 atmospheres);
- air or pure oxygen;
- continuous oxidant addition;
- batch and continuous operation capability for both liquid and gas phases;
- post-process flash cooling and separation capability;
- post-process pH adjustment; and
- development of in-process or post-process options for ammoniacal nitrogen removal.

Following the successful completion of pilot trials, the plant is envisaged to provide a functional basis for further development. This would include the ability to:

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- evaluate thermal decomposition on different types of organic wastes;
- evaluate the benefits of integrating with other pilot plants, such as anaerobic digestion; and
- develop the ability effectively separate greater component fractions for beneficial reuse.

Conclusions

Overall, the results of the Waste 2 Gold project suggest that there are few technical barriers at laboratory scale to implementing the Scion Thermal Oxidative Process. The process has the potential to achieve a 30-fold reduction in final disposal volumes. Economic and life cycle analyses confirmed that such a process can provide a net commercial and environmental benefit in the case study chosen.

Opportunities have been identified and protected through patenting for:

- segregation of carbon, nitrogen and phosphorus for efficient value recovery; and
- systems that effectively balance energy demand against operational benefits and volume reductions.

Critical scale-up issues should now be addressed through construction, commissioning and testing of a pilot scale plant and implementing an appropriate investment/partnering strategy to take this opportunity to full-scale.

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2010 Waste Minimisation Fund Application

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Feasibility Study Summary

"Changing the way New Zealand thinks about waste"

Waste 2 Gold

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Contents

Executive Summary 21
Introduction 25
Resource Characterisation 30
Deconstruction and Segregation 34
Process Sustainability 49
Value Recovery 41
Summary 54
Conclusions and Recommendations 55
Pilot Plant Design 57

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Executive Summary

Scion's Waste 2 Gold technology is being developed to support the Rotorua District Council's (RDC) goal to divert organic solid wastes from its Atiamuri landfill. The technology seeks to achieve a substantial solids reduction for the wastes through a deconstruction process which breaks down the physical structure of the material and segregates the solids into useable process outputs, such as readily degradable carbon feedstocks and recoverable nitrogen and phosphorus.



In addition to the substantial reductions in transportation and landfill costs achieved by solids reduction (>$700K/yr for RDC sewage biosolids alone), the process outputs could improve overall economic efficiency by offering a number of viable, added-value opportunities:

- Replacement of existing ethanol supplementation (currently $380K/yr) at the RDC Wastewater Treatment Plant (WWTP).
- Energy recovery from the processed organic wastes; as heat, methane or electricity.
- Feedstocks for novel industrial biotechnology applications, such as production of biodegradable plastics and liquid biofuels.
- Separation of nutrients and potential fertiliser manufacture from recovered nitrogen and phosphorus.

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The Scion-RDC Waste 2 Gold development pipeline initially focuses on WWTP biosolids, which are considered a priority disposal issue for the council. RDC is seeking innovative solutions to manage handling issues (e.g. high water content, odours and putrescibility); downstream environmental impacts (e.g. greenhouse gas emissions from landfill; additional nutrient loadings to WWTP from landfill leachates); and disposal costs (e.g. transportation and storage). These environmental and regulatory pressures mean the landfilling of biosolids is not a sustainable long term option and alternatives are needed.

Subject to suitable outcomes from a scale-up strategy that manages technical and economic risk, the Waste 2 Gold opportunity could expand to encompass the broader flow of organic wastes to the Atiamuri landfill. An estimated 60% of current total waste volume could be utilised in this manner, with a potential net benefit of approximately $4 M/yr.

Central to the Waste 2 Gold platform is a thermal deconstruction process (wet oxidation) that uses high pressure and temperature to treat biosolids generated in the wastewater treatment plant. The purpose of this study was to analyse the thermal deconstruction process at laboratory scale and deliver the following outcomes:

1. Define the composition of RDC WWTP biosolids, with particular emphasis on parameters relevant to deconstruction efficiencies;
2. Develop a high level operational envelope for the deconstruction of biosolids, with a particular emphasis on solids reduction and constituent segregation;
3. Determine the suitability of the deconstruction products for i) re-introduction as a carbon supplement into the Biological Nitrogen Removal (BNR) process, and ii) production of methane for energy recovery;
4. Identify technologies for the recovery and use of segregated nutrients (i.e. nitrogen and phosphorus);
5. Develop economic models and life cycle analyses to compare the operational-cost benefits for implementation of waste deconstruction relative to alternative options (e.g. anaerobic digestion);Determine design parameters and construction costs for a pilot scale facility.

Key Results

Laboratory-scale thermal deconstruction tests carried out on RDC biosolids showed that solids destruction rates of 90% were achievable under single stage wet oxidation conditions. The residual solids after treatment were essentially a fine ash with a low volatile content (<25% organic material). Testing of a commercially-available biosolids reduction process achieved significantly lower solids destruction rates (approx. 20%).

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The thermal deconstruction tests carried out on RDC biosolids produced large concentrations of small molecule carbon compounds, particularly acetic acid, in the process liquors. This process liquor was shown to be very suitable as a carbon supplement in the RDC WWTP denitrification process.

At full scale, use of a single stage wet oxidation process would generate more than 500 kg per day of acetic acid at the Rotorua WWTP, sufficient to substitute a significant proportion of the current ethanol dosing in the BNR process.

The majority of the phosphorus from the biosolids was retained in the residual solid material, which settled out after the wet oxidation process. Phosphorus concentrations in this material reached 12% as phosphorus or 38% as phosphate equivalent. As such, there are opportunities to recover phosphorus directly from the biosolids using the wet oxidation process. This material could be suitable for added value fertiliser applications. Future addition of chemical precipitation stages for the treated wastewaters would further increase recoverable levels of phosphorus from the WWTP solid waste streams.

The organic nitrogen content in the biosolids was converted by the deconstruction process into ammonia. The high concentrations of this nitrogen product offer economic opportunities for recovery and re-use if effectively managed (with respect to WWTP performance). Preliminary technical work was completed to assess the potential for ammonia separation and further work is recommended.

A literature review identified a range of potential technologies that could take advantage of the thermal deconstruction process's capacity to segregate carbon, nitrogen and phosphorus and thereby achieve the most beneficial value addition opportunities arising from the system.

Despite the relatively high predicted costs for wet oxidation processing of biosolids, analysis showed that these were more than offset by the reduction in costs for WWTP ethanol addition, landfilling and methane/CO_2 production. Such scenarios are particularly favourable when total landfill costs exceed $80/tonne. Indeed, economic assessments suggest there are operational scenarios which integrate the thermal deconstruction processes and achieve net benefits (in terms of cost reduction) of over $650K/yr ($490/dry tonne) for the RDC WWTP biosolids waste



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streams alone. Such analyses do not yet integrate additional economic returns for nutrient recovery or added-value biotechnology applications.

Conclusions & Recommendations

This project has addressed the key technical barriers (at laboratory scale) to implementing the Waste 2 Gold concept for RDC WWTP biosolids. There is a potential to achieve a 30-fold reduction in final disposal volumes of biosolids from the WWTP and the capacity to substantially offset current carbon supplementation costs for nutrient management. Economic and life cycle analyses confirmed that such a process can provide a significant net commercial and environmental benefit to RDC.

Opportunities were identified for a) segregation of carbon, nitrogen and phosphorus for efficient value recovery; and b) hybrid wet oxidation-anaerobic digestion systems, which effectively balance energy demand against operational benefits and solids reductions.

Scion would recommend that critical scale-up issues could now be addressed through the construction, commissioning and testing of a pilot-scale plant for wet oxidation and BNR, which could be located directly at the RDC WWTP site. Design specifications and costings for such a plant are included in the project outputs.

Full details of the Feasibility Study are available in the contract report: Waste 2 Gold – Biosolids Management Opportunities for the Rotorua District Council – Technical Report – January 2009 – Contract No.75502.
This report can be made available under confidentiality if requested.

→ Feasibility Study

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Introduction

In a world of increasing demand for sustainable waste management, the drivers for reducing waste volumes to landfills have become critical. Here in New Zealand, the Waste Minimisation Act 2008 was introduced to 'encourage waste minimisation and decrease waste disposal in New Zealand'. Under the Act, a $10 per tonne levy (excluding GST) on all waste disposed to public landfills was imposed from 1 July 2009. There is no legislative limit to how much the landfill levy can increase and it can be expected that the levy will continue to rise as the government seeks to incentivise diversion.



Organic solid wastes create some of the greatest concerns regarding landfill operation:

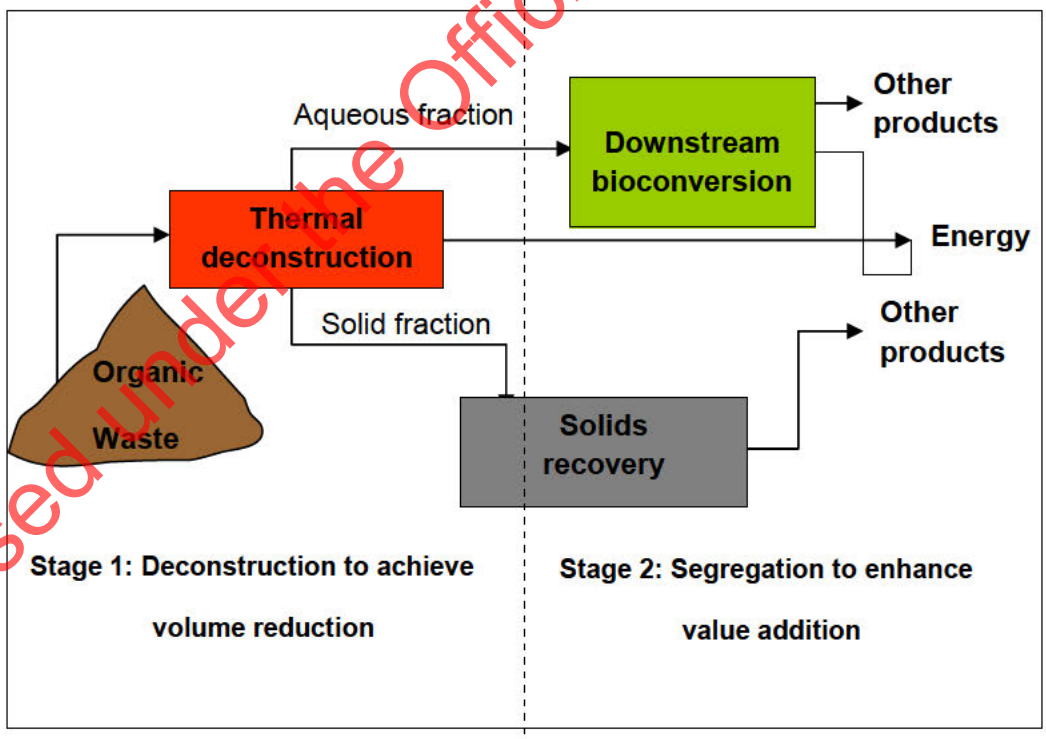
- Typically, organics represent over 50% of total waste volumes entering municipal landfills in New Zealand;
- High moisture content makes transportation costs high;
- Under landfill conditions, organic wastes generate large volumes of poorly recoverable methane, a potent greenhouse gas;
- Leachates generated from these wastes contribute to eutrophication of waterways;
- Some organic wastes, such as wastewater treatment plant biosolids, contain pathogens or heavy metals, creating health and safety issues.

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Despite increasing legislative and economic pressures, significant diversion from landfills remains a considerable challenge. For example, available technologies for organic waste diversion from landfills are only partially successful due to a range of factors, including:

- Inability to achieve required solids reductions (e.g. anaerobic digestion).
- Significant land areas required (e.g. vermicomposting).
- Odour generation (e.g. windrow composting).
- Inadequate energy balances (e.g. incineration or drying).
- Lack of sufficient markets for diverted products (e.g. mulches).
- Contain contaminants that preclude substantial re-direction (e.g. pathogens and/or heavy metal limits for land application of biosolids).

The Scion Waste 2 Gold programme seeks to develop technology platforms that address these needs for organic wastes by i) achieving substantive solids reductions; ii) maximising embodied energy recovery from these low-value carbon substrates; iii) generating added value co-products where appropriate; and iv) ensuring that recalcitrant contaminants are destroyed or segregated (Fig. 1).



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Simplistically, our approach is to break down complex organic wastes into simple, short-chained organic molecules. These molecules can then be converted to a range of end-products, including bioenergy.

Central to the Waste 2 Gold technology approach is a thermal deconstruction process that combines high pressures and temperature with oxygen to break down the physical structure of the waste material. This deconstruction process leads to a substantive solids reduction and is controlled in a manner that retains a carbon fraction as a readily degradable liquid organic feedstock:

This carbon-rich output can be used for a range of added-value opportunities, such as:

- Replacement of existing ethanol supplementation in biological nutrient removal wastewater treatment plants (currently $380K/yr at RDC WWTP);
- Energy production as heat, methane or electricity;
- Feedstocks for novel industrial biotechnology applications, such as production of biodegradable plastics and liquid biofuels.

This technology also has the advantage of producing fractions high in recoverable nitrogen, phosphorus and metals, these valuable nutrients could be extracted for beneficial re-use (e.g. fertilisers).

These opportunities to extract value from the carbon and nutrient content of the wastes are an important feature of the Waste 2 Gold concept. Other available technologies do not have the same ability to use of waste outputs to the levels offered by this approach.

In addition to the above technical opportunities, the benefits of the Waste 2 Gold concept to Rotorua District Council organic waste management might include:

- Elimination of the landfill's single highest volume waste source extend potential landfill life;
- The opportunity for RDC to receive and process other regional biosolids at the plant;
- Potentially simplifies the consenting process because it is likely to be a permitted activity at both the WWTP (for biosolids) and the landfill;
- Potential to mine organic materials from decommissioned landfills, thus increasing future landfill capacity;
- Potential to gain GHG credits through voluntary reduction in organic waste volumes entering the landfill and consequent decreases in methane release;
- Elimination the transportation of high water content biosolids from WWTP ($650K per year for transport and landfill charges) and/or investment in supplementary technologies (e.g. drying systems) to lower transportation volumes;

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- Reduction in costs associated with the waste levy being introduced in 2009, starting at $10/tonne and likely to rise, representing a minimum cost of $90-100K (biosolids portion) in the first year;
- Elimination of carbon supplementation costs at the WWTP (approx. $380K/yr) through the production of biologically available carbon (e.g. acetic acid);
- Elimination of potential health issues associated with handling and disposal of biosolids due to the sterilisation inherent in the thermal deconstruction process;
- Creation of an alternative pathway for value-added products away from existing, marginally economic, composting operations.

Wider opportunities exist for technology transfer. The Waste 2 Gold concept could be adopted nationally and internationally for the improved management of biosolids and other organic waste streams. It is clear that most Councils in New Zealand are struggling with the biosolids issue and, as such, this is a key target for the NZ Waste Strategy.

Opportunity pipeline

This report summarises the outcomes of the first of six proposed stages of a technology development pipeline aimed at realising the broader Waste 2 Gold opportunity for the Rotorua District Council:

Stage 1: Laboratory-scale investigation to determine the operational envelope for deconstruction of RDC biosolids. The outcome focus is on substantive solids reduction and production of low molecular weight organics suitable for WWTP carbon supplementation. Stage 1 also provides design parameters for a pilot-scale thermal deconstruction facility.

Stage 2: Construction, commissioning, and operation of a pilot-scale deconstruction system in order to test the technology in real-time at the RDC WWTP and provide design parameters for a full-scale facility.

Stage 3: Construction, commissioning, and operation of a demonstration plant sized to deconstruct the entire WWTP biosolids stream.

Stage 4: Laboratory-scale investigations to establish the operational envelope for deconstruction and added-value utilisation of other components of the Atiamuri landfill organic solid waste stream (e.g. paper, food wastes, putrescibles).

Stage 5: Operation and optimisation of the pilot-scale and/or demonstration plant on broader organic solid wastes to define and confirm technical and economic performance requirements.

Stage 6: Design, construction, and commissioning of a full-scale deconstruction facility at the landfill.

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Contracted deliverables

The purpose of this Phase 1 study was to prove the thermal deconstruction process at laboratory scale and deliver the following outcomes:

- Define the composition of RDC WWTP biosolids, with particular emphasis on parameters relevant to deconstruction efficiencies;
- Develop a high level operational envelope for the deconstruction of biosolids, with a particular emphasis on solids reduction and constituent segregation;
- Determine the suitability of the deconstruction products for i) re-introduction as a carbon supplement into the Biological Nitrogen Removal (BNR) process, and ii) production of methane for energy recovery;
- Identify technologies for the recovery and use of segregated nutrients (i.e. nitrogen and phosphorus);
- Develop economic models and life cycle analyses and use these to compare the operational cost-benefits for implementation of waste deconstruction relative to alternative options (e.g. anaerobic digestion);
- Determine design parameters and construction costs for a pilot scale facility.

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Resource Characterisation

When evaluating options for the biosolids treatment process, it was necessary to characterise the biosolids at various stages throughout the sewage treatment process. This material can vary in composition and volume. Consequently, this study provided a comprehensive dataset on RDC biosolids characteristics, with a particular emphasis on parameters that might influence the effectiveness of a thermal deconstruction process.

Rotorua District Council records showed that, on average, the WWTP generated 22,933 kg wet weight of biosolids per day (period June 2006 until April 2009). The total amount of dry solids produced equated to 3,595 kg per day (average moisture content of 85.1%). Of these dry weight solids, 32% (1,142 kg per day) originated from primary solids and 68% (2,453 kg per day) from the waste activated sludge (WAS) system. Since 1998 the proportion of this material composted has decreased from 90% to just 10% due to issues with respect to product quality and market acceptance.

A sampling programme and analysis of the final belt press solids (the target feedstock for this project) demonstrated that this material was very consistent over the five month sampling period for the major parameters analysed (Table 1). This relative homogeneity, combined with a high volatile solids and embodied energy content, mean that this material is an excellent substrate for deconstruction to achieve significant solids reduction and energy and carbon recovery.



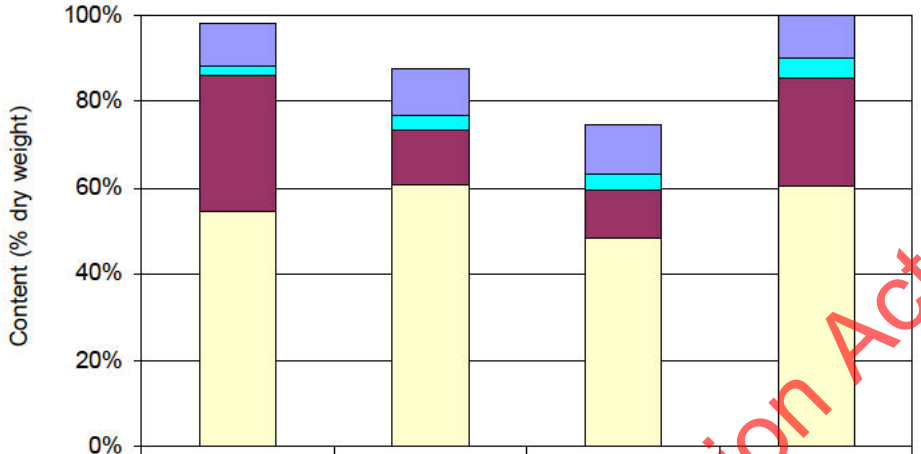
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The content of various bulk organics was obtained by ^{13}C Nuclear Magnetic Resonance (NMR). This analysis showed that protein was the dominant constituent in the biosolids (Fig. 2). The carbohydrates in the primary solids consisted in a large part of cellulose, which likely originated from tissue paper. Each of these bulk organic fractions (proteins, fats, carbohydrates and aromatics) are readily amenable to wet oxidation and therefore were not expected to cause issues in the thermal deconstruction process.

Table 1: Parameter ranges for final dewatered solids averaged over time

Analyte	Unit	Average	Range	Range
			Minimum	Maximum
Solids	%	14.9	11.5	19.5
Calorific value	MJ/ dry kg	18.6	18.1	19.1
Fecal coliforms	MPN/ dry g	1,300,000	n/a	n/a
pH	-	5.70	5.67	5.72
conductivity	µS/cm	1259	1204	1291
Volatile solids	% dry solids	83.3	80.3	87.8
C	% dry solids	44.5	43.1	46.3
O	% dry solids	33.5	33.4	33.5
H	% dry solids	6.5	6.5	6.5
N	% dry solids	6.2	4.8	7.6
P	% dry solids	2.3	0.62	3.2

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	Primary solids	Secondary solids	Mixed solids	Beltpress solids
Fatty acids	10%	11%	11%	10%
Aromatics	2%	4%	4%	5%
Carbohydrates	32%	13%	11%	25%
Protein	54%	61%	49%	60%

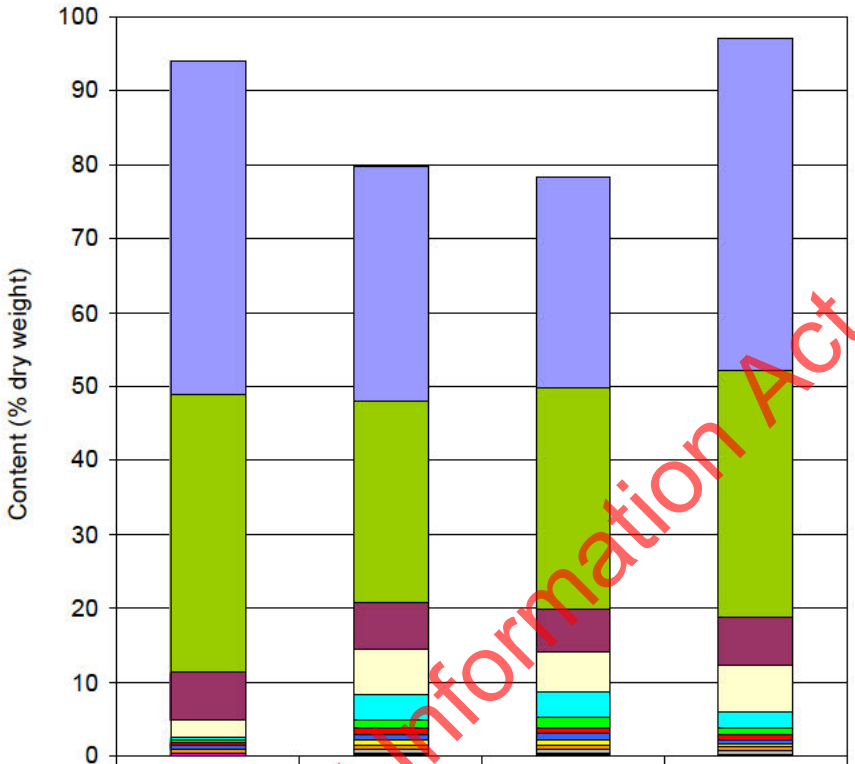
Figure 2: Solid state NMR analysis of RDC biosolids composition

Primary, secondary, mixed, and belt press solids from the RDC WWTP were also submitted to broader elemental composition analysis (Fig. 3). The main differences were that the carbon content was greater in the primary biosolids, while nitrogen and phosphorus content was greater in the secondary biosolids. The mixing ratio of primary to secondary solids could potentially have some impact on the final biosolids composition. The production of primary and secondary solids is generally relatively consistent, suggesting that mixing ratios will not significantly impact on process efficiencies within the thermal deconstruction process.

Nitrogen and phosphorus levels in the final belt press solids were similar to commercially available potting mixes. The metals content was typical for these types of wastes. Additionally, the presence of metals in the biosolids could provide a catalytic effect during the thermal deconstruction process, which may lower energy demands and increase break down efficiencies.

Overall, the RDC WWTP biosolids appeared to be typical of such wastes. No significant compositional impediments to deconstruction were identified and this material provided an excellent baseline product for testing and developing the overall Waste 2 Gold concept for both WWTP biosolids and a broader range of organic waste streams.

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	Primary solids	Secondary solids	Mixed solids	Beltpress solids
C	45.3	31.7	28.4	44.9
O	37.6	27.3	29.9	33.5
H	6.38	6.36	5.70	6.48
N	2.36	6.07	5.40	6.42
P	0.38	3.30	3.50	2.20
K	0.19	1.30	1.40	0.80
Ca	0.67	0.85	0.89	0.76
S	0.39	0.73	0.75	0.56
Mg	0.09	0.67	0.72	0.47
Al	0.25	0.52	0.54	0.46
Fe	0.21	0.43	0.46	0.41
Na	0.31	0.35	0.35	0.09
Heavy metals total	0.04	0.09	0.10	0.08
Rest of micro metals total	0.02	0.05	0.05	0.04

Figure 3: Elemental composition for RDC WWTP biosolids

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Deconstruction and Segregation

Thermal deconstruction is carried out by subjecting the wet biosolids to high temperature and pressure conditions. The specific conditions typically fall into one of two primary categories, thermal hydrolysis and wet oxidation. These are carried out within a wide range of temperatures and pressures; however the fundamental difference between the two, is the addition of an oxidant to the wet oxidation process.

Typical commercial applications of these processes are targeted at improving digester biogas yield (thermal hydrolysis) or complete oxidation of biosolids (wet oxidation), where all the carbon is turned into carbon dioxide. In contrast, the Waste 2 Gold approach is to maximise the potential value that can be realised from the biosolids as an integral part of the solids reduction goal. That potential value is obtainable by selecting operating conditions that maximise the production of chemical products and promote energy recoveries to self sustain the process heat requirements.

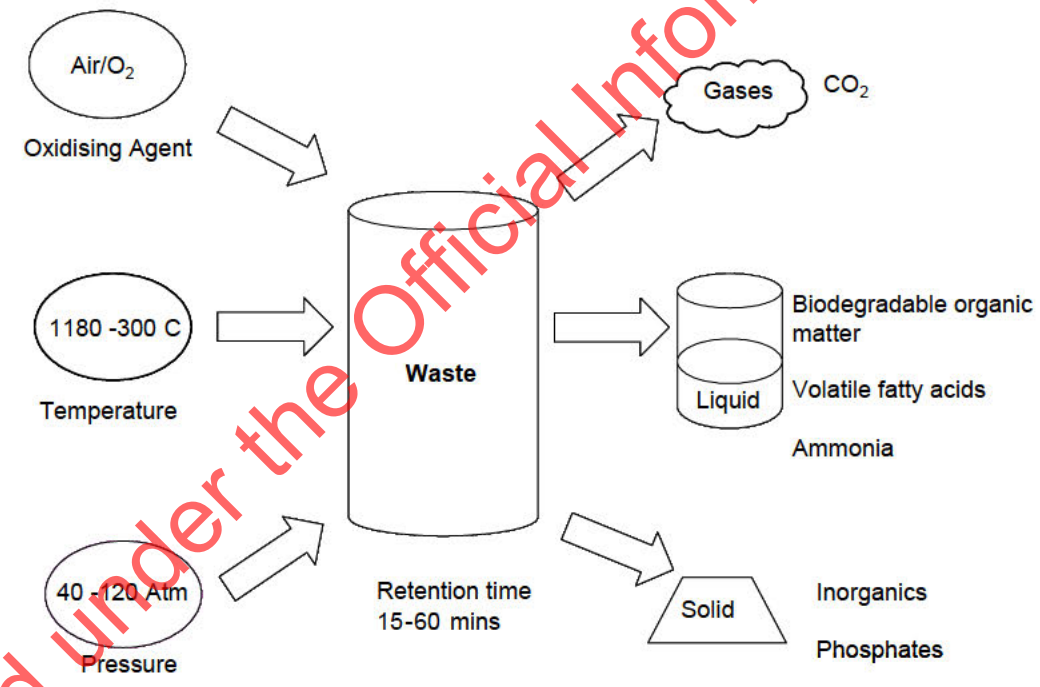


Figure 4: Thermal deconstruction through wet oxidation and thermal hydrolysis

The diagram (Figure 4) shows the overall concept in the thermal deconstruction of biosolids using thermal hydrolysis or wet oxidation. Typical operating conditions for these processes are described in Table 2.

Table 2: Typical thermal deconstruction conditions

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Parameter	Thermal hydrolysis	Wet oxidation
Temperature	125-180°C	150-350°C
Pressure	10-30 bar	50-200 bar
Oxidant	Steam	Air, O_2, O_3, H_2O_2
Influent COD	20-200 g/l	20-200 g/l
COD removal	30-55%	30-95%
Solids reduction	20-30%	90-95%
Retention time	30-45 mins	30-60 mins
Catalyst	None	None, Fe, Cu, etc



The Waste 2 Gold approach employs thermal deconstruction processes using highly controlled conditions to effectively destroy the physical properties of the solids (gasification and/or solubilisation) whilst producing useful by-products, such as chemical feedstocks and generating heat.

The result is a massive reduction in final disposal volumes. This is due to a combination of both significant solids reduction and large improvements in the dewaterability of the final residue.

The production of Volatile Fatty Acids (VFAs) as small molecule carbon compounds is a specific goal for the thermal deconstruction system. VFAs are readily biodegradable, and therefore provide a potentially valuable carbon source for the biological denitrification process employed at the RDC WWTP, or for other biotechnology applications.

The potential ability to separate the carbon, nitrogen, and phosphorus fractions provides a significant advantage for beneficial re-use of these components. Effective separation would allow the VFAs to be fully utilised as a carbon source for denitrification in a BNR process without increasing the nitrogen load on the WWTP.

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Nutrient recovery potential

Municipal biosolids contain considerable amounts of nutrients (e.g. nitrogen and phosphorus) which, after thermal deconstruction, become solubilised or precipitated in the final liquor/solids. A literature review identified technologies suitable for nutrient recovery. Some preliminary laboratory-scale nutrient removal work was also completed on the thermal deconstruction liquors produced from the treatment plant biosolids.

In order to identify various nutrient removal technologies in this report, their underlying technological removal principles were grouped in the following categories:

- Physical removal, which includes mechanisms based on filtration, absorption or ion exchange.
- Physico-chemical removal, which includes mechanisms based on precipitation, crystallisation or evaporation.
- Chemical removal, which includes mechanisms based on oxidation.
- Biological removal, which includes mechanisms based on biological metabolism.

The review identified several technologies available to remove nutrients from thermal deconstruction liquors, including:

- Natural/modified zeolite absorption of ammonia or phosphate.
- Breakpoint chlorination of ammonia.
- Ammonia stripping.
- Struvite production in combination with
    - natural zeolite absorption of ammonium nitrogen, or
    - ammonia stripping.
- Liquid fertiliser applications.

Preference for which of these technologies, or combination of technologies, are most appropriate will depend on (1) the level of nutrient removal required, (2) whether carbon sources are able to be separated before nutrient removal, and (3) the volume of liquor produced, which in turn depends on the solids content at which the deconstruction process takes place. Such factors will become clearer at the pilot plant design stage. A decision tree has been developed for further consideration of these issues (Fig. 10).

In preliminary laboratory tests, both natural and chemically modified zeolites were able to adsorb ammonium and phosphorus from deconstruction liquors. Natural zeolite was more effective at adsorbing ammonium, while modified zeolite was better at adsorbing phosphorus. The different adsorption behaviours for natural and modified zeolites present an opportunity to target more ammonium or more phosphorus removal by using combinations of natural and modified zeolite.

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The economics of using zeolites (or any other process) for nutrient stripping were not assessed, and more work will be required to ensure that any chosen option is viable for the RDC situation. In particular, success in achieving zeolite regeneration would prove highly profitable for the overall process economics.

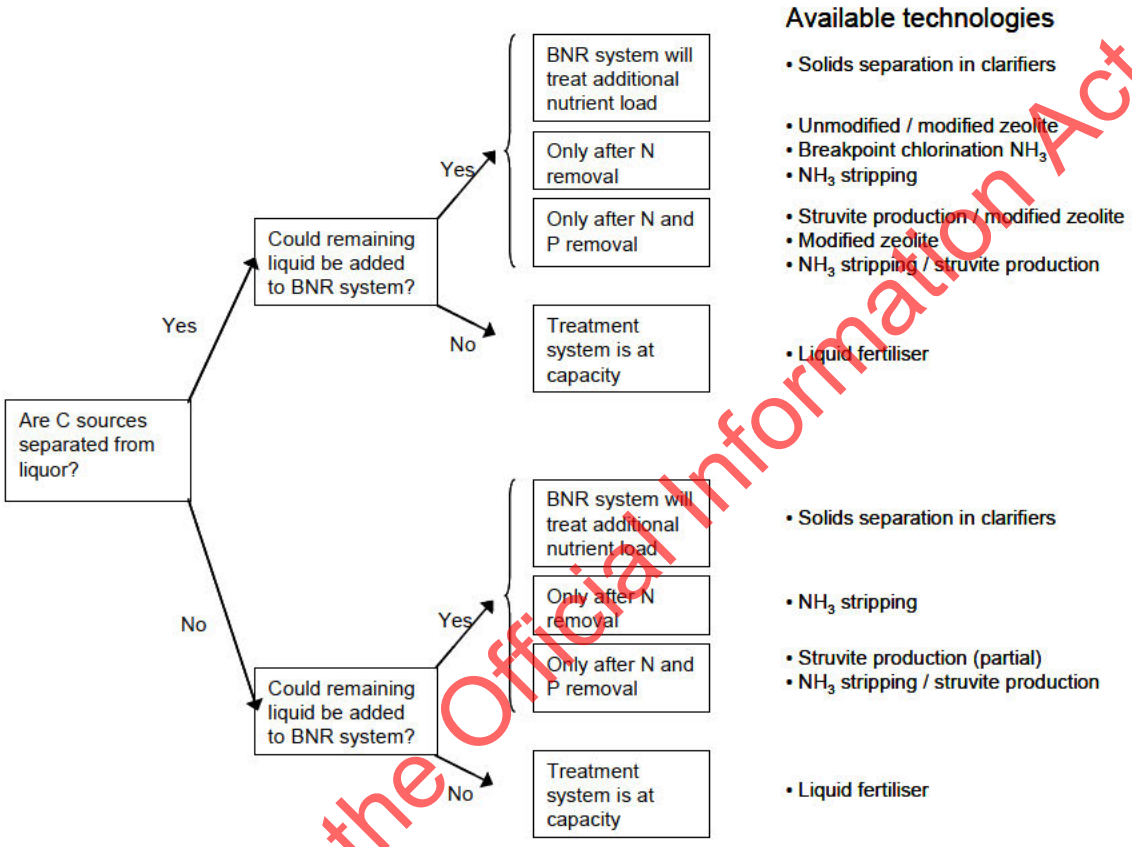


Figure 10: Decision tree for nutrient recovery options

Summary

Results of the value recovery section of this project support the technical and economic advantages of the Waste 2 Gold platform. Even under the relatively sub-optimal conditions utilised for deconstruction at laboratory scale, the resultant wet oxidation liquor is high in readily degradable carbon, especially acetate, and was shown to be an effective carbon supplement for improved nitrogen removal within the WWTP.

This degradable carbon was also a very good feedstock for biomethane generation, supporting its use for energy production at the plant site. The deconstruction process did lower the total methane production potential (relative to raw biosolids) due to the oxidation reactions. However, such reductions could be eliminated through adoption of a hybrid anaerobic digestion/wet oxidation process, which would significantly increase the total energy output of the process without impacting on the observed solids reduction and carbon supplementation benefits.

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A key outcome of the Waste 2 Gold deconstruction process is the highly efficient segregation and homogenisation of the carbon, nitrogen and phosphorus content of the biosolids into simple, readily recoverable chemical feedstocks. Preliminary laboratory studies and a literature review have identified several pathways for more effectively exploiting this benefit.

Process Sustainability

Beyond the technical focus of the current project, it was important to consider the overall economic and environmental sustainability of the proposed Waste 2 Gold platform. Further, this process holds commercial opportunities beyond its potential application to the RDC WWTP site. A patenting strategy and freedom to operate analysis was also initiated. These aspects of the project are summarised below.

Economic Model

A process engineering model was developed to describe the thermal deconstruction of biomass solids arising from a wastewater treatment system. The model included key mass, carbon and energy flows. The model design has flexibility in selecting a range of input variables, thus providing a description of a general process flow, under different mass inputs (e.g. biosolids mass flow) or process performance criteria (e.g. wet oxidation efficiency).

This process model was used to complete high level economic analyses. These analyses describe the integration of a wet oxidation technology into the biological wastewater treatment system and biosolids landfilling process stages appropriate to the RDC situation.



The process model has been extended to describe a number of alternative scenarios, for comparison against the current biosolids landfilling practice. All scenarios begin with a denitrification process (DN, this being part of the existing WWTP process).

Anaerobic digestion is the most widely used conventional sludge solids reduction technology in use today. As such the alternative scenarios that have been built from this work reflect a bias towards integration of AD as a unit operation.

Acetic Recycle (AR) is also an important aspect of the process alternatives. Within wet oxidation, the biosolids are converted to small molecules, represented by acetic acid. This can be used back within the WWTP as a substitute for the ethanol supplementation currently practiced.

Table 7 provides a descriptive overview of the process alternative scenarios which were assessed within the economic analysis.

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Table 7: Economic analysis scenarios

Scenario	Code	Description	*Relevance*
Baseline	LF	Current landfill operations	
1	WO-AD	Wet oxidation (WO) followed by anaerobic digestion (AD)	*WO liquors produce a beneficial feed for AD (high in soluble organic acids)*
2	WO-AR/AD	Wet oxidation with re-use of liquor as ethanol substitute. Residual acetate used in anaerobic digestion for biogas production	*Scenario useful if limited carbon is required back within WWTP and excess acetic acid is produced during wet oxidation*
3	WO-AR	Wet oxidation only with liquor used as ethanol substitute	*Target scenario for RDC project, reflecting reuse of wet oxidation liquors into WWTP*
4	AD-WO-AR	Anaerobic digestion, followed by wet oxidation, with liquor used as ethanol substitute	*AD yields methane, as energy source. Lower oxygen requirements in WO process as a result of AD "pretreatment".*
5	AD	Anaerobic digestion only	*Conventional scenario for biosolids minimisation*

The costs for the key process steps were integrated into the model, allowing examination of the potential economic impact of changes to these costs, for the different scenarios and under variations to the model inputs. At this stage, the association of costs with these process steps has a great deal of uncertainty, and further work is needed to reduce the level of this uncertainty. With this caveat, some basic analyses are presented in Table 8.

The key observations from the scenario analyses are as follows:

- All alternative scenarios provide a better long term option than landfilling, particularly as landfill charges, levies and greenhouse gas emission charges increase;
- The scenarios with AD prior to WO, or AD alone, seem to produce the lowest operational and capex cost demands;
- Wet oxidation costs are predicted to be significant, working out to be 50-90% of the total costs of Scenarios 1-4.
- Despite high processing costs, the reduction in costs of ethanol addition, landfilling and GHG production are able to more than offset this impact. This results in significant potential for economic benefit to arise from the thermal deconstruction of RDC biosolids.

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Table 8: Summary economic analyses of waste management scenarios for RDC WWTP biosolids-base case

Description	Landfill	Scenario 1 WO-AD	Scenario 2 WO-Ar/AD	Scenario 3 WO-AR	Scenario 4 AD-WO-AR	Scenario 5 AD
Ethanol cost ($/annum)	$367,000	$367,000	$36,000	$36,000	$235,000	$367,000
Wet oxidation processing cost ($/annum)	$-	$877,000	$877,000	$877,000	$359,000	$-
Anaerobic digestion energy generation cost ($/annum)	$-	$47,300	$12,600	$-	$126,000	$126,000
Transport fees ($/annum)	$91,300	$17,600	$16,800	$6,950	$3,060	$42,600
Waste levy fees ($/annum)	$91,300	$17,600	$16,800	$6,950	$3,060	$42,600
Landfill fees ($/annum)	$548,000	$105,000	$101,000	$41,700	$18,400	$256,000
Carbon tax ($/annum)	$270,000	$69,800	$58,300	$70,900	$64,100	$144,000
Landfill energy generation cost ($/annum)	$-	$-	$-	$-	$-	$-
Revenue from electricity ($/annum)	$-	$47,300	$12,600	$-	$126,000	$126,000
Subtotal Landfilling cost (Transport,levy,LF fee) ($/annum)	$731,000	$141,000	$135,000	$55,600	$24,500	$341,000
Gross Revenue	$-	$47,300	$12,600	$-	$126,000	$126,000
Cost ($/annum)	$1,370,000	$1,500,000	$1,120,000	$1,040,000	$809,000	$978,000
Net cost ($/annum)	$1,370,000	$1,450,000	$1,110,000	$1,040,000	$683,000	$852,000
Savings compared to landfill ($/annum)	$-	-$86,000	$263,000	$329,000	$686,000	$517,000
Net benefit per tonne biomass diverted from landfill ($/dry tonne)	**-$0.00**	**-$100**	**$180**	**$230**	**$490**	**$370**

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Sensitivity analyses were conducted on wet oxidation, landfilling and anaerobic digestion costs, along with the efficiency parameters for anaerobic digestion and wet oxidation processes. Key conclusions from the sensitivity analyses were as follows:



- Wet oxidative treatment of sludge at the RDC site becomes viable at around $600/dry tonne, costs consistent with energetic and capital requirements for wet oxidation;
- Landfill and transportation costs are key to the economic viability of all other scenarios:
    - At landfill costs over $80/wet tonne of disposed solids, wet oxidation scenarios are favoured over the current situation;
    - The geographic proximity of the RDC WWTP to the landfill means that transport costs for biosolids are low (approx. $80/tonne). When considering other sites, these costs are likely to be substantially higher. As one example, landfilling costs at Queenstown are estimated at over $200/tonne. In that location, the potential benefit of Scenario 4 would be over $1M per year, using the base-case dataset.
- Integrated processes appear to have significant potential. The model scenarios identify anaerobic digestion, followed by wet oxidation (Scenario 4), to potentially be the most viable alternative. This occurs because anaerobic digestion acts as a pre-stage for extracting useful energy from the biosolids and reducing material flows to the wet oxidation plant, whilst the destructive capabilities of the latter process are retained. This hybrid approach should be addressed in ongoing work.

Not included within the analysis is any benefit from extraction and sale of nutrients from the wet oxidation liquors. The technical work completed in this project has demonstrated that an inorganic solid containing high levels of phosphorus is produced from the wet oxidation process. Superphosphate reportedly sells for approximately $400/tonne for a product containing 15% P (phosphorus value therefore $2700/tonne P). Phosphorus recovery within the solid fraction at the RDC WWTP would be 10-15 kg/dry tonne feed biosolids for the RDC material. At a solids flow of 1350 dry tonne/yr, this would equate to a revenue proposition of $36,000-54,000, without any associated extraction costs.

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It would be useful to consider integrating additional phosphorus recovery from the final treated discharge of the RDC WWTP (e.g. by precipitation/deconstruction). This would further improve the value addition opportunities for fertilizers and substantially reduce a key point source of eutrophication for the Lake Rotorua catchment.

The potential returns on phosphorus extraction and sale are insufficient to make a major impact on the process economics, for the current site. However, it may provide an interesting revenue stream for the material, should extraction costs be low, and the product of acceptable quality. Further, at larger sites, the revenue opportunity could become compelling.

Uncertainty around key model inputs limits absolute quantitation of cost savings over the current biosolids disposal methods used by RDC. However, the model does not highlight any major barriers to the goal of obtaining significant savings for RDC, using the thermal deconstruction approaches addressed in this report.

In summary, the high level economic analyses suggest there are operational scenarios which integrate the thermal deconstruction processes with potential to achieve substantial net benefits for the RDC WWTP biosolids waste streams alone.

It is very important to note that the RDC Atiamuri landfilling costs are low relative to most operations in New Zealand. Indeed, other landfills may have costs of over $200/tonne and considerably greater transport distances. Therefore it can be assumed that the overall net benefits beyond the current RDC landfill (and without consideration of increased waste levies) would like to be higher for many other New Zealand and international WWTP and landfill operators.

Life cycle assessment

Environmental Life Cycle Assessment (LCA) is an analytical tool for the systematic evaluation of the environmental impacts of a product or service system through all stages of its life. This was undertaken for a range of potential waste scenarios for the Rotorua District Council. These scenarios were chosen to represent possible future waste handling options, specifically around the treatment of biosolids from Rotorua's WWTP.

Five possible scenarios for the WWTP biosolids were modelled using the LCA software GaBi 4.3:

- Disposed directly to the RDC landfill (the current situation).
- Disposed to a landfill that represents the 2010 predicted New Zealand average landfill (i.e. includes methane capture and energy generation).
- Treated in a thermal deconstruction (wet oxidation) plant, followed by anaerobic digestion of the acetic acid output and energy generation (WO-AR/AD).
- Treated in a thermal deconstruction (wet oxidation) plant to produce acetic acid which is fed back to the WWTP to be used in the denitrification process (WO-AR).
- Treated by anaerobic digestion for energy generation (AD).

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As expected, landfilling resulted in the highest methane emissions, and no reduction of solids or eutrophication. When methane is captured however, there is energy production and a reduction of potential climate change impacts.

The results showed that the scenarios incorporating wet oxidation had the greatest solids reduction, and the greatest benefits for climate change and eutrophication. From the perspective of energy, acidification and ozone depletion, anaerobic digestion was the best option, as it produced the largest amount of energy and therefore displaced energy from other (including fossil) sources. This again highlights the prospective benefits of combining both wet oxidation and anaerobic digestion into a hybrid system.

The process scenarios point to a high level of sensitivity in energy requirements for the wet oxidation process alternatives, based on the efficiency of dewatering in the final biosolids feedstock to the thermal deconstruction process. Moving from 3% to 7% solids (a 133% increase) yielded a 70% reduction in predicted energy requirements and, as a result, the process becoming self-sustaining from a heat input perspective and therefore favourable from an energy use and displacement perspective.

Further LCA work required for this project includes updating parameters based on more rigorous analysis from larger-scale trials. Energy requirements and sources (including the option of geothermal heating) will need to be more rigorously defined. Also updating any overseas models (for example for oxygen production) with New Zealand data would be beneficial to the accuracy of this LCA.

Summary

Economic and life cycle analyses have quantified the positive cost savings and environmental benefits of adopting the Waste 2 Gold platform, A hybrid system, integrating deconstruction with anaerobic digestion, was found to be particularly beneficial when compared with landfilling. Under this scenario, combined treatment of RDC WWTP biosolids would generate a net benefit of $686,000 per year. If such an approach was adopted for all of the RDC organic wastes currently landfilled at Atiamuri, then the overall benefit could be approximately $4 million per year.

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Conclusions and Recommendations

An extensive laboratory-based evaluation of the Waste 2 Gold concept has identified wet oxidation as a thermal deconstruction process that is a viable treatment option for RDC biosolids. Wet oxidation is able to achieve solids reduction levels of 96% equating to a potential saving of approximately $700k per year in landfill costs. The product liquor is likely to be able to be recycled to the WWTP as a carbon supplement without the need for further treatment.

In contrast to competing technologies, the Waste 2 Gold approach targets the production of biodegradable carbon as a valuable product. Carbon in the form of acetic acid was produced in considerable concentrations during the wet oxidation of RDC biosolids. The potential for this carbon to offset the ethanol dosing being undertaken at the RDC WWTP was investigated through intensive laboratory-scale studies and process modelling. This concluded that the product is suitable for use as a BNR carbon source and can substantially offset the current ethanol consumption at the RDC WWTP (currently costing ~$380k per year).



This project identified further opportunities for enhanced value recovery through a) segregation of carbon, nitrogen and phosphorus products and b) hybrid wet oxidation-anaerobic digestion systems which could effectively balance energy demand against operational benefits and solids reductions. Methane generation has been demonstrated to be a feasible potential use of the product liquor as an alternative value recovery option.

Economic and life cycle analyses confirmed that thermal deconstruction can provide a significant net commercial and environmental benefit to RDC. Furthermore, the economic modelling highlighted a potentially improved process by incorporating an upfront anaerobic digestion stage. The additional stage would optimise the potential value recovery by producing biogas and reduce the second stage wet oxidation costs. This concept would require further investigation and is considered to be a likely second generation deconstruction process.

Overall, the results of this project suggest there may be few (if any) technical barriers at laboratory scale to implementing the Waste 2 Gold concept for RDC WWTP biosolids. There is a potential to achieve a 30-fold reduction in final disposal volumes of biosolids from the WWTP and the capacity to substantially offset current carbon supplementation costs for nutrient management.

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Recommendations

Scion would recommend that critical scale-up issues could now be addressed through the construction, commissioning and testing of a pilot-scale plant to be located directly at the RDC WWTP site. Design specifications and costings for such a plant are included in the project outputs.

There are significant costs involved in building and operating pilot plant facilities for a technology development project of this nature. As such, it is imperative to determine an appropriate development plan and secure sufficient funding to commercialise. The recently launched Ministry for Environment Waste Fund has been identified as a highly appropriate potential funding source for this project. There are immediate timelines for applications to this fund and as such, it is recommended that Scion and RDC enter good faith negotiations as soon as possible with a view to agreeing a suitable structure for supporting the further development and application of this technology.

It is envisaged that the first generation of this technology will initially be targeted at the municipal biosolids sector and that this will be expanded to encompass other organic waste flows through a continuing process of development. The substantial body of knowledge generated during this project provides an excellent platform for the creation of a consortium to develop the technology. This would involve bringing together an appropriate suite of partners to provide critical co-funding and application or technology guidance.

Once an appropriate technology development vehicle has been determined it is recommended that further laboratory-scale investigations are initiated in the areas identified as providing potential additional benefits to the core technology. Specifically, this would include hybridisation with anaerobic digestion and refinement of potential nutrient (N, P) co-products. Depending on relevance, these may feed into the first generation technology tailored to biosolids or further future generations where feasible.

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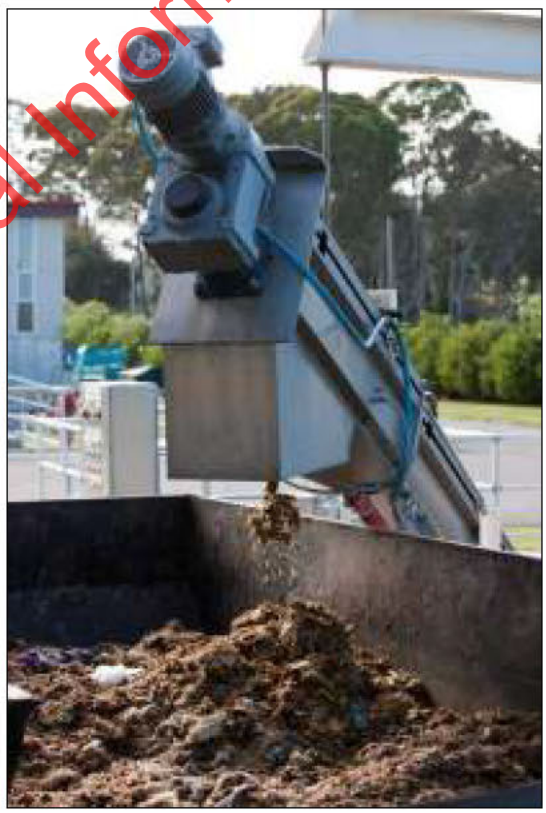
Pilot Plant Design

The production of a pilot plant design for a thermal deconstruction system is a specific deliverable for the RDC Biosolids project. The development of the design was carried out in conjunction with external design engineers, Allan Estcourt Limited (AEL), who were contracted to produce the detailed technical specification for construction.

A pilot plant provides the flexibility to permit a range of tests at a scale that is transferable to a full-scale commercial plant. The distinguishing characteristic of a pilot plant is that its main product is data, not a large volume of physical goods. These data include engineering design information, impact of operating parameters on process efficiency and product quality, feedstock qualification, development of safe operating procedures and assessment of capital and operating costs.

The thermal deconstruction investigations carried out on RDC biosolids provided an operating envelope for the pilot plant design to be based on. The principal criteria identified were:

- Process temperatures capable of maintaining up to 260°C.
- Process pressure greater than 50 bar.
- Air or pure oxygen as oxidant source.
- Continuous oxidant addition.
- Batch and continuous operation capability for both liquid and gas phases.
- Maximise feed solids concentration in continuous mode.
- Minimum reaction period of 60 minutes.
- Post process flash cooling and separation capability.
- Post process chemical dosing capability (i.e. pH adjustment).



These criteria combined with practical constraints, such as standard equipment sizing, were used as part of the design brief to the external design engineers for the pilot plant technical specification.

Whilst the pilot plant phase of the project centres on a thermal deconstruction process, the inclusion of a Biological Nitrogen Removal (BNR) pilot plant is also required. This will allow the evaluation of the impact of the thermal deconstruction products on the RDC wastewater treatment process and accurately assess the potential benefit as a carbon source.

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A pilot scale wet oxidation plant will have the potential to fulfil a number of different objectives for the purposes of both, research and development, and commercial scale-up.

Scale-up strategy

The two principal objectives for the RDC pilot scale biosolids application are:

- Demonstrate thermal deconstruction process scale-up and repeat the performance achieved at lab-scale on RDC Biosolids;
- Produce a viable commercial scale design basis for the RDC WWTP

Following the successful completion of pilot trials, the plant is envisaged to provide a functional basis to further the research and development. This would include the ability to:

- Evaluate thermal deconstruction on different types of organic wastes including bio-solids from other waste water treatment processes;
- Evaluate benefits of integrating with other pilot plants, such as anaerobic digestion;
- Develop the ability to effectively separate greater component fractions for beneficial re-use;
- Reconfiguration into high temperature biological reactor.

The design team identified three different modes of operation as a basis for initial runs which can be further extended based on experience gained during the actual runs. The operational modes were; batch operation, continuous operation, and semi-batch operation.

A schematic for the process design representing the three operational scenarios is shown in Figure 11:

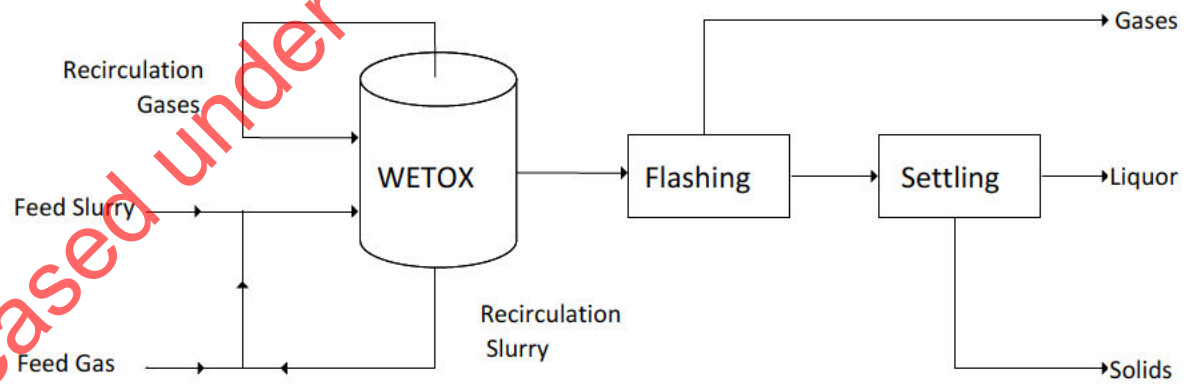


Figure 11: Schematic of Wet Oxidation process flow diagram

The capital cost estimate for the pilot plant has been produced by AEL as part of the production of the technical specification. The estimate for the construction and installation of the proposed thermal deconstruction pilot plant is **$848,500.** This sum has an accuracy of +/- 20% and includes project management and research equipment specified by Scion.

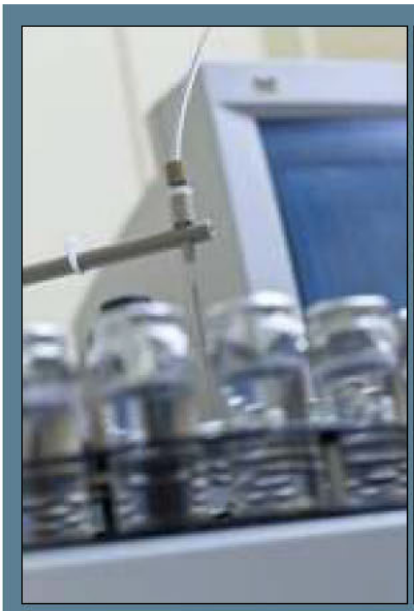
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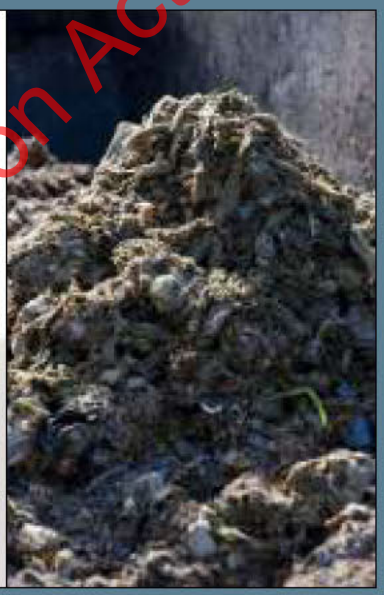
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Next generation biomaterials

2010 Waste Minimisation Fund Application

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Business Plan

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"Changing the way New Zealand thinks about waste"

Waste 2 Gold

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Contents

Executive Summary 62
Introduction 64
Key Parties 65
The Challenge 68
The Process 69
Competitive Analysis 71
Market Analysis 77
Market Entry Plan 79
Key Technical and Commercial Milestones 82
Financial and Investment Plan 84
National Return on Investment 86
Governance and Project Management 87
Risk Management 89

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Executive Summary

Scion's Waste 2 Gold platform is being developed to support national goals and legislation to divert organic solid wastes from landfills. The technology can achieve substantial solids removals (>96%) for these wastes through a proprietary thermal oxidation deconstruction process which breaks down the physical structure of the material and generates useable by-products.

In addition to large reductions in transportation and landfill costs achieved by solids reduction, the process outputs improve overall economic efficiency by offering added-value opportunities:

- Novel industrial biotechnology applications to offset fossil fuel imports, such as production of biodegradable plastics and liquid biofuels;
- Energy generation from the processed organic wastes; as heat, methane or electricity;
- Fertiliser manufacture from recovered nitrogen and phosphorus side streams;
- Replacement of commercial carbon supplements (eg ethanol) currently used in the wastewater treatment plant (WWTP) to maintain nitrogen removal performance.



The primary customers for the process are seen to be Territorial Authorities and specific primary industry operators which generate large volumes of organic waste.

The Thermal Oxidation Process development pipeline initially focuses on WWTP biosolids, which are considered a priority disposal issue due to handling issues (potentially hazardous, high water content, odours and putrescibility), downstream environmental impacts (greenhouse gas emissions, nutrient-enriched leachates from landfill) and disposal constraints (regulatory guidelines on heavy metal content, limited compost markets).

An existing partnership between Scion and Rotorua District Council has de-risked this opportunity at laboratory scale and demonstrated the following benefits for biosolids disposal:

- 96% reduction in landfill costs;
- 76% reduction in greenhouse gas emissions;
- 36% reduction in wastewater treatment costs;
- 40% reduction in eutrophication potential; and
- 90% reduction in photochemical ozone creation potential.

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Overall, the process could generate a net benefit of $490 per dry tonne of biosolids with predicted savings to Rotorua District Council of $700,000 per annum for their current landfill operations.

This business plan encompasses a scale-up strategy that manages technical and economic risks to allow the Waste 2 Gold opportunity to target a broader range of organic wastes currently sent to New Zealand landfills. It is estimated that 53% of current total NZ waste volumes (i.e. 2.2 million tonnes/year) could be processed using this deconstruction process. A ten year roll-out plan has been developed that would initially divert 342,000 tonnes per annum from public and company landfills, representing about 16% of the New Zealand organic waste stream.

Several barriers have been identified that could hinder or stall implementation (e.g. lack of capital, shortage of engineering capability, insufficient cost benefit advantages, adaptability of existing infrastructure). Most of these barriers should only slow down implementation, rather than present a terminal problem.

The technical, financial, social and investment risks associated with the plan will be managed in accordance with best practice engineering approaches and in through best practice Stage Gate management. This directs that each stage is reviewed to make sure that all levels of risk are assessed to minimise surprises and ensure the project continues to deliver the expected outcomes (see Scion Capability Section).

Scion, FRST and its industry partners have invested $2.6 million to date to demonstrate the potential of this opportunity at laboratory scale. Scion, on behalf of the Waste 2 Gold partners, is now seeking $1.7 million over two years from the Waste Minimisation Fund to take this process to pilot scale. This will be supported by $1.9 million in leveraged partnership investment. Based on current figures, the return on investment for the Waste Minimisation Fund would be 1480% per annum after 10 years.

In summary, we believe the wider application of this platform to New Zealand will reap considerable benefits including:

- substantive landfill volume reductions through introduction of a truly disruptive technology;
- significant improvements in waste environmental footprints for end users;
- cost reductions and capacity extension for existing sewage treatment and landfill operations;
- development of new revenue streams through product sales, with concurrent new manufacturing opportunities.

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Introduction

Scope

This business plan addresses the context and critical actions necessary to implement Scion's Thermal Oxidation Process (the Process) to deliver national benefits of avoiding landfilling of municipal biosolids as a lead to diverting a broader range of organic wastes from landfill and simultaneously realising economic benefits to the nation.

Municipal biosolids are classified as hazardous wastes and arise from the treatment of sewage wastes. Landfilling such wastes creates a financial burden on Territorial Authorities associated with transport and dumping. It also creates an environmental burden on the landfill area due to leachate generation and their ready conversion to greenhouse gases.

Over the next two years, the project will focus on development of the Process to pilot scale. The pilot plant will enable the Process to be scaled up from a laboratory-scale operation to a commercial facility with the least risk. The core partner for development will be Rotorua District Council, which represents a typical New Zealand territorial authority. They have identified biosolids as their primary waste issue and have already committed leveraged investment to this project.

Beyond our Territorial Authority partner, the project will undertake a formal expansion process at a regional level. The Bay of Plenty (BOP) represents a exemplar microcosm for New Zealand waste management and we believe it is an ideal model for a national-level initiative:

- It contains some of the fastest growing municipalities in New Zealand with a consequent increasing biosolids management issue. Future scale up of the Process in the region would provide a direct solution to this issue.
- The largest point sources (approximately 200,000 t/yr) of NZ industrial organic wastes are generated within 50 km of Rotorua by two pulp and paper mills. The wastes from these mills are similar to biosolids and therefore are appropriate feedstocks for direct introduction into the Process.
- The BOP contains examples of all New Zealand's major primary industry sectors – dairy, meat, horticulture, pulp & paper and fishing - all of which have appropriate feedstocks to demonstrate the application of the Process to a broad range of national waste streams.

Context

This business plan is written to address a national value proposition associated with investment from the Waste Minimisation Fund. It is important to recognise that there are several parties to this proposition, each of which is seeking a range of benefits associated with developing and implementing the Process. This plan is therefore a critical part of the larger business strategy associated with providing value to a range of parties including:

1. **Early science and technology investors** who supported the underpinning research for the Process, which include Scion and Foundation for Research Science and Technology.

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2. **Early adopter investment parties** who wish to de-risk the opportunity to an appropriate scale, which include Rotorua District Council, Norske Skog and Carter Holt Harvey.

3. **Evolving investors and stakeholders** who will implement the commercial solution and include the above parties plus other territorial authorities and industrial processing end users, engineering companies and commercial investors.

Structure

This Business Plan has been developed by the Waste to Gold Alliance. The key parties are Scion and the Rotorua District Council. Also considering inclusion are special interest stakeholders, including Norske Skog, Carter Holt Harvey and AWT New Zealand Ltd. Although it has been operating through a joint contractual structure, the Alliance is in the process of formalising this arrangement to ensure appropriate levels of governance and management are in place. All contracts will be managed by Scion on behalf of the partnership.

Key Parties

Scion

Scion is one of eight Crown Research institutes in New Zealand. The corporate intent for Scion is to deliver benefit to New Zealand. It achieves this through development of technology-based solutions and partnering with appropriate commercial entities to implement these solutions. As a CRI, Scion is highly experienced in managing and delivering publically-funded or public-private co-funded projects and opportunities.



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Scion has a strong track record of successes in areas complementary to the current project, such as:

- developing waste management solutions for the New Zealand pulp and paper industries (via Pulp and Paper Waste Minimisation Project Committee; approx. $250,000/yr industry co-investment over past 15 years) that allowed the companies to cost effectively meet key discharge consent requirements;



- a nutrient capping system implemented in the Rotorua Lakes by Environment Bay of Plenty in association with Blue Pacific Minerals Ltd (full-scale manufacture and application of approximately 150 tonnes product to a highly eutrophic lake, Lake Okaro, since 2007);
- a long-term land application research programme, which has delivered suitable wastewater and biosolids solutions to a diverse range of clients including PF Olsen Ltd (biosolids application to Rabbit Island) and Rotorua District Council (wastewater spray irrigation to Whakarewarewa Forest);
- implementation of large scale engineering solutions through various partners, including the DRYSPEC kiln drying system with Windsor Engineering Ltd, which is used to dry over 90% of all softwoods in Australasia.

Rotorua District Council (RDC)

RDC is an innovative territorial authority located in the heart of the Bay of Plenty. RDC have been aggressively seeking a solution to manage the increasing quantities of biosolids (8,400 tonnes per annum and rising) that are generated from their WWTP. They have recognised that a solution is urgently needed beyond business as usual and have been a key participant in developing the Process beyond laboratory application to the point where it has demonstrated its commercial potential. The RDC are both an end-user and an investor into this process development as they recognise the potential value that can be achieved from its wider application in New Zealand.

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RDC have demonstrated a long term commitment to be an early adopter of innovative solutions that deliver good commercial outcomes. Examples include:

- installation of one of the world's first commercial-scale Bardenpho WWTP to remove phosphorus from sewage wastewaters and reduce the eutrophication of the Rotorua lakes;
- development of a commercial composting system for biosolids management (90% of biosolids processed in this system in 1998 – since decreased to 10% due to technical and market limitations);
- installation of an extensive land application system for treated wastewater – a spray irrigation infrastructure that is built around tourism use of the Whakarewarewa Forest; and
- a successful resource recovery centre that diverts as much materia from landfills as traditional kerbside recycling schemes.

Norske Skog Tasman (NZ) Ltd/Carter Holt Harvey Pulp and Paper

The pulp and paper industry has been working with Scion for the last 20 years on environmental issues and have been a core partner for investment and development of environmental technology solutions with Scion in that time.

Their company landfills are nearing capacity limits and they need alternative solutions in the near future. Their wastes closely resemble biosolids (essentially pulp fibre and wastewater treatment system biosolids) and thus they are actively engaged in seeking biosolids management solutions as a significant part of their waste management processes. As the largest point source generators of organic industrial wastes in New Zealand, delivering a new solution to their organic waste issues will directly target 30% of New Zealand's total industrial organic waste flow (Scion National Organic Waste Audit, 2008). Active engagement and negotiations with industry representatives for this specific Alliance are currently underway.

AWT NZ Ltd

AWT is an Australasian leader in advanced wastewater technologies and systems optimisation. They are interested in developing commercial solutions and are seen by the industry as an early adopter of innovative solutions to water treatment issues. Examples include:

- Design, build and commissioning of membrane bioreactor and anaerobic digestion wastewater treatment systems;
- Development of advanced wastewater treatment software models for municipal sewage treatment plants to ensure optimisation of treatment performance and running costs;
- Development of advanced integrated waste treatment systems for enhanced removal of BOD, nitrogen and phosphorus from farm dairy effluents.

Other Partners

The Alliance is actively seeking additional partners within the BOP region and beyond to ensure that the technical and commercialisation pathway is well populated with the appropriate channels to

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implementation. Successful co-funding will target extension of the Process applications to i) non-biosolids organic waste streams (e.g. putrescibles) and ii) enhanced value addition (e.g. novel nutrient separation technologies).

The Challenge

The targets for organic waste in the New Zealand Waste Strategy (2002) were to:

- divert 60% of organic wastes from landfill and use beneficially by 2005 and to exceed 95% diversion by 2010; and
- divert 95% of biosolids disposed to landfill into compost, beneficial use or treated to reduce harm.

The 2006 MfE Targets in the New Zealand Waste Strategy: Review of Progress estimated that only 35% of organic waste and 32% of biosolids were diverted – both well below the target. In addition, the majority of the diversion schemes mainly focused on turning organic material into compost. Product quality, restrictions on use (e.g. due to metals content) and market development were identified as the three main difficulties encountered by those diversion schemes.

Indeed, since the 2006 Review, the Wellington scheme to divert biosolids to produce compost has terminated and the RDC has been scaling back their biosolids composting operation from 90% diversion in 1998 to 10% diversion in 2008 due to lack of markets for the compost.

The Scion-led Waste 2 Gold Project proposes a significant progression to achieving organic waste diversion by integrating substantive volume reduction with new, higher-value products. It also targets and develops new markets for end use products.

Biosolids have been chosen as the priority waste for Process development for the following reasons:

- limited alternative options for disposal due to their characteristics (high water content, odours, putrescibility and hazardous nature) and volumes;
- represent a relatively homogenous waste source available across all of New Zealand;
- contributes a significant percentage of total organic waste flow which could be targeted by a single, generic technology platform;
- process design is readily scalable to waste source due to direct correlation to target populations and population changes.
- convenient waste to manage as they are all delivered/generated at one point – a wastewater treatment plant.
- nature of the Thermal Oxidation Process directly addresses key disposal issues for these waste types (e.g. elimination of pathogens; segregation of nutrients; recovery of energy; elimination of greenhouse gases)

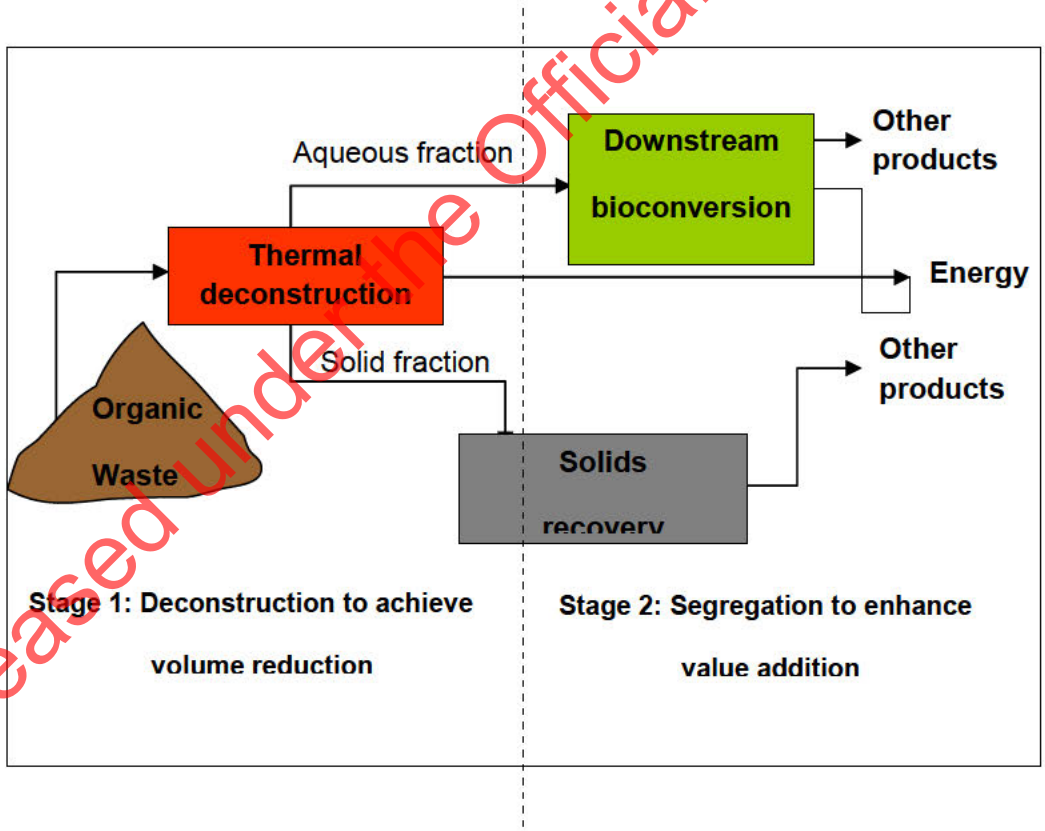
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The Process

Scion has developed and provisionally patented (Patent No. 583082) a novel technology platform for treating very high moisture content organic biomass. The technology was conceived and developed with the following biosolids metrics in mind:

1. **high moisture content**: typically greater than 85% moisture – makes costs of pre-drying/incineration prohibitive;
2. **hazardous constituents**: contain biological pathogens, pharmaceutical residues and heavy metals, such as mercury, that must be destroyed/contained in the process;
3. **energy content**: have a net calorific value of approximately 19GJ/ dry tonne – an intrinsic value which should be recovered during processing;
4. **conversion potential**: have a carbon content of 450 kg/t dry weight, which could be re-used for bioenergy and biomaterials applications;
5. **nutrient loading**: significant loadings of nitrogen (6.2% dw) and phosphorus (2.3% dw) should be captured to avoid downstream eutrophication impacts.

The overall technology is schematically described below:



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The core step is a thermal oxidative deconstruction stage that combines high pressure and temperature with oxygen to break down the physical structure of the waste material. There is a greater than 96% volume reduction in the substrate and, as an exothermic process, excess heat is generated for energy recovery and re-use.

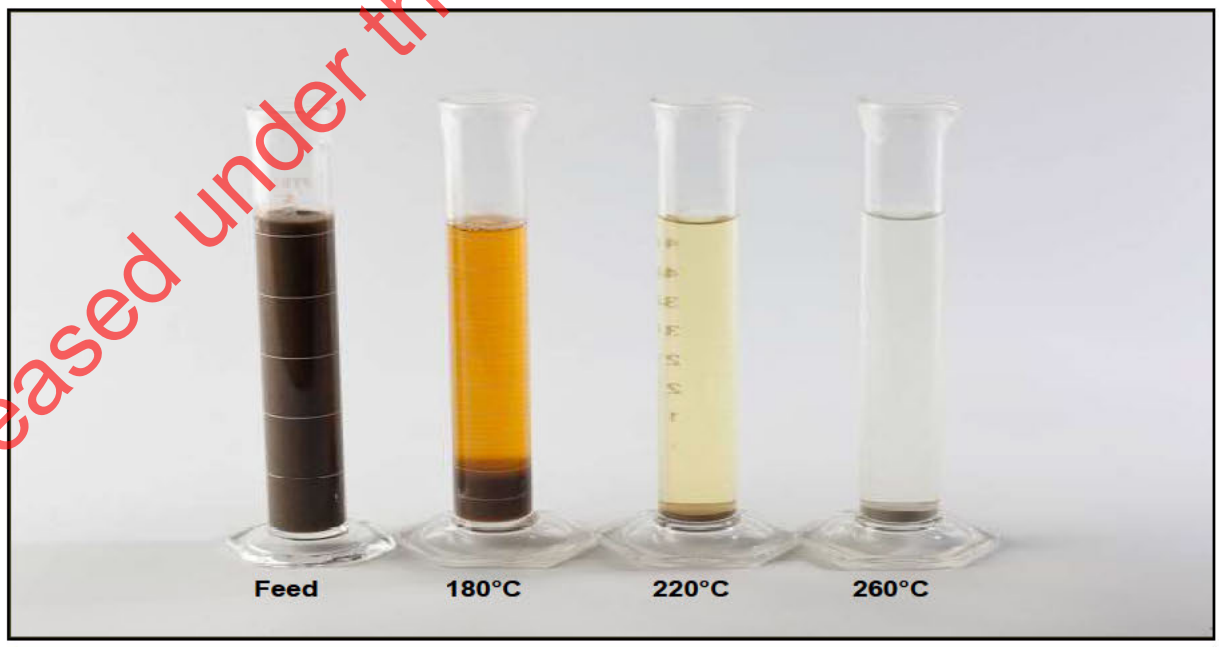
A fraction of the carbon is retained as a readily degradable liquid organic fraction (38% acetic acid) that can itself be used for a range of valuable by-products such as producing:

- biomethane for energy/electricity generation;
- a sterile, high carbon feedstock for industrial biotechnology applications, such as bioplastics or biofuels production.
- a readily degradable carbon supplement that can be recycled into the broader sewage treatment process to offset supplement needs;

In addition, this approach has the advantage of segregating the nitrogen and phosphorus in recoverable fractions from which valuable nutrients can be extracted for beneficent re-use (e.g. fertilisers).

Scion has designed and manufactured a laboratory-scale deconstruction system that integrates a prioprietary on-line monitoring/control system, high pressure reaction vessels and downstream processing and testing infrastructure. This system has been used to complete a feasibility study for the process (see attached summary). Further work has also been completed on added value analysis, including laboratory scale biomethane generation and nutrient recovery processes.

The effectiveness of the Process is shown below. This shows an almost complete removal of biomass solids and the production of a clear, carbon-rich by-product.



Deconstruction Temperature

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Competitive Analysis

A sustainable and acceptable option for the long-term disposal of biosolid wastes must be one that:

- Overcomes the current negative perceptions towards beneficial re-use of bio-solids;
- Minimises or eliminates waste residues;
- Eliminates any potential toxicity or human health issues;
- Generates value; and
- Can be implemented at the source of waste generation to minimise transportation costs.

In addition, the long-term economic, environmental and social sustainability of any disposal technology will see an increasing desire to avoid solutions that have:

- high energy demand as energy cost continues to increase;
- large land area requirements;
- produce unacceptable levels of green house gases, either directly or via indirect activities (e.g. transportation);
- impact on neighbouring land users through, for example, odour production;
- Address cultural issues associated with disposal (e.g. Restoration of mauri through land cleansing)

Scion has completed a comprehensive review of technical and management solutions that can address these issues. The review results are summarised below:

Options for biosolids treatment

Process	Status	Potential for value recovery	Considerations
Sludge stabilisation			
Anaerobic digestion	Established (NZ and international)	High - energy recovery through burning methane gas	Long retention times required; sludge generated requires disposal; skilled operation required to maintain performance
Aerobic digestion	Established (international)	Low – possible to use digested solids further	Energy intensive due to oxygen requirement; potential for odours; sludge generated requires disposal
Autothermal aerobic digestion	Established (international)	Low – possible to use digested	Retention times optimised over aerobic digestion; elevated ammonium discharge

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(ATAD)		solids further	
Air and thermal drying	Established (international)	Low – possible to use dried solids further	Air drying requires large footprint; potential for odours; dried sludge still requires disposal
Composting	Established (NZ and international)	Medium – value depends on market demand	Large footprint; process takes a long time; markets limited
Vermicomposting	Emerging (NZ and international)	Medium – value depends on market demand	Large footprint; C:N ratio potentially unfavourable for processing; growing public interest in vermiculture
Landfilling	Established (NZ and international)	None – legacy issues possible	Greenhouse gas/leachate concerns; landfill space; diminishing acceptance; NZ Waste Strategy in place
Soil enhancement			
Land application	Established (NZ and international)	Low – value added is indirect through forest productivity	Negative public perception, both in New Zealand and internationally; metals content may exceed guidelines; potential adverse effects on timber quality when applied to plantation forests
Energy recovery			
Incineration/co-combustion	Established (international)	High – boiler fuel	Scaling an issue; ash requires disposal; high capital costs; efficiency depends on moisture content of solids; poor performance leads to toxic byproducts
Super critical water oxidation	Emerging (international)	High – energy recovered from biosolids	Scaling and corrosion an issue; few large scale plants yet established due to high capital costs
Wet air oxidation	Established (international)	Medium – some energy recovery	Organic acids require disposal or further processing; dewatering not essential
Pyrolysis	Emerging (international)	Medium – syngas and biochar	Lower energy value product; requires dry starting material
Gasification	Emerging (international)	Medium - syngas	Lower energy value product; requires dry starting material
Vitrification	Established	Medium – energy recovery	Potential for net energy generation; glass aggregate product generally of low value; large plants likely to be necessary for good process economics

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A technology ranking system was used to define the market acceptability of potential technology solutions.

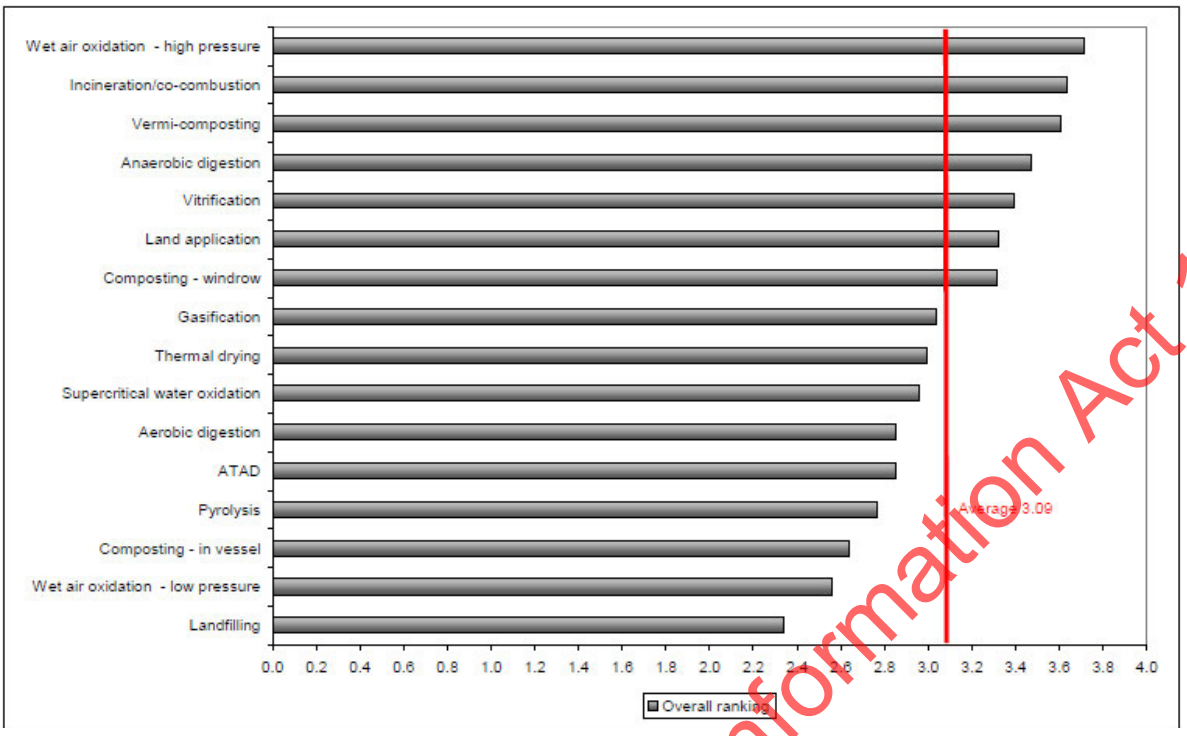
The technologies were ranked according to the highest frequency in a particular placing along with a weighting that considered the importance of the category. The average weighted score was then calculated at each placing to give an overall ranking according to the following criteria:

Category	Scoring
Regulatory/end user acceptance	1 - limited, 3 - acceptable, 5 - high
Public acceptance	1 - limited, 3 - acceptable, 5 - high
Transfer to other organic wastes	1 - limited, 5 - high
Further treatment	1 - eg disposal to landfill, 5 - none
Gas scrubbing/effluent treatment	1 - required, 5 - not required
Operating difficulties	1 - difficult, 5 - few
Capital cost	1 - high, 5 - low
Operating cost	1 - high, 5 - low
Established/emerging	1 - emerging, 5 - established
Value recovery	1 - low, 5 - high

In all scenarios, regulatory/end user acceptance have been given a high weighting, as a sustainable technology into the future must be accepted by both regulators and end users to ensure widespread adoption. In other scenarios, the capital cost of the technology was given an equal weighting to regulatory/end user acceptance.

No single technology was ranked the highest in every scenario, highlighting that many factors contribute to a decision to adopt any particular technology. However, in summary the relative rankings of available or emerging sewage biosolids technologies were as follows:

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High pressure wet air oxidation best met the increasingly important requirements to reduce net energy consumption (i.e. net producer of energy), have a very low land footprint, and a low environmental footprint.

There are a range of wet air oxidation processes currently commercialised in the market by companies such as Siemens, Lenntech, Nippon Shokubai, Siemens, Veolia and Bayer. The different processes largely differ by the presence and type of catalyst used and the nature of the organic biosolids treated. In terms of disposal of wastewater treatment sludge, both Bayer and Veolia have commercial wet air oxidation product offerings that are respectively named LOPROX® and ATHOS™.

All these competing technologies are primarily designed to completely eliminate solid wastes during processing (i.e. "Waste 2 Gone" approach). This requires high temperatures and pressures to ensure the organic material is fully converted to carbon dioxide. High capital and operating costs for these plants have limited their broader introduction into the market.

The Scion Thermal Oxidation Process specifically sets out to deconstruct these waste streams in a manner that combines substantive volume reduction with maximum value recovery (i.e. "Waste 2 Gold" approach). To achieve this, it combines fermentation and chemical oxidative stages to i) generate and capture volatile fatty acids and other carbon-rich by-products and ii) convert nitrogen and phosphorus components into simple forms for segregation and recovery.

The operational advantages provided by the Scion process over other systems include:

1. Utilises specific thermodynamic oxidation reaction barriers to ensure usable by-products generated in the fermentation stage are retained during the chemical oxidative phase;

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2. Reduction in the amount of oxidative energy required during the oxidation stage. This reduces pressure and temperature demands of the reaction vessel and, therefore, capital costs;

3. By-product characteristics (for carbon, nitrogen and phosphorus) simplify recovery and re-use options and costs.

The Proposition

Landfilling is becoming an increasingly expensive option for local bodies and is now strongly discouraged by the New Zealand Government via the 2002 New Zealand Waste Strategy and the 2008 Waste Minimisation Act. The Process can substantially reduce the need for landfilling, which is the current practice for dealing with biosolids from a municipal treatment plant.

Laboratory-scale proof-of-concept studies, embodying technical, economic and sustainability assessments, have been completed. A feasibility study for Rotorua District Council WWTP biosolids (8,400 tonnes per year) demonstrated that the Process could achieve:

- 96% reduction in landfill costs;
- 76% reduction in greenhouse gas emissions;
- 40% reduction in eutrophication potential; and
- 90% reduction in photochemical ozone creation potential.

In addition, use of deconstructed carbon feedstocks in the RDC Bardenpho wastewater treatment plant (currently supplemented with up to 650 L/day commercial ethanol) could substantially offset supplementation costs (equivalent to $367,000 per year).

Overall, the process could generate a net benefit of $490 per dry tonne of biosolids with predicted landfill cost savings to Rotorua District Council of approximately $700,000 per annum:

	Landfill*	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Ethanol cost ($/annum)	$367,000	$367,000	$36,000	$36,000	$235,000	$367,000
Wet oxidation processing cost ($/annum)	$-	$877,000	$877,000	$877,000	$359,000	$-
Anaerobic digestion cost ($/annum)	$-	$47,300	$12,600	$-	$126,000	$126,000
Transport fees ($/annum)	$91,300	$17,600	$16,800	$6,950	$3,060	$42,600
Waste levy fees ($/annum)	$91,300	$17,600	$16,800	$6,950	$3,060	$42,600

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Landfill fees ($/annum)	$548,000	$105,000	$101,000	$41,700	$18,400	$256,000
Carbon tax ($/annum)	$270,000	$69,800	$58,300	$70,900	$64,100	$144,000
Electricity revenue ($/annum)	$-	$47,300	$12,600	$-	$126,000	$126,000
Landfilling cost (Transport,levy,LF fee) ($/annum)	$731,000	$141,000	$135,000	$55,600	$24,500	$341,000
Gross Revenue	$-	$47,300	$12,600	$-	$126,000	$126,000
Cost ($/annum)	$1,370,000	$1,500,000	$1,120,000	$1,040,000	$809,000	$978,000
Net cost ($/annum)	$1,370,000	$1,450,000	$1,110,000	$1,040,000	$683,000	$852,000
Savings compared to landfill ($/annum)	$-	-$86,000	$263,000	$329,000	$686,000	$517,000
Net benefit per tonne ($/dry tonne)	-$0.00	-$100	$180	$230	$490	$370

** Scion and RDC have developed a number of operating scenarios for the Process implementation for the Rotorua area. They compare the current landfill model with various combinations of wet oxidation (WO), anaerobic digestion (AD) and acetic acid recycling (AR).*

It is important to note that this value proposition for biosolids is relatively conservative, since landfill transportation and gate fee costs for RDC are considerably lower (total $80/tonne) than in many other parts of the country.

In addition, the biosolid volumes within the RDC catchment are relatively small (sewage treatment catchment is only 55,000 people), meaning that the net economic benefit for larger municipalities (e.g. Auckland, Hamilton, Christchurch) would be substantially greater.

In summary, successful national implementation of the Waste 2 Gold technology platform would reap benefits to a wide group of stakeholders:

End-users

- An ability to substantially reduce the costs associated with current municipal sewerage and industrial wastewater treatment and, more broadly, organic waste disposal;
- The potential to reduce their environmental footprint through reduction in waste transportation, landfill leachates and green house gas emissions;
- The ability to develop new revenue streams through sales of products of the process.

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New Zealand community

- Reduced environmental impacts through reduced waste to landfill, reduced greenhouse gas emissions, reduced eutrophication and reduced ozone depletion;
- Improved capacity to move towards the NZ Waste Strategy Targets;
- Ability to develop new Waste 2 Gold manufacturing opportunities for domestic and export development.

Direct investors

- An economic return from exploitation of the technology both in New Zealand and internationally.

Market Analysis

Our primary customers are territorial authorities seeking to improve the efficiency of municipal waste stream disposal and the requirement of and need to landfill the biosolids associated with conventional treatment processes.

Our secondary customers are major industrial operations that utilise biological wastewater treatment systems (e.g. pulp and paper, dairy, and meat processing) and as a consequence need to dispose of the large volumes of primary and secondary biosolids produced from these plants.

Preliminary laboratory testing work undertaken at Scion has confirmed that this technology is able to successfully deconstruct and re-use putrescibles (e.g. food wastes), waste paper, and green wastes, further extending the market for this opportunity. As such, potential target wastes may represent up to 53% of the total waste streams currently landfilled in New Zealand.

To determine the potential size of the market for organic waste deconstruction in New Zealand, Scion conducted a 2008-2009 survey of territorial authorities and regional councils to obtain up-to-date data relating to the sourcing, characterising and documentation of waste streams in New Zealand (full report available on request).

The data collected presents a more comprehensive picture than has been possible through previous surveys and builds on the work done for the Targets in the New Zealand Waste Strategy: 2006 Review of Progress (2007), Sinclair, Knight and Merz (2008), Waste Not Consulting (2006 – 8) and the WINFO database.

As with previous studies, the accuracy of the data varied considerably for each region, due mainly to the lack of data or non-response from some survey recipients. Data was not scaled to take account of these gaps. As a result, the summary data shown below represents a very conservative analysis of the potential organic waste market:

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Organic wastes by region – public landfills only (tonnes/yr)Z

Region	Putrescible	Greenwaste	Biosolid	Other	Total	t/capita[1]
Northland	13,828	6,800	5000	13,420	39,048	0.25
Auckland	138,000	52,000	131,581	3000	324,581[2]	0.23
Waikato	110,000	83,000	10,260	890,000	1,093,260	2.72
BOP	73,100	114,190	19,540	nd[3]	206,830	0.77
Gisborne	3,623	19,056	nd	66,020	88,699	1.93
Taranaki	26,000	8720	1260	nd	35,980	0.33
Hawke's Bay	62,300	8,360	nd	130,477	201,137	1.32
Horizons	11,623	44,867	5951	321	62,762	0.27
Wellington	98,510	23,535	21,836	nd	143,881	0.30
Nelson/Marl	8,220	7,580	15,243	25,000	56,043	0.41
Southland	24,000	11,735	nd	13,000	48,735	0.52
West Coast	4900	nd	854	4100	9,854	0.31
Otago	5650	23,621	13,079	2130	44,480	0.22
Canterbury	43,803	88,947	28,766	44	161,560	0.29
Total	**623,557**	**492,411**	**253,370**	**1,147,512**	**2,516,294**	

1 Based on 2006 population Census data (www.stats.govt.nz)
2 Limited Auckland data made available – as the largest municipality in NZ, this figure is likely to be significantly lower than actuals.
3 nd – no data



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Based on the Project's technology and market development strategy, it is anticipated that after a 10 year period, 20% of New Zealand's organic waste could be diverted from landfills and company landfills using this technology platform:

Targeted annual diversion from landfills in 10 years

Waste source	W2G Capacity [1]	Proportion diverted within Bay of Plenty[2]	National waste production	Proportion diverted within New Zealand[2]
Municipal organics[3]	144,000 t	96%	1,272,000 t	11%
Municipal biosolids	125,700 t	96%	253,000 t	50%
Company landfills - organics	72,000 t	38%	560,000 t[4]	13%
Total	**341,700 t**	**73%**	**2,085,000 t**	**16%**

1 *Total waste throughput entering deconstruction process*
2 *Based on 96% volume reduction following deconstruction*
3 *Comprises organic, timber, paper, textiles, nappies and sanitary (http://www.mfe.govt.nz/environmental-reporting/report-cards/waste-composition/2009/index.html)*
4 *Partial estimate only*

Market Entry Plan

The overall goal of the Project is to target significant quantities of New Zealand's municipal biosolids (being at least 253,000 tonnes per annum), a proportion of general organic wastes (e.g. putrescibles and greenwastes) and key sources of industrial organic waste arising from the pulp and paper, food, dairy and meat processing operations.

The market entry strategy is to develop the deconstruction process to a scale where the level of economic feasibility and operability is well defined through a key alliance of industry, local government and research interests to extrapolate this engineering solution to the wider market.

The Rotorua District Council is a typical exemplar for engagement with New Zealand territorial authorities. They have identified biosolids as their current priority waste issue. Investment by the Rotorua District Council and Scion (via FRST Pre-seed Accelerator Funding) in laboratory-scale feasibility studies has allowed the process to be tested on typical biosolids as a suitable organic source. We believe this has substantially reduced the risks for the next phase scale-up to Pilot Plant level (see attached Feasibility Study).

Scion and the Rotorua District Council have collectively verified and formalised their participation in the opportunity. Creating this partnership also opens up the opportunity to extrapolate this to the wider Bay of Plenty area as a test bed opportunity for the Process that will facilitate its further development across New Zealand. The Bay of Plenty has been chosen as the starting point since it represents a microcosm of New Zealand waste management issues. It is the fastest growing part of

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New Zealand (thereby creating pressure for WWTP biosolids disposal) and contains national-scale examples of other industrial sectors relevant to the application of the Process. This includes the dairy sector, the pulp and paper sector, horticulture, fishing and food processing, all within a relatively small area.

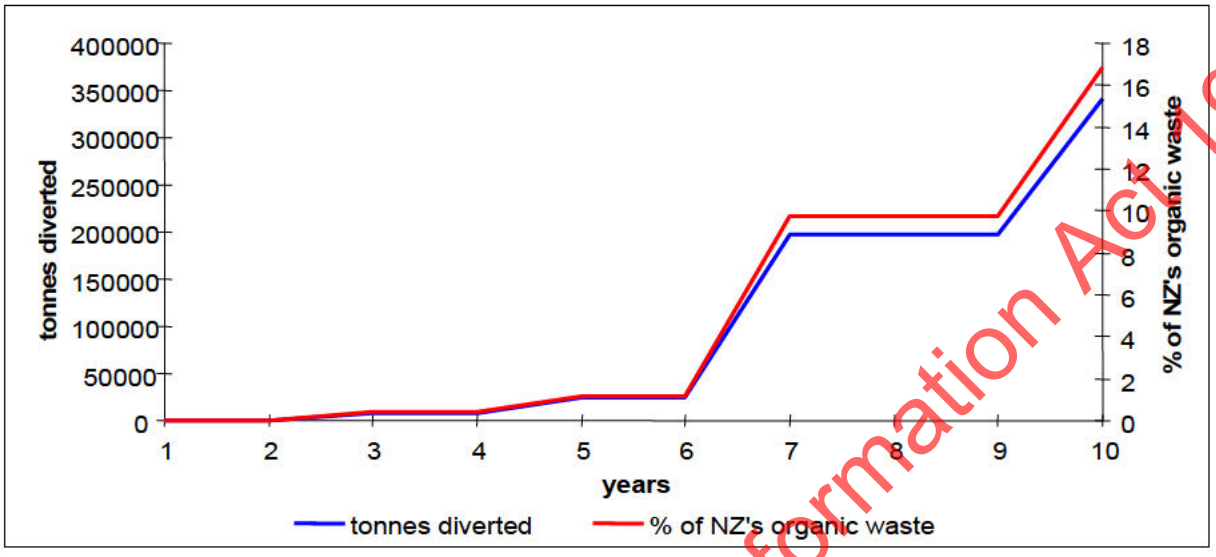
The proposed market penetration plan is summarised as follows:

Year	Waste	Quantity diverted (t/yr)	Residue landfilled* (t/yr)	Rationale
3	RDC biosolids	8,400	336	Priority waste for Rotorua District Council - formal partner in Alliance who has committed to co-investment to de-risk opportunity at pilot-scale
5	Tauranga biosolids	16,500	660	Solution for NZ's fastest growing municipality (biosolids currently transported out of region) and leverages off RDC influence in BOP
7	Pulp and paper biosolids	75,000	2,700	Both major NZ pulp and paper sites located within 50 km of Rotorua. Represents largest point source of industrial organic waste in NZ – success will leverage into other industrial organic waste producers
7	Auckland biosolids	106,000	4,240	Largest point source of biosolids in NZ. Scion is already working with Watercare under contract to come up with a range of solutions for biosolids – this technology fits well with this portfolio
10	BOP organics	150,000	6,000	Expansion to a broader BOP solution leveraging off the solutions already in place – creates option of "Waste Management Islands" for integrated waste processing at existing landfills

** based on 96% destruction efficiency by the Process and no further extraction of useful materials in the remaining solid residues*

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As can be seen, we envisage a stepped growth strategy that could see 6-8 deconstruction plants in operation in the Bay of Plenty/Auckland regions within 10 years with sufficient capacity to divert 16% of New Zealand's total organic waste flows:



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Key Technical and Commercial Milestones

The critical criteria for broader scale-up and commercial development of the Waste 2 Gold opportunity is to complete design and construction of a working system at our Rotorua District Council WWTP reference site. To achieve this, the following Objective structure for the Waste Management Fund-supported project has been put in place:

Objective	Activity	Key Performance Indicator
To establish a modular thermal deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	-Tender, construct, install and commission Wet Oxidation module as the basis for Thermal Deconstruction process. -Configure, install, and commission Biological Nutrient Removal module to simulate the full-scale RDC WWTP. -Design, construct, install and commission pre-fermentation module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids.
To demonstrate viable scale up of the complete Thermal Deconstruction process by 31 December 2011.	Carry out pilot trial runs under a range of process conditions analysing performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated Demonstrated product value as a carbon source at pilot scale.
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to alternative organic waste streams.
To produce a viable commercial scale design for application at the Rotorua wastewater treatment plant by 30 June 2012.	Development of a process engineering and economic model for the full scale application of the technology Produce design specifications for a commercial plant.	Process model in place capable of capital and operating cost estimates for full scale plant. A viable commercial scale design is produced.

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Progress (current and planned) towards these Objectives is outlined below:

Phase	Summary	Progress to date	Timing for completion
1	Assess technology to proof of concept and secure a key partner	Completed	June 2008
2	Scale up to laboratory-scale evaluations and complete engineering and economic feasibility study	Completed	December 2009
3	Undertake Freedom to Operate analysis and file patent application	Completed	February 2010
4	Secure investment for the construction of a pilot plant facility with a leading municipal authority	Completed	February 2010
5	Development of a partnership to provide appropriate governance and project management and address non-technical risk issues.	Alliance has been formed with formal structure under development Information Memorandum drafted to submission to additional potential partners	April 2010
6	Secure investment to complete technical and engineering de-risking and development of engineering designs.	Approximately 50% of the investment has been raised. Application to MfE WMF for support	July 1 2010
7	Construct and commission the Pilot Plant	Engineering design drawings and costings have been completed Engineering companies identified and assessed for construction of pilot plant	March 2011
8	Secure key engineering partner to extrapolate solution to other end-users	Engineering companies identified and assessed for market development One company engaged in negotiation as an Alliance partner/investor	June 2011
9	Complete engineering development and initiate construction of a reference plant treating 8,500 tonnes biosolids per annum	Plant has been signed off in the RDC 10 year capital plan.	June 2012

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Financial and Investment Plan

Scion (on behalf of the Waste 2 Gold Alliance) is seeking $1.7 million from MfE via the Waste Management Fund. This investment will play an important part in catalysing the development and utilisation of the pilot plant and therefore rapidly affecting the core outcomes and the speed of achieving these outcomes.

Further investment from Private Investors will be sought once the pilot plant is in operation. At that point, strategies to address the bulk of the technical and business risk will be minimised and so raising Private Investment is not expected to be difficult. The Alliance has not sought such Private Investment too early as this will prejudice the current focus on achieving early benefit to New Zealand.

An Information Memorandum has been drafted (see Project Background attached) and Scion and RDC are holding strategy workshops (with facilitation from The Icehouse Business Growth Centre) to identify the most suitable investment strategy and investor profile for the Project.

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→ Business Plan

The current investment plan is described below:

Action	Total Investment	Status	Investment period
Secure investment (Foundation for Research Science and Technology plus pulp and paper industry co-funding) to develop the Scion Thermal Oxidation Process to a proof of concept at a laboratory scale	$1.9 million	Completed	2005-2008
Secure Scion Capital Expenditure investment for design and construction of a specialist Waste 2 Gold laboratory and equipment	$150,000	Completed	2009
Secure investment from a key end-user (RDC) to complete technical feasibility study and validate engineering and economic options	$685,000	Completed	2009-2010
Secure FRST Pre-seed Accelerator Fund (PSAF) to support technical development and patenting of thermal deconstruction process.	$200,000	Completed	2009-2010
Secure Capital Expenditure investment from key end-user (RDC) for construction of a pilot scale plant	$848,000	Completed (available from 1 July 2010)	2010
Secure investment to formally demonstrate (at pilot scale) viability of the engineering solution to other municipal and industrial applications	$2.8 million	Have raised $1.1 million $1.7 million requested from the MfE Waste Minimisation Fund	2010- 2012
Secure investment to translate technology to turnkey engineering solutions	$0.5 million	To be raised through expansion of Alliance to commercial investors	2012-2013

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Ministry for Environment Waste Minimisation Funding is sought to support the pilot scale plant development plan (total investment $3.6 million = $848,000 capital + $2.8 million operating). The following cost structure is proposed:

Technical focus	Cost	Explanation
Thermal deconstruction pilot plant constructed and commissioned	$975,000	Alliance partners have already completed design and costings for plant
Thermal deconstruction performance successfully proven at pilot scale	$200,000	Critical requirement for energy balance calculations and patent protection
Biological nutrient removal pilot plant is installed and ready for operation	$65,000	Required to de-risk use of byproducts for supplementation
Biological nutrient removal plant under steady state operation and successfully simulating full-scale operation	$110,000	Required to de-risk use of byproducts for supplementation
Construction and commissioning of pre-fermentation pilot plant module	$435,000	Critical part of the IP description and protection
Successful integration of biological nutrient removal and thermal deconstruction pilot plants Successful integration of pre-fermentation pilot plant Successful demonstration of complete process in long duration trials	1,195,000	Demonstrating integrated process will de-risk opportunity and provide confidence to commercial investors
Evaluate potential application to pulp mill biosolids and other organic waste sources	300,000	Allows market expansion outside biosolids to be evaluated
Process engineering and economic model developed Viable full-scale commercial design complete	$320,000	Critical final step to completing a working reference site.

National Return on Investment

The proposed Waste Minimisation Fund investment of $1.7 million is an important requirement to leverage end-user funding ($1.9 million) over the next two years in order to achieve a critical milestone (pilot plant operation) for delivery of this opportunity.

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By Year 10, the Waste 2 Gold Alliance (via subsequent commercial vehicles/partnerships) seeks to have diverted approximately 340,000 tonnes of waste material from New Zealand landfills annually. This would equate to waste disposal cost savings of up to $25.1 million per annum (based on Scenario 4 in RDC case study):

Year	Waste diverted (t/yr)	Worst case scenario (Scenario 2 RDC)		Best case scenario (Scenario 4 RDC)	
		Benefit	*ROI*	*Benefit*	*ROI*
3	8,060	$220k	13%	$590k	35%
5	23,900	$650k	38%	$1.8M	103%
7	197,700	$5.3M	310%	$14.5M	860%
10	341,700	$9.2M	540%	$25.1M	1480%

The above analysis assumes a land fill cost of $80 per tonne. This is current for the RDC but indications are that this is quite low at a national level, where transport distances are greater and the cost of land is typically higher (e.g. Queenstown landfill charges $200 per tonne). Therefore, even small increases will have a substantial bearing on the returns.

Governance and Project Management

The final Alliance Structure is currently under development pending strategic workshops and outcomes of the initial funding application to MfE. The formal structure will be operational by June 2010.

Project Governance

Overall delivery and strategic development of the Project will be controlled by a Project Governance group as follows:

s 9(2)(a)

Independent Chair (to be appointed)

The Alliance will be seeking an experienced individual who has an engineering, infrastructure and investment background.

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Project Management

The alliance has brought together a senior project management team from across the partnership. It will be responsible for milestones and outcome delivery.

s 9(2)(a)



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Risk Management

There are a number of technical, financial, social and investment risks associated with this project. The overall technical and operational risk is being managed via a Governance Group and in accordance with best practice engineering approaches. This includes staged development. Specifically, this is the managed scale up from laboratory testing to pilot-scale system and on to a full scale reference plant. This incorporates testing the economic and engineering feasibility at each stage.

It is also being managed in accordance with best practice Stage Gate management (a requirement of all projects where Scion has investment) ensuring that each stage is reviewed to make sure that all levels of risk are assessed, to minimise surprises and ensure the project continues to meet the requirements of its investors.

The risk management plan recognises that there are a number of barriers that could either hinder or stall the implementation of this business plan, including:

- **Adverse change in government policy**: This may slow down adoption, but New Zealand will be under increasing pressure from our major markets to improve its environmental performance. Reduction of recoverable material, particularly the organic fraction, from landfills will be a prime target as has been demonstrated by the European Union;
- **The needed capital is not available**: This may slow down adoption but, assuming the process is technically and economically robust, then pressure to adopt processes of this type (as Best Available Technologies) will still drive investment in this direction;
- **The district plan does not allow for construction of such plants**: If the territorial authority considers that the building of a plant is a priority, the district plan can be changed through a consultation process under the Local Government Act (2002). As a precedent, the Waste 2 Gold process has already been integrated into the RDC 10-year district plan;
- **The benefits do not outweigh the costs**: The territorial authority or private business will need to consider whether they are prepared to bear the additional cost when considering the long term implications (e.g. possible increases in Waste Levy charges);
- **The engineering capability to build the plants may be outstripped by the demand for new plants**: Engineering expertise could be sourced internationally (e.g. through licensing to major environmental engineering companies, such as Veolia) and introduction could be staged to accommodate availability of facilities and people;
- **Ratepayers do not accept the need for the plants**: The ten year market growth plan only considers participation in the BOP region and one plant in Auckland. Other territorial authorities and businesses could be approached as alternatives;

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- **The existing investment in infrastructure precludes consideration of alternative treatment processes**: The most likely alternative infrastructure is anaerobic digestion. This can be readily integrated with a new deconstruction plant to provide the combined benefits demonstrated during our feasibility study.

Taking these factors into account, the Project's risk management strategy is as follows:

Risk source	Management approach
Capital risk and return on investment	Managed in accordance with best practice engineering development with ongoing review of economic criteria. Within Scion it is managed by a Stage Gate process whereby each progression to a new stage is reviewed and agreed to.
Technical risk	The key sources are: *Unfavourable energy balance*: current evaluations indicate that the energy balance is neutral but the aim is to provide net energy outputs. This may integrate use of low grade heat or geothermal energy. *Managing inorganic build up (scaling)*: Scion has an alliance with University of Manitoba, who specialise in this area. They will be used as technical experts to assist in assessing and alleviating this issue. *Other operational risks*: Managed through involvement of very experienced external engineers and engineering companies
Social and public risk.	The re-use of products from biosolids may create concerns with public and in particular with Maori. This is being worked through with local Iwi and is a key role for the Project's Maori liaison team. The plant uses high pressures and temperatures. The process will be subjected to full HAZOP analyses at each stage. Public acceptance is not expected to be a problem as such processes are now quite common in public works activities. However it will be part of the public consultation process.
Market risk	The RDC have already committed to see the project through to pilot plant construction subject to acceptable progress. Interest has already been formally expressed by Watercare, Norske Skog and Carter Holt Harvey. These interests are now being formally developed. A working pilot plant will significantly improve market acceptance of this technology.

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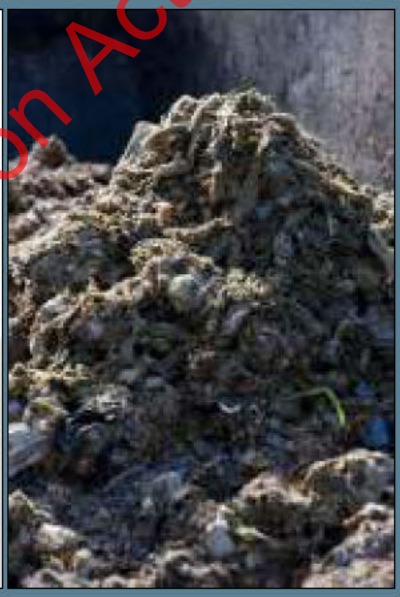
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SCION
Next generation biomaterials

2010 Waste Minimisation Fund Application

Scion



Scion Organisation and Capability

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"Changing the way New Zealand thinks about waste"

Waste 2 Gold



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Contents

Scion – The Organisation 95
Scion's Mission 95
Services Provided by Scion 96
Organisation and Operation 100
Technological Management 102
Networks and International Links 108
Equipment and Infrastructure 110
Working capital and Sustainability 112
Results and Achievements 113
Research and Development Projects 114

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Scion – The Organisation

The New Zealand Forest Research Institute Limited, trading as Scion, is a Crown Research Institute (CRI) dedicated to improving the international competitiveness of the New Zealand forest industry and building a stronger bio-based economy for New Zealand. Scion is constituted under the Companies Act 1993 and the Crown Research Institutes Act 1992. New Zealand has a total of eight Crown Research Institutes, which span the key primary industry sectors, natural resource management and industrial research.

CRIs, such as Scion, have a key role to play in continuing New Zealand's transformation to a high-value, knowledge-based economy. The government sees CRIs as agents for transformation by creating the value that will create advantage for New Zealand.

The Crown is the sole shareholder of each CRI and acts to protect its investment on behalf of the people of New Zealand. Each CRI has two shareholding Ministers: the Minister of Research, Science & Technology and the Minister of Finance, each of whom holds 50% of the company's shares. Shareholder interests are represented by the Crown Company Monitoring and Advisory Unit (CCMAU). An independent Board of Directors, appointed by the Government Cabinet, provides governance and strategic direction for the company.

Board of Directors

Directors of the Centre, their roles and the institution that they represent:

s 9(2)(a)



Scion's Mission

Scion's primary responsibility as a CRI is to contribute to the achievement of national outcomes and the translation of research outcomes into benefits for New Zealand. The strategic focus for the organisation is summarised below:

Vision

Biomaterial Futures: Advancing the widespread utilisation of renewable materials and products derived from plants for economic, environmental, cultural and social returns.

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Mission

To improve the international competitiveness of the New Zealand forest industry and build a stronger bio-based economy for New Zealand

Value proposition

The organisation's Strategic Business Plan for the period 2009 to 2012 is focussed on delivering Scion's Vision and Mission through three strategic science goals and one underpinning management goal:

Goal 1: Accelerate growth of the Bioeconomy

Scion will focus a critical mass of research on market-led opportunities which provide competitive advantage for lignocellulosic- and biopolymer-based products. Scion will provide national leadership in lignocellulosic biorefining and industrial biotechnology research. Scion's active engagement with policy makers and key stakeholders, such as Maori, will ensure it offers appropriate support for bioeconomy strategies and frameworks.

Goal 2: Increase profitability of New Zealand's forest industries

Scion's science will ensure that return on investment from the New Zealand forest industries increases in line with sector plans. Scion will help expand the sector into new, higher-value markets and take advantage of the economic benefits offered by Environmental Services.

Goal 3: Optimise the value of marginal land

Scion's science and decision-support tools will help inform owners of marginal land and policy makers about the most appropriate land-use options and, where relevant, develop forestry-based solutions to extract the greatest quadruple bottom-line benefits from marginal land.

Goal 4: Maximise the quality and impact of Scion's science

Scion will foster a culture of innovation by investing in its high-performing individuals and teams and providing a research environment and infrastructure that is world class. Scion will actively engage with its local, national and international community through energising partnerships and active communication of its successes.

Services Provided by Scion

Scion's active relationships with end-users have enabled us to maximise the quality and impact of our research, development and commercialisation activities to our clients and stakeholders. In 2009, the quality of our science has been recognised through several prestigious international awards and publications. At the same time, Scion has provided strong support for policy agencies in the areas of economic development, sustainable land use, energy, waste, and climate change.

Scion is an active participant in international scientific and policy networks. For example, our representation on the technical committee for the Montreal Process has assisted in the development of criteria and indicators to ensure sustainable management of the world's forests. In

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2009, we also significantly extended our European partnerships aligned with the NZ-EU Joint Science and Technology Cooperation agreement.

The expertise, confidence and commitment of our staff were further recognised when Scion was named New Zealand's most "exciting research and science company" by the National Business Review (NBR) in 2009.

Specific research and development activities relevant to this application are outlined below:

Clean Technologies

Scion is committed to research that guides the emerging policy and regulatory requirements relating to the bioeconomy and, where necessary, provides technical solutions for end users. Examples include:

- The Waste to Gold (W2G) platform is based on deconstruction processes that use heat, pressure and air to convert organic wastes into i) readily degradable organic feedstocks, which can be used for industrial biotechnology applications, such as biodegradable plastics or bioenergy/electricity production and (ii) a byproduct containing nutrients and metal salts suitable for further value recovery (e.g. fertilisers). The programme is supported by the NZ government and a range of industrial and municipal waste producers, environmental technology companies and regulatory authorities.

- A contract completed by Scion under the Sustainable Land Management & Climate Change (SLMCC) programme for Ministry of Agriculture and Forestry has focused on adapting LCA data and methods for New Zealand buildings. The purpose of the research was to develop New Zealand-specific datasets for a range of building materials. The results of this project, in combination with the greenhouse gas foot printing research for the forestry sector, will lay the basis for understanding the impact and design of different building types.

- Effective waste management and utilisation requires strong community acceptance. A collaborative research programme entitled "Closing the loop – Rebuilding our soils with biowastes" fully integrates environmental, social, cultural and economic knowledge within case study communities. It fully recognises the distinctive contribution and role that Maori culture and communities must have alongside social and biophysical research in developing solutions and processes to deal with biosolids.

Advanced Bioproduction Technologies and Products

Scion has significant global scientific partnerships in bioproduct development and we are focused on adapting these developments specifically for New Zealand-grown material, infrastructure and targeted domestic and international markets. Examples include:

- The Biopolymer Network Ltd (BPN) is a unique stand-alone company that demonstrates the power of Scion's scientific partnerships. With an equal shareholding from each of three CRIs (Scion, AgResearch and Plant & Food), BPN has a mission to commercialise or manufacture new biologically-based products arising from the collaborations of the three science partners. Major recognition of BPN's success was achieved this year when a new

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environmentally-friendly biofoam developed by Scion won the "Best Innovation in Bioplastics" category at the 2009 International Bioplastics Awards announced in Munich.

- Scion researchers have developed new biopolymers for industrial applications with wood processing partners, based on the materials isolated from pine bark. Tannin extracts and modified tannins have been formulated into commercial plastics, coatings and adhesives.

- Scion is also working on the combination of bioplastics and wood fibres for new product opportunities. Scion has developed a wood fibre plastic pellet product that can be used as a new feedstock in producing wood polymer composites. Samples of this novel feedstock have been provided to moulding companies in New Zealand and overseas for evaluation and have subsequently attracted interest from a major producer in Europe.

- Scion is focused on developing biorefinery processes to create new products from renewable lignocellulosic (woody) materials. A key programme builds on intellectual property (IP) developed in the New Zealand Lignocellulosic Bioethanol Initiative (NZLBI), a partnership created two years ago between several public and private enterprises, including Scion and Verenium, a US biotechnology company. The partners have co-invested in research and development of softwood-based second generation bioethanol technologies that achieve high conversion efficiencies and high quality lignin substrates for co-product generation.

- Scion's research programmes are developing techniques to open up new possibilities for alternative uses for lignin as a raw material for various chemicals. Scion was successful this year in winning support from FRST s International Investment Opportunities Fund (IIOF) to investigate the use of lignin for producing chemicals. The IIOF project supports Scion's participation in an international research collaboration led by VTT in Finland. The ultimate goal of this work is the valorisation of lignin to provide a sustainable source of chemicals and materials that will subsidise commodity bioethanol production costs in a biorefinery context.

- Scion specialises in developing sustainable options for food packaging based on plastic and paper technologies. New materials under development include lightweight biopolymer products, hybrid fibre-bioplastic products, bioplastics and biofoams. A new coating developed by Scion that provides an environmentally-friendly solution for water vapour resistance in corrugated paperboard has taken steps towards commercialisation this year.

- Scion researchers are also working with indigenous people to identify biomaterials opportunities for native plants. Scientists have identified sites of various sources of indigenous plants and made progress on the extracting and characterising the fibres from leaves. Fibres prepared using both classic physico-chemical techniques and also the traditional Maori approach (retting) have provided an excellent material with potential application as reinforcement in advanced composites.

Sustainable Forest Management

Scion is utilising its close partnerships with both the existing forest growing industry and emerging participants (e.g. indigenous peoples (Maori) land and forest owners) to develop innovative research

→ Organisation and Capability

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programmes and technology uptake initiatives for this sector. Research programmes aimed at increasing forest productivity and forest diversity, decreasing production costs, and meeting international environmental and product standards will help the sector to achieve its target of increasing export revenue to $14 billion per year by 2025. Examples include:

- Scion has partnered with the majority of the owners and managers in the New Zealand forestry sector to create Future Forests Research Ltd (FFR), an organisation focused on increasing forest productivity, improving wood quality and ensuring environmental sustainability. Research activities and membership are clustered around four themes: Radiata Pine Management (productivity models, forest inventories and weed management), Diverse Forests (Douglas fir, eucalypts, redwoods, cypresses and indigenous species), Harvesting, and Environmental and Social Research. FFR provides a valuable link with end users of research who include forest growers, regional councils, education providers and consultants.

- Scion has an ongoing relationship with the Radiata Pine Breeding Company, a New Zealand company focused on the provision of superior radiata pine germplasm to its shareholders and customers in Australasia. In addition to research carried out for RPBC, Scion has a highly experienced molecular genetics team focused on applying the latest plant (bio)technologies to tree improvement activities.

- Scion has been a key player in developing carbon modelling methods and forest inventory procedures for the NZ Ministry for the Environment (MfE) to enable a robust assessment of national carbon stocks in planted forest under the Kyoto Protocol. Scion has also completed a detailed study on the carbon footprint of log production from New Zealand's radiata pine plantation for the NZ Ministry of Agriculture and Forestry (MAF). This information is being used to inform policy making, provide a benchmark for forestry operations, and enable life cycle assessment (LCA) on wood-based products.

- For several years, Scion has been strongly involved in revising the international set of Montréal Process Indicators of Sustainable Forest Management. Scion researchers have provided important continuity in the revision process, which has resulted in the inclusion of indicators covering new concepts, such as avoided fossil fuel emissions and ecosystem services.

Building international capability

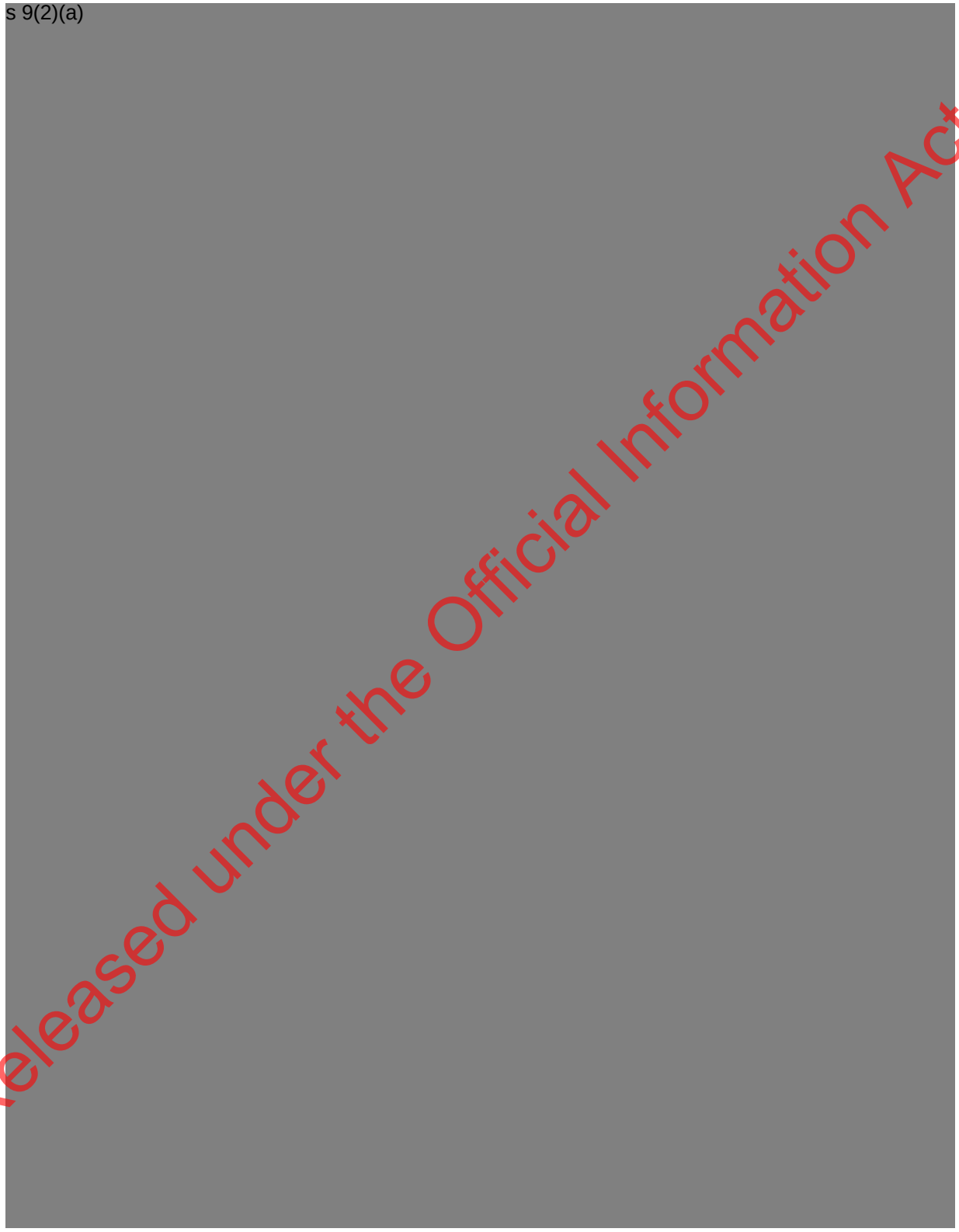
Scion is an active participant in international networks aimed at building science capacity to underpin the development of a bioeconomy. For example, in February 2009, Scion was one of the successful partners in the establishment of a new collaboration known as "TRANZFOR" as part of the European Union (EU) International Research Staff Exchange Scheme (IRSES). The five TRANZFOR partners are: Scion; CSIRO, Australia; Institut Nationale de la Recherche Agronomique (INRA), France; Forest Research, United Kingdom, and; Instituto Superior de Agronomia (ISA), Portugal.

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Organisation and Operation

Organisational Chart

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Members of Staff

Members of Staff dedicated to Research and Development

Category	Quantity	Average time dedicated (full time equivalent, FTE = 1750 hrs per year)
Director	3	3 FTE (Scion designation: Group Manager)
Deputy Director	9	9 FTE (Scion designation: Team Leader)
Doctoral researchers	68	64 FTE
Post doctoral researchers	7	7 FTE
Technicians	66	56 FTE
Other (non-PhD scientists and researchers)	98	93 FTE
Total R&D staff	251	232 FTE

Members of Staff not working in Research and Development

Category	Quantity	Average time dedicated (full time equivalent, FTE = 1750 hrs per year)
Director/Department Manager	4	4 FTE
Coordinator	7	7 FTE
Other (Science Support)	15	12 FTE
Other (Corporate)	73	65 FTE
Total non-R&D staff	99	88 FTE

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Technological Management

Processes of Innovation Cycle

Intellectual Property

Scion has an Intellectual Property Policy that sets in place the framework within which it will manage Intellectual Property in both a strategic and an operational sense and to best practice standards. Research conducted within Scion is subject to this framework in order to best enable a pathway to commercialisation and maximize the benefit to New Zealand.

Under this policy, all employees have agreed that the ownership of intellectual property will vest with Scion except for cases where the intellectual property was developed for a client or as part of collaboration pursuant to the terms of agreement. Scion has a process to keep information concerning intellectual property confidential and report any key inventions or developments to the Intellectual Property Manager. Scientists record work formally in lab books which are countersigned. Scion encourages development of tangible intellectual property (e.g. patents, trade secrets, copyright, and material) through its Intellectual Property Rewards Policy by sharing intellectual property revenue from sales and licenses of intellectual property with inventors and respective scientific teams.

The Scion Intellectual Property Team has the organisational responsibility for management of Scion's Intellectual Property. The following activities describe how Intellectual Property is managed during project planning, investigation and development stages:

- Searching for prior art disclosed in literature and patent databases that may effect research strategy and limit creation of new intellectual property;
- Identifying any freedom to operate issues from existing third-party intellectual property (e.g. patents) that may effect ability to conduct research and strategy for commercial implementation of research outcomes;
- Engaging opinions on patentability of any disclosed inventions before filing new patent applications;
- Filing of patents, trademarks, plant variety rights, and other such legal instruments to secure Intellectual Property rights;
- Advising on intellectual property terms of agreement relating to confidentiality, licenses, sales or partnerships for the purpose of protecting, developing and commercialisation of Scion's intellectual property;
- Maintain cultural integrity of research to avoid misappropriation of cultural IP under the Treaty of Waitangi.

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An internal committee within Scion is responsible for determining the appropriate form of Intellectual Property protection (e.g. trade secret, copyright, patent, etc.) and strategy (including such matters as what to patent, when to patent, where to patent) based upon the recommendations of the Intellectual Property Manager.

Valuation

Scion is committed to increasing its success in technology development and commercialisation. Fundamental to achieving this goal is the implementation of internationally recognised best-practice processes for the management of technology development and product/process development throughout the company. These Stage-Gate™ processes have been fully integrated into our technology development process to provide a seamless process from ideas conception to market roll out.

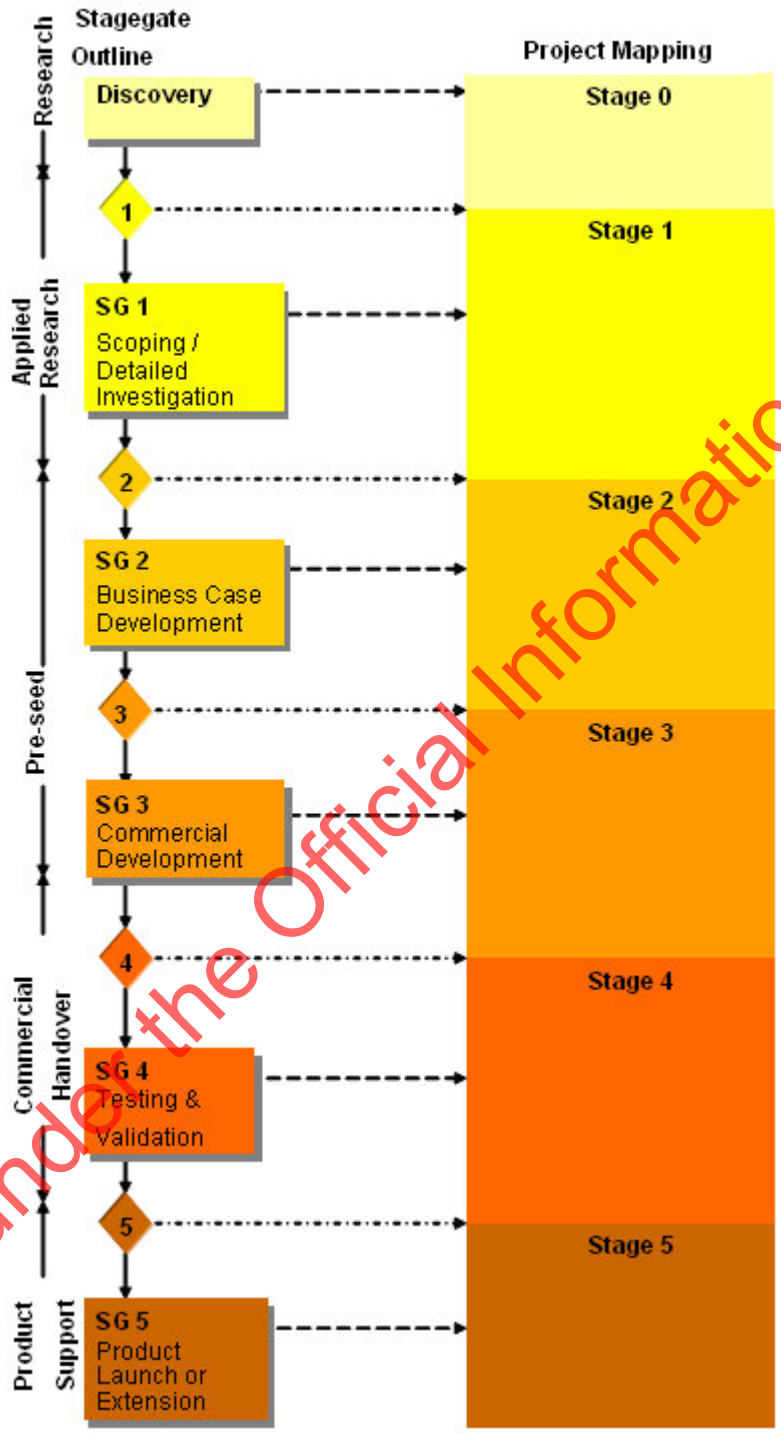
The Stage-Gate™ *TD Navigator* and *SG Navigator* tools are used for implementing and managing technology developments, product (and process) developments and valuations through to the appropriate commercial outcome. They do this by providing a framework which enables robust, quality decisions to be made through use of established criteria that ensure a firm understanding of the commercial and strategic opportunities.

An internal committee (Strategic Investment Committee) within Scion works with the lead researchers for a commercial opportunity and the Group Manager – Business Development and Commercialisation to ensure appropriate valuations are completed as part of the broader Stage-Gating process. These valuations may be undertaken by internal business development staff or through the services of external professional business development and investment consultants.

Packaging and Technological Transfer

Scion has customised Stage-Gating tools for our use, which are designed to oversee the commercial exploitation of technologies and products arising from the organisation. It achieves this by focusing project management on business and customer requirements, enabling better decision making:

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Stage-Gate™ is designed for "research" projects – e.g., science projects, fundamental research, platform developments – projects where the desired "deliverable" is new knowledge or new capability. The process consists of three stages and four gates and integrates with the Stage-Gate™ Development process. It incorporates industry best practices for the successful and timely execution of research projects.

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The development is designed for projects aiming to fill a defined market need and where a probable technical solution is known. The solution can be a new product or new process. The process consists of five stages and gates. For some low risk projects this may be reduced to three stages/gates.

Clearly defined gates with pre-determined deliverables are used to facilitate technology packaging and transfer decision-making. Gates ensure that projects are visible to management, and that resources are committed to worthwhile projects. The Gates are used to enable the setting of priorities across the range of technologies under development and promote quality-of-execution, sharp and stable project and product definition, and better business inputs into projects.

Stage-Gate™ manages business risk by breaking resource commitments into increments or stages. Each stage is more costly than the previous one, so the emphasis is on getting the right information to drive uncertainty down. The process uses standard criteria that help identify key uncertainties and risks. Specifically in product/process development, the process promotes better customer input early in the project. This means fewer mistakes and less rework and recycle later in the process.

An internal committee (Strategic Investment Committee) within Scion works with the lead researchers for a commercial opportunity and the Group Manager – Business Development and Commercialisation to ensure appropriate Technology Packaging and Transfer are completed as part of the broader Stage-Gating process. Technology transfer to external parties may be undertaken by internal business development staff or through the services of external professional business development and investment consultants.

Marketing

Scion has strong interest in targeting both national and international end users for its technologies, products and services. It has licensed or marketed 18 opportunities over the past three years.

As a research organisation first and foremost, Scion is expected to remain focused on its core research activities, including the transfer of knowledge and technologies to end users. Commercial ventures must be underpinned by a realistic business and investment plan with measurable interim and ultimate objectives. CRIs are not expected to be long-term holders of commercial ventures except under exceptional circumstances. Conversely, CRIs are not expected to transfer their IP to the private sector at devalued rates. They are expected to derive an adequate return on their investment.

Marketing of technologies developed within Scion is undertaken as part of the integrated TechMate and Strategic Investment Committee process outlined above. A dedicated team of six business development, intellectual property and/or client relationship managers work with the three Scion Science Group Managers to put in place appropriate strategies for each technology opportunity.

Scion generally seeks early engagement with potential end users of our technologies as the CRI model focuses on generating national benefit, rather than on specifically developing and operating its own stand-alone businesses. In some cases, however, the organisation does retain equity in a business, such as ATLAS Technology, which is a software development business with its own team of technical software engineers, software testers, and client service managers.

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Knowledge Management

Scion is committed to maintaining records management systems, which meet business needs, whilst also ensuring that statutory requirements for accountability and recordkeeping are met. Scion recognizes that the efficient management of its records is necessary to support its business functions and activities. It is committed to ensuring that responsibilities are assigned for the creation and maintenance of full and accurate records and marketing information and to ensuring that this material is maintained for as long as it is required to support business needs and accountabilities.

The organisation has put in place a knowledge management policy framework, through which effective records and information management can be achieved and audited. A dedicated Knowledge Centre Manager and five staff are responsible for ensuring that Scion's knowledge management practices and standards support the objectives of this policy. A Marketing and Communications team (4 staff) ensure that knowledge transfer from Scion is appropriately packaged and provided to end users, stakeholders and the media.

Specific tools have also been put in place for knowledge management, such as a laboratory book management system and nationally-relevant archives (e.g. Scion manages the New Zealand National Forestry Library and the National Forestry Herbarium). SIDNEY (Scientific Information Database Now Electronically Yours) is a customised database developed by Scion to capture all of its scientific and technical outputs. There are over 30,000 entries in SIDNEY by Scion staff dating back to the 1960's. Over half of the outputs have electronic copies of the reports/papers attached, with reports also available in hard copy. SIDNEY is used as a tool for scientists to find past research completed at Scion. It is also used to assist in fulfilling various internal and external reporting requirements, including annual reporting to government shareholders.

Policies and Regulations

Intellectual Property underpins Scion's consultancy business, research services business, and technology development and commercialisation business. It is also the key vehicle for establishing competitive advantage to our clients and for returning benefit to New Zealand in social, economic, and environmental terms.

Unless specified to the contrary, all Intellectual Property owned by the Scion and utilised in the provision of services to third parties, including improvements to such Intellectual Property, remains the property of Scion. Formal agreements can be negotiated with third parties for the rights and access to intellectual property, or the division of rights on the basis of relative value of the Scion/third party inputs into the development. Specific results of the services are typically owned by the third party.

Any transaction involving the Company's Intellectual Property (existing or being developed) must be subject to a written agreement which complies with Scion's standard provisions on Intellectual Property. Where any joint development/joint venture agreement or licensing agreement is concerned, matters concerning intellectual property must be referred to the Scion's Strategic

Investment Committee. Before IP sales are undertaken Scion works in association with the

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Company's Patent Attorneys to ensure that the Company has unfettered ownership of the Intellectual Property assets and that there are no potential claims or liabilities associated with it.

Regulatory conditions

Regulatory conditions concerning the disposition and modality of use (in-kind; rental; monthly payment for service or other) with regard to the Centre's ASSETS (Laboratories; Equipment; Physical Infrastructure; Brand; licences; patents, among others)

There are no regulatory conditions that apply. These issues are entirely up to the policies of Scion and appropriate Delegated Authorities within its operational structure.

Link to the Productive Sector

Research projects and direct application to productive sectors

The most relevant research projects developed by Scion which currently have applications used in the market place:

Research Projects	Application	Company or Institution
Accoya®	Acetylated wood – process renders wood more dimensionally stable and extremely durable.	Titan Wood Ltd – sales of this wood product throughout the world
A-Grader	Instrument to measure stiffness on green rough-sawn, dry gauged lumber, and timber blocks	Falcon Engineering - installed in sawmills and remanufacturing companies in New Zealand
Biomac-P BioPeg	Biodegradable fastener for securing erosion control mats, weed mats and mulch pads	Maccaferri New Zealand Ltd – the leading geosynthetic company in the South Pacific region
DrySpec	Wood drying kiln control software	Windsor Engineering – worldwide applications in place
Dynamic Stiffness Tester (DST)	Corrugated board torsional stiffness tester	KoruTest Ltd - customers are major corrugators based in the USA, Europe, Australia, New Zealand and Oceania.
Greenweld	Gluing system for finger-jointing wet timber	Greenweld Technologies Ltd – nine mills operating worldwide
Modified zeolite technologies	Mineral phosphate capture product to remediate eutrophic waterways and lakes	Blue Pacific Minerals Ltd – sales of 180 tonnes product to date
Sentry	Sapstain control for wood	Arch Wood Protection Ltd – worldwide applications

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Main current agreements Scion has, in particular with other research institutions, belonging to other countries (as examples):

Name of Institution	Location (city, country)	Description of the Link (status of commitment)
CSIRO	Australia (multiple locations)	Formal collaborative partnership related to forestry and wood processing research
INRA	Paris, France	Tranzfor - a 4 year coordinated joint programme (EU, Australia and NZ co-funding) for exchange of researchers in forest management arena
Joint BioEnergy Institute	Berkley, USA	Formal collaborative partnership on biorefinery research, particularly related to lignocellulosics
University of Concepción	Concepción, Chile	Formal collaborative partnership related to teaching and research in ergonomics
University of Manitoba	Winnipeg, Canada	Member of formal Genome Canada partnership on Microbial Genomics for Biofuels and Co-Products from Biorefining Processes
Verenium Corporation	Boston, USA	Formal collaborative partnership on lignocellulosic bioethanol
VTT Technical Research Centre	Espoo, Finland	Formal collaborative partnership on biorefinery research, particularly related to lignin valorisation

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Equipment and Infrastructure

Equipment

High technology equipment used in the development of research projects at Scion:

Equipment (brief description)	Estimated current value of the equipment (replacement value US$)	Age (in years)
Mechanical fibre refining pilot plant (25 tonne/hr capacity)	10,000,000	15
Injection Moulder - BOY 15S	150,000	5
Extruder- OMC (twin screw)	150,000	5
Amersham-Pharmacia AKTA FPLC system	100,000	1
DIONEX AS/EG/ED/GS50 Ion Chromatography suite	100,000	1
BD FACSVantage™ SE flow cytometer	500,000	3
Solid State Multinuclear 200 MHz NMR - Bruker Avance DRX200	300,000	8
Solution State Multinuclear 400 MHz NMR (2D and pseudo 3D experiments possible) - Bruker Avance DPX400	450,000	4
1H Microimaging (200 MHz) - Bruker Avance DRX200 (10 mm maximum sample diameter)	200,000	10
LC-MS - Thermo Finnigan LCQ DECA XP	300,000	6
GC-MS (including pyrolysis) - Fison Instruments VG Platform GC8000 series	200,000	10
Agilent Technologies GC System 6890N (GC/MS)	150,000	8
Titrametric Off-gas MS Analyser (TOGA)	250,000	1
FT-IR (including microscope attachment) - Bruker Vector 33 and IR-scope II	100,000	3
Confocal Microscope - Leica TCS NT	250,000	6
Field Emission S/TEM (including EDX) - Jeol JSM-6700F	500,000	2
Advanced Rheometer- AR2000	150,000	3
Differential Scanning Calorimeter (DSC)- Rheometer Scientific DSC-SP	150,000	3
Dynamic Mechanical Thermal Analysis (DMTA)- Rheometric Scientific DMTA-V	200,000	2

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Infrastructure

Offices, laboratories and special facilities at Scion campuses:

Use (brief description)	Location (Institution, City)	Capacity (m^2)
Scion Rotorua campus – offices/labs	Rotorua	13,870
Scion Wellington campus - offices	Wellington	318
Scion Christchurch campus – offices/labs	Christchurch	667
Scion Auckland campus - offices	Auckland	41
Biosecurity Quarantine Facilities	Rotorua	284
GMO Quarantine Facilities	Rotorua	357
Tree nursery and tree progeny reserve	Rotorua	8,428
Tree progeny reserve and archive	Rotorua	803,490

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Working Capital and Sustainability

Sources of income financing and the breakdown of Scion's overall spending:

Income	**2006**		**2007**		**2008***	
Indicate annual amount (US$), and the percentage with respect to total income	Amount (000)	%	Amount (000)	%	Amount (000)	%
Public Funds	5998	38	5768	35	16185	52
Private Funds (national and international)	6228	39	7839	48	14340	46
Own Funds (from supply of services, sales and/or creation of spin offs, or others)	289	2	0	0	148	0
Contribution owners and/or members	0	0	0	0	0	0
Others	3270	21	2828	17	183	1
TOTAL	**15785***	**100**	**16435***	**100**	**30857**	**100**
Spending	**2006**		**2007**		**2008***	
Indicate annual amount (US$), and the percentage with regard to total spending	Amount (000)	%	Amount (000)	%	Amount (000)	%
Spending R+D	7364	44	8566	51	23381	78
Operational Costs	9387	56	8248	49	6748	22
Others	0	0	0	0	0	0
TOTAL	16751	100	16814	100	30129	100

** These figures include only the net profits from a joint venture with CSIRO (called ensis). 50% share of ensis revenue for Scion was US$18.6M and US$19.4M in 2006 and 2007 respectively.*

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Results and Achievements

Main results and achievements for Scion (specific indicators):

Indicators	2006	2007	2008*
Number of publications per researcher/year	0.95	0.74	0.93
Total patent applications	4	8	10
Total patents granted	2	5	3
Total licences	12	1	3
Total marketed products and services	5	6	7

Prizes and/or recognition received by Scion over the past five years:

Nomination	Institution awarding it	Years
Forester of the Year (David Bergin)	NZ Institute of Forestry	2009
MacDiarmid Young Scientists of the Year (Karen Love and Tripti Singh)	Foundation for Research, Science and Technology	2009
Best Innovation in Bioplastics (PLA Biofoam)	International BioPlastics Award	2009
Most Exciting Business Award (Research and Science category)	National Business Review	2008
Nobel Peace Prize (Peter Beets - as part of IPCC)	Nobel Institute	2007
Skellerup Award for Services to Chemical Engineering and Wood Processing (Russell Burton)	NZ Institute of Professional Engineers	2007
Best PhD thesis in Soil Science (Haydon Jones)	Morice Fields Memorial Award	2005

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Research and Development Projects

Eco-Smart Technologies

Demonstrates our ability to deliver novel environmental technologies to market

Research Project	**Eco-Smart Technologies – Turning environmental negatives into economic positives**		
Start date	June 2004	End date	October 2009
Location Indicate where the research project was carried out	Country of origin New Zealand Scion lead	Affiliate New Zealand: *University of Auckland*	Outside Centre premises USA: *Carnegie Mellon University*

Categorisation (Areas of Knowledge)	
Disciplines	Environmental science, industrial biotechnology
Sub disciplines	Wastewater treatment, microbiology, green chemistry

Topics developed

Molecular microbiology of mixed culture bacterial systems;

Advanced oxidation technologies for recalcitrant organic remediation (e.g. colour, ecotoxicants);

Novel biological wastewater treatment processes for high carbon waste streams;

Production of biopolymers from high carbon waste streams;

Environmental fate and behaviour of anthropogenic micro-pollutants and endocrine disruptors

Budget		
Total amount (US$) (not including valued contributions)	US$1.05 M per year	
Leveraging of Resources (source of financing and distribution)	%	Source of Financing
	66	Public
	34	Private

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Work Team which took part			
Category	Quantity	Dedication of Time (full time =100%)	Speciality
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Doctoral Researchers	4	100% each	Microbiology; analytical chemistry; waste treatment; polymer science
Technical staff	4	100% each	Analytical chemistry; waste treatment, organic chemistry; ecotoxicology

Results and Applications		
Result of the Research Project	Applications	Final Users
Understand population dynamics of bacterial consortia in treatment systems	Optimise treatment performance of industrial wastewater processes	International pulp and paper industry and various high carbon effluent industries – savings of US$140K per year per mill
Patented nitrogen-fixing wastewater treatment processes for high carbon feedstocks – full scale trials	Commercial opportunities for advanced biological treatment systems with lower costs and smaller ecological footprint	International pulp and paper industry and various high carbon effluent industries – 9 system conversions to date
Patented process for production of biopolyesters from high carbon feedstocks – pilot scale trials	Commercial opportunities for production of bioplastics from waste streams and development of prototype, programmed degradation products	High carbon effluent industries can offset treatment costs through added value bioplastics production; Plastics manufacturers testing as sustainable source of biodegradable plastics and products
Novel green catalysts for remediation of recalcitrant organic constituents from industrial waste streams	Full scale trials of a colour removal process at a pulp and paper mill; can also be used to destroy toxic pollutants from effluents	High coloured effluent-generating industries (eg pulp and paper) can cost effectively meet colour and toxicity discharge limits; Spin-off company formed by USA

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		partner to manufacture and market catalysts
Development of an on-line metabolite monitoring instrument to follow bioreactor fluxes and kinetics	Utilise control system to monitor and control chemical reactor and biological reactor systems	Sales to municipal and industrial wastewater treatment plant operators and industrial biotechnology system manufacturers – one sale to date

Intellectual Property		
Product / process / method or other	N° of requested patents/ N° patents granted / N° of licences	Destination (USA, Europe, Asia, Oceania, Latin America, others)
See above – new catalysts, treatment systems, and bioplastics produced; novel methods for mixed culture analysis also generated.	4 patents filed: two granted, one pending; licenses under negotiation	Filed as PTO to cover all major markets for these applications

Publications (5 most relevant ones)			
Title, date	Author and co-author(s)	Journal	N° of citations / ISI
N-ViroTech: a novel process for the treatment of nutrient limited wastewaters. 2004	s 9(2)(a)		
Environmentally Intelligent Biocomposites. 2007			
Iron-TAML catalysts in the pulp and paper industry. 2006			
Review of reproductive-endocrine effects of a New Zealand pulp and paper mill effluent. 2004			

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		Publications. Lancaster, PA, USA. D.L. Borton, T.J. Hall, R.P. Fisher, and J.F. Thomas (eds)	
Colour remediation of pulp mill effluent using purified fungal cellobiose dehydrogenase: Reaction optimization and mechanism of degradation. 2005	s 9(2)(a)	Biotechnology and Bioengineering	?
Average yearly publications per researcher	2		

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Bionergy Options

Demonstrates our ability to influence national policy direction in sustainability

Research Project		**Bioenergy Options**					
Start date	March 2007			**End date**	October 2009		
Location Indicate where the research project was carried out		Country of origin New Zealand Scion lead		Affiliate Nil		Outside Centre premises New Zealand: *Landcare Research, NIWA, Infometrics, Waste Solutions, CRL Energy*	
Categorisation (Areas of Knowledge)							
Disciplines	Biomass resource data and modelling; Energy supply and demand; Economics and environmental impacts of forestry to energy						
Sub disciplines	GIS analysis of biomass supply, forest growth modelling, costs analysis of biomass supply, biomass to energy conversion options						
Topics developed							
GIS modelling of biomass supply Economic modelling of bioenergy industry Cost modelling of biomass supply							
Budget							
Total amount (US$) (not including valued contributions)	US$1.866 million						
Leveraging of Resources (source of financing and distribution)	**%**	**Source of Financing**					
	100	Public					
		Private					
		Other (identify)					
Work Team which took part							
Category	**Quantity**	**Dedication of Time**	**Speciality**				

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		(full time = 100%)	
Project Manager	P. Hall	60%	Forest supply chain and resource assessment
Doctoral Researchers	9	33% each	GIS modelling; Forest growth modelling; Economics; Erosion; Soil nutrition and nutrient runoff; Catchment water yield modelling; Biomass combustion and gasification; Energy supply and demand modelling
Technicians	3	100% each	Energy supply and demand data collection; Biomass resource supply and demand data collection
Other	2	25% each	Project support

Results and Applications

Result of the Research Project	**Applications**	**Final Users**
Concept strategy for low carbon renewable energy supply for New Zealand based on large-scale forestry	New Zealand energy planning and strategy	New Zealand government agencies
Five summary reports on bioenergy options for New Zealand	Inform New Zealand energy, forestry and farming industry of the energy opportunity	NZ landowners and major industry groups

Intellectual Property

Product / process / method or other	**Nº of requested patents/ Nº patents granted / Nº of licences**	**Destination** (USA, Europe, Asia, Oceania, Latin America, others)
N/A	N/A	N/A

Publications (5 most relevant ones)

Title, date	**Author and co-author(s)**	**Journal**	**Nº of citations / ISI**
Bioenergy Options for New Zealand: Situation analysis - Biomass resources and conversion technologies. 2008	P. Hall and J. Gifford; Contributing Authors; S. Saggar, D. Giltrap, V. Forgie, R. Renquist, S. Heubeck, R. Craggs, B. Fields, H. Trolove, M. Garrood, J. Thiele,	Scion public report, 2008	N/A

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	R.Newman, K.Wong, P.Hall, T. Evanson, C. Hodgson, P. Nielsen and I. Nicholas.		
Bioenergy Options for New Zealand: Pathways analysis - Energy demand, pathways evaluation, economics of purpose grown energy forests, life cycle analysis of biomass resource to consumer energy. 2008	P. Hall and M. Jack; Contributing Authors; P. Hall, J. Turner, J. Thiele, R. Andrew, V. Forgie, D. Giltrap, J. Sandilands, S. Love, A. Campbell,, M. McCurdy, and G. Williamson	Scion public report, 2008	N/A
Bioenergy Options for New Zealand: Research and development strategy. 2009	M. Jack and P. Hall,	Scion public report, 2009	N/A
Bioenergy Options for New Zealand: Analysis of large-scale forestry for bioenergy. 2009	P. Hall and M. Jack Contributing Authors; B. Hock, D. Palmer, M. Kimberly, S. Pawson, C. Walter, P. Wilcox, D. Giltrap, A-G. Aussiel, J. Ekanayake, P. Newsome, J. Dymond, M. Todd, W. Zhang, S. Kerr, and A. Stroombergen	Scion public report, 2009	N/A
Bioenergy Options for New Zealand: Transition analysis – the role of woody biomass from existing forests and drivers for change in energy supply in New Zealand. 2009	P. Hall and M. Jack Contributing Authors; B. Hock, D. Palmer, I. Nicholas, A. Stroombergen, D. McKissack, R. de Vos and S.Heubeck	Scion public report, 2009	N/A
Average yearly publications per researcher		2	

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Future Forests Research (FFR)

Demonstrates our ability to manage public/private partnerships

Research Project	**Future Forests Research Ltd (FFR) – a collaboration of forest industry companies combining to support quality research from Scion for the benefit of FFR members**		
Start date	October 2007	**End date**	Contracted until 2013
Location Indicate where the research project was carried out	Country of Origin: New Zealand; Scion Lead	Affiliate: Nil	Outside premises: Nil

Categorisation (Areas of Knowledge)	
Disciplines	Forestry research and subsequent tools to support productivity and cost savings for the forest industry
Sub disciplines	Forest production; ecosystem services; land use management

Topics developed

Transform the economics of sustainable forestry by improving tree growth and protecting and enhancing the environment through forestry. Consists of four Research Themes:

- Intensive forest systems
- Diverse species
- Environment and Social
- Harvesting

Budget		
Total amount (US$)	US$30,899,836 over a 6 year period	
Leveraging of Resources (source of financing and distribution)	**%**	**Source of Financing**
	50	Public
	50	Private
		Other

Work Team which took part

Category	**Quantity**	**Dedication of Time (full time =100%)**	**Speciality**
CEO	R. Dale	100%	Forest production
Research Leaders	K. Richards, M. Reardon, P. Milne, K. Raymond,	33% each	Forest production and harvesting
Task & Milestone owners	90+	100% each	Forest management, harvesting, botany, macroeconomics, soil science, climate change etc.
Other	3	50% each	Support and administration

Results and Applications

Result of the Research Project	**Applications**	**Final Users**
Scientific reports, technical notes and knowledge transfer. New intellectual property on forest productivity surfaces and management systems	Decision Support Systems, tools, calculators, models, manuals and guidelines to support improved forest management	FFR members only (members represent 80% of New Zealand's forest estate)

Intellectual Property

Product / process / method or other	**Nº of requested patents/ Nº patents granted / Nº of licences**	**Destination** (USA, Europe, Asia, Oceania, Latin America, others)
Genetic algorithm systems	Software licenses via Atlas Technology Ltd	New Zealand via FFR members; other regions at discretion of shareholders

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Forest productivity surfaces	Licensed databases to forest owners	New Zealand via FFR members; other regions at discretion of shareholders
Novel forest management systems and species	Trade secret applications of forest management systems	New Zealand via FFR members; other regions at discretion of shareholders
Improved harvesting systems	Potential patents in future	New Zealand via FFR members; other regions at discretion of shareholders

Publications (5 most relevant ones)

Title, date	Author and co-author(s)	Journal	Nº of citations / ISI
Predicting Pinus radiata productivity from soil, climate and environmental variables: National and regional perspectives, 2008	D Palmer, Mark Kimberley, M. Watt	FFR Members only	N/A
Demand and supply driven Bullwhip Effect, 2008	T Adams	FFR Members only	N/A
Effects of pruning intensity: Analysis of the second log pruning trial series, 2009	P Silcock, M Kimberley, A Callahan	FFR Members only	N/A
Modelling the influence of site and weed competition on juvenile modulus of elasticity in Pinus radiata across broad environmental gradients, 2009	B Rawley	FFR Members only	N/A
Value Chain Pilot Study	G West, J Harrington, D Pont, S	FFR Members only	N/A

Average yearly publications per researcher 5+

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Biowastes

Demonstrates our ability to develop and manage long term waste management options.

Research Project	**Improving land use productivity through biowastes**				
Start date	October 2003		**End date**	September 2013	
Location Indicate where the research project was carried out	Country of origin New Zealand Scion Lead		Affiliate Nil		Outside premises New Zealand: *Landcare Research, Plant and Food Research. ESR, University of Canterbury*

Categorisation (Areas of Knowledge)	
Disciplines	Environmental science
Sub disciplines	Land use management, waste treatment, remediation, social research

Topics developed

Sustainable biosolids use solutions resulting from biophysical, social, cultural and economic research;
Identification of biological risk factors and impacts of complex contaminants;
Characteristics of biosolids and different treatment process;
Long-term field trials of land applied biosolids;
Social/cultural/economic/environmental input into integrated case studies.

Budget		
Total amount (US$) (not including valued contributions)	US$ 1,680,000 per annum over 10 years	
Leveraging of Resources (source of financing and distribution)	**%**	**Source of Financing**
		Public 80%
		Private 20%
		Other

Work Team which took part

Category	Quantity	Dedication of Time (full time =100%)	Speciality
Programme Leader	Horswell	65%	Environmental science
Objective Leaders	Langer, Tremblay, Northcott	50% each	Environmental/biological/social sciences
Doctoral Researchers	8	50% each	Environmental/biological/social sciences
Post doctoral researcher	1	100%	Environmental science
Technicians	6	50% each	Environmental/biological/social sciences
Other	2	100% each	Environmental/biological/social sciences

Results and Applications

Result of the Research Project	Applications	Final Users
Refereed papers, conference papers, scientific reports, technical notes and knowledge transfer	Guidelines for government policy development; Biosolids use solutions for local government and industrial end users	Waste managers, forest managers, land owners, consultants, national government departments, local government, iwi (Māori tribes) and communities

Intellectual Property

Product / process / method or other	Nº of requested patents/ Nº patents granted / Nº of licences	Destination

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N/A	N/A	N/A	
Publications (5 most relevant ones)			
Title, date	**Author and co-author(s)**	**Journal**	**Nº of citations / ISI**
Economic analysis of growth response from a pine plantation forest applied with biosolids. 2004	Kimberley, M., Wang, H., Wilks, P.J., Fisher, C.R., and Magesan, G.N.	Forest Ecology and Management	14
Application of municipal and industrial residuals in New Zealand forests: An overview. 2004	Magesan, G.N., Wang, H.	Australian Journal of Soil Research	11
Environmental and nutritional responses of a Pinus radiata plantation to biosolids application. 2004	Wang, H., Magesan, G.N., Kimberley, M.O., Payn, T.W., Wilks, P.J., Fisher, C.R.	Plant and Soil	8
Biosolids-derived nitrogen mineralisation and transformation in forest soils. 2003	Wang, H., Kimberley, M.O., Schlegelmilch, M.	Journal of Environmental Quality	8
The potential of public engagement in sustainable waste management: Designing the future for biosolids in New Zealand. 2009	Goven, J., Langer, E.R.	Journal of Environmental Management	
Average yearly publications per researcher	**3**		

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Lignocellulosic Bioethanol Initiative

Demonstrates our ability to develop and scale up complex engineering solutions.

Research Project	**New Zealand Lignocellulosic Bioethanol Initiative**		
Start date	October, 2006	**End date**	September, 2011
Location Indicate where the research project was carried out	Country of Origin: New Zealand; Scion Lead	Affiliate	Outside premises: Finland, USA: *VTT, Verenium Corp.*

Categorisation (Areas of Knowledge)	
Disciplines	Renewable energy
Sub disciplines	Wood fibre processing, enzymology, industrial biotechnology

Topics developed (do not list more than 5 per research project)

Mechanical pre-treatment technologies for lignocellulosic feedstocks;
Enzymatic conversion and fermentation of lignocellulosic feedstocks to ethanol;
Valorisation of lignin for added value fine chemicals and biomaterials;
Exergy and life cycle modelling of lignocellulosic biofuels;
Scale-up and investment strategies for softwood liquid biofuels production

Budget		
Total amount (US$) (not including valued contributions)	US$ 1.8 Million per year	
Leveraging of Resources (source of financing and distribution)	**%**	**Source of Financing**
	98%	Public
	2%	Private
		Other

Work Team which took part

Category	Quantity	Dedication of Time (full time =100%)	Speciality
Programme Leader	s 9(2)(a)	20%	Industrial biotechnology and sustainability strategy
Operational Leaders	Suckling, Watton	50% each	Biofibre processing
Doctoral Researchers	8	50% each	Biofibre processing; enzymology, fermentation, exergy analysis
Post doctoral researchers	1	50%	Thermodynamic modelling
Technicians	15	30% each	Biofibre processing; analytical chemistry; enzymology, fermentation,
Other	5	30% each	Life cycle analysis, biofibre processing

Results and Applications

Result of the Research Project	Applications	Final Users
Novel physicochemical processes for softwood attrition	Preparation of softwoods through pre-treatments that improve enzymatic digestion	International wood-to-biofuels companies
Advanced thermodynamic and exergy models for lignocellulosic processing	Identify and prioritise the most critical steps and pinchpoints in thermal and biological conversion processes for lignocellulosic biofuels production	International wood-to-biofuels companies
Novel lignin recovery and	Create added value by-products	International wood-to-biofuels

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processing technologies	from biofuel production residues	companies
Optimised enzyme cocktails for softwood saccharification	Improve conversion efficiencies and economics for biofuels production	International wood-to-biofuels companies

Intellectual Property

Product / process / method or other	**Nº of requested patents/ Nº patents granted / Nº of licences**	**Destination** (USA, Europe, Asia, Oceania, Latin America, others)
Novel attrition processes	Trade secret for LBI partners – patents as required are pending	Global patenting and licensing strategy
Novel lignin derivatives for fine chemicals and biomaterials production	Trade secret for LBI partners – patents as required are pending	Global patenting and licensing strategy

Publications (5 most relevant ones)

Title, date	**Author and co-author(s)**	**Journal**	**Nº of citations / ISI**
Bioethanol - Status report on bioethanol production from wood and other lignocellulosic feedstocks. 2009	T Johnson, B Johnson, C Scott-Kerr, J Kiviaho	Proceedings of the 63rd Appita Annual Conference and Exhibition	?
New Zealand Lignocellulosic Bioethanol Initiative – Feasibility study short report, 2008	J Flexman, R Curtis, T Stuthridge, J Stege	Scion Public Report, 2008	?
International developments in cellulosic biomass technologies, 2008	Ramakrishna, S., Yukawa, H., Stuthridge, T., Turner, D.	Proceedings of the 2008 World congress on industrial biotechnology and bioprocessing	?
Sustainability in the pulp & paper industry, 2007	DG Allen, AJ Ragauskas, TR Stuthridge	Industrial Biotechnology	?
Average yearly publications per researcher	2		

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SCION
Next generation biomaterials

2010 Waste Minimisation Fund Application

Scion



Letters of Reference

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"Changing the way New Zealand thinks about waste"

Waste 2 Gold

DESTINATION
ROTORUA
ROTORUA DISTRICT COUNCIL

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18 February 2010

File Ref: 55-27-061

Doc No: RDC-102866

TO WHOM IT MAY CONCERN

Rotorua District Council (Council) has worked with Scion over the years particularly in the area of Waste Management and as a partner in the Rotorua Lakes Strategy Group with Te Arawa Lakes Trust and Environment Bay of Plenty.

Scion has undertaken requirements for those projects in a professional timely manner, demonstrating a high level of skill and innovative approach. A recent example is a project involving locking up of phosphorous in lakebed sediments to prevent their release into the water column during anoxic events. This involved modifying and refining a zeolite material to ensure efficiency, evenly spread and longevity of the application. The multi-million dollar project has been successful in reducing nutrient concentration in the water column on a small lake (Lake Okaro) and is currently being investigated for a much larger water body. For further information please contact Andy Bruere, Manager Lakes Restoration Programme at Environment Bay of Plenty.

On the Waste 2 Gold project Council engaged Scion to demonstrate a "proof of concept" for treating biosolids from our Wastewater Treatment Plant. Scion delivered the requirements of the contract on time and presented the results to Council on 2nd February 2010. Council was so impressed with the results of the study to date it had no hesitation in allocating a sum of $850,000 for construction of a pilot plant in order to advance the project.

Biosolids disposal is Council's single largest waste disposal problem both in terms of cost and environmental effect. A solution that satisfactorily deals with this problem is eagerly sought by Council and the Waste 2 Gold platform delivers this opportunity.

Further, there is potential to move beyond biosolids and treat the district's organic waste stream which constitutes about 60% of the currently landfilled waste.

Rotorua District Council is firmly behind the Waste 2 Gold project, demonstrating its commitment with the allocation of significant financial and logistical support. The concept is technically, financially and environmentally viable and as such Council wishes to see it advanced to production scale.

Yours faithfully

s 9(2)(a)

Chief Executive

ROTORUA PARTNER SHAPING ROTORUA

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Our Ref: 4.01146/1

19 February 2010

Environment Bay of Plenty
REGIONAL COUNCIL

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TO WHOM IT MAY CONCERN

Scion: Waste to Gold Project

Environment Bay of Plenty has worked with Scion for a number of years particularly in the area of Lake Water Quality Restoration. Scion is represented on both the Lakes Water quality Technical Advisory Group and the Land Use Technical Advisory Group. These groups form part of the advisory team for the partners in the Rotorua Lakes Strategy Group in the Rotorua Lakes Protection and Restoration Programme. This is a $200M programme of lake water quality protection and restoration covering 12 lakes in the Rotorua district.

A significant project which Scion has been engaged in has been the production of a product to prevent the release of phosphorus from lake bed sediments. Overseas work has mainly centred on the use of aluminium sulphate (alum) for this application. Alum has a number of negative side effects in the environment including lowering water pH and potential to release toxic Al^{3+} ions. This limits the volumes of alum which can be applied due to risk of side effects.

To overcome some of the issues with use of alum, Scion has developed a product using a locally mined zeolite amended with aluminium, which is effective in locking up phosphorus released from lake bed sediments, and which avoids the release of aluminium into the water column. This product has been tested on Lake Okaro, a 30 Ha lake in the lake restoration programme.

Scion has provided the technical specifications for this product, and technical support during the testing programme. Scion has also developed a business relationship with a manufacturing company that has enabled commercial production of the product for full scale application on Lake Okaro. The application of the product at Okaro is the initial testing which is likely to ultimately lead to a $20M to $25M application to Lake Rotorua, the largest lake in the programme with an area of 80 km^2.

Scion's relationship with Environment Bay of Plenty throughout this and other projects has been innovative and professional. Scion has access to a range of expertise which has complemented project objectives.

Although the Waste to Gold project is not a component of the Lakes Protection and Restoration Programme, Environment Bay of Plenty is supportive for two key reasons:

1. Minimisation of waste and utilisation of waste for production of useful end products aligns with council objectives and in particular the Regional Policy Statement, and

2. One of the likely benefits from application of the project will be a reduction in environment emissions from the Rotorua land fill. This aligns well with the objectives of the lake restoration programme, of reducing nutrient inputs within lakes catchments.

Environment Bay of Plenty applauds this initiative and is extremely supportive of this work taking place within the Bay of Plenty Region.

Yours faithfully

s 9(2)(a)

Chief Executive

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Ministry for the Environment
Manatū Mō Te Taiao

REDUCE • REUSE • RECYCLE • RECOVER

WMF Milestone Report

This is your opportunity to tell us how the delivery phase of your project is progressing.

Milestone reports should be made on those dates agreed in your funding deed (unless otherwise discussed with your Fund Analyst). If there are any problems or issues, or you wish to make major changes to your project, please discuss with your Fund Analyst **before** completing and submitting this report.

Please read the *Waste Minimisation Fund – Grantee Guide* before you complete this report.

Project and report details

Organisation name	Scion
Project title	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation
Contract number	WMF-00000137
Project duration *if a multi-year project select the project duration*	Two years
Current year *if a multi-year project select the current project year*	Year One
Total number of milestones *select the total number of project milestones for the current year*	Three
Current milestone *select the current milestone for this report*	Two
Due date *agreed report due date as per your funding deed*	09/05/11
Date submitted *actual date the report was submitted*	09/05/11
Report type *select whether this is an interim report or the final milestone report for the project*	Interim

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Milestone Two details

Enter the name of the milestone, and then list all of the tasks and deliverables (as agreed in your funding deed) for this milestone in the tables below.

Indicate whether each task and deliverable is complete, and provide a summary of progress in the Comment column. If any task or deliverable is not complete, provide an explanation, and list the actions you plan to take in response.

You will also need to attach evidence of your deliverables to this report.

Press TAB on your keyboard to add a new row, if required.

Milestone name: Pilot Operation Phase

Tasks *tasks as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Thermal oxidation initial pilot trials	No	The initial pilot trials have been delayed by the late delivery of the thermal oxidation pilot plant. This is now onsite and will be the subject of considerable focus for the project over the coming months. Considerable preparatory work has been undertaken during this period to expedite the trial implementation. The pilot plant official opening has been scheduled for the 31st May 2011. Overall the delay in this task is not seen as an impediment to achieving the first major project objective *"To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011"* See Technical Progress Statement for further information
Establish steady state operation on BNR pilot plant module	Yes	To confirm operational efficacy, the BNR pilot plant has been successfully operating at steady state and under half-load conditions for over a month. Cycle structure for the operation has been confirmed and initiated, and the plant will now operate under the design appropriate for modelling a biological nutrient removal process. See Technical Progress Statement for further information
Hybrid lab trial completion and pilot plant design specification	Yes	The hybrid system has been trialled under batch conditions. An internal report for this has been written and will be lodged with Scion's reporting system. The laboratory trials have provided confidence that the pilot plant has been designed to the appropriate specifications.

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Engage suitably skilled consultant to design and tender fermentation pilot plant module	Yes	Our waste 2 Gold development partner, AWT Water Ltd, has been contracted to design and tender the fermentation pilot plant module as per the project plan and WMF application. See Technical Progress Statement for Further information
Continue process engineering model development through calibration with live pilot and lab hybrid trial results	Yes	The process engineering model has been developed to a high level. It is now ready for formal reporting by the contractor. It has been designed to be calibrated against two plant sizes: for a plant equivalent to the Rotorua condition, and a much larger plant, appropriate for the size of Auckland. Process parameters can be manipulated to reflect laboratory data, and capital and operating costing is complete to the level appropriate to this first stage model.

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Deliverables *deliverables as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Fermentation pilot plant module design specification	Yes	The fermentation pilot plant module design specification was completed based on lab trial work carried out over the prior months. This enabled the detailed plant design to be undertaken by the engineering consultant, AWT Water Ltd.
Design and tender fermentation pilot consultant contract in place	Yes	The detailed design and tender of the fermentation pilot plant module has been contracted to AWT Water Ltd as outlined in the Project Plan and WMF application. At the end of this milestone period the design work and competitive tender pre-qualification exercise had been completed. The next phase will involve final tendering and contracting for the construction of the plant.
Quarterly technical progress statement describing thermal oxidation pilot trial technical results to date and establishment of steady state operation on BNR pilot plant module	Yes	Please see attached
Final hybrid lab trial outcomes, and progress on the fermentation pilot plant procurement reported	Yes	The final outcomes of the first laboratory hybrid trial have been reported into a Scion internal report. The fermentation plant procurement process is in place, with tender requests to be initiated.

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Key performance indicators (KPIs)

For each waste type(s) and target annual tonnage you identified in your project plan, please provide the actual values your project reduced, reused, or recycled/recovered during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual tonnages fall short of targets, then please provide a short statement to explain why in the space beneath (eg, the equipment utilised for this project is not yet operating at its maximum capacity).

Press the TAB key on your keyboard to add more rows to the table, if required.

	Quantity of waste (tonnes)					
Waste type	**Reduce**		**Reuse**		**Recover/Recycle**	
	Target	***Actual***	***Target***	***Actual***	***Target***	***Actual***
Rotorua District Council biosolids					Up to 1 tonne per day (pilot-scale process)	Negligible –Yet to start pilot operations
Pulp and paper primary and secondary solids					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start pilot operations
Rotorua District Council Atiamuri Landfill municipal organic wastes					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start pilot operations

This project is focused on technology development and scale-up of a proprietary waste deconstruction process that will enable significant diversion of municipal and industrial organic wastes in the future. During the course of pilot-scale plant operations the actual diverted volumes are expected to be minimal – but sufficient to demonstrate the scalability and suitability of the Process for the targeted outcomes.

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Objectives, activities and measures

As part of your project plan, you specified SMART objectives for the project, provided detail about the types of activity(ies) required, and set annual target measurements. Please provide the actual measure your project achieved during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual measures fall short of targets, then please provide a short statement to explain why in the space beneath.

Press the TAB key on your keyboard to add more rows to the table, if required.

Objective	Activity	Measure	
		Target	*Actual*
To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process. Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP. Design, construct, install and commission Pre-fermentation Module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids as per the project schedule.	Progress to target is good with the BNR module commissioned and operating satisfactorily, the Thermal oxidation module onsite and entering commissioning, and the Fermentation module design complete and procurement initiated.
To demonstrate viable scale up of the complete waste deconstruction process by 31 December 2011.	Carry out pilot trial runs under a range of process conditions and configurations. Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated. Pilot-scale demonstration of product value as a carbon source for WWTP	Project has not yet reached this point as the pilot plant scale up is currently in development.
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to at least three alternative organic waste streams.	This element of the project is primarily the target of the year 2 work plan. However, some preliminary experiments have been conducted, summarised briefly in the first technical progress statement.

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To produce a viable commercial scale design basis for application at the Rotorua wastewater treatment plant by 30 June 2012.	Development of a process engineering and economic model for the full-scale application of the technology. Produce design specifications and costings for a commercial plant.	Process model in place capable of capital and operating cost estimates for full-scale plant. A viable commercial scale design is produced.	The first version of the process engineering model is largely complete and will be populated with lab and pilot trial data as this becomes generated.

Additional project benefits

Please list any additional benefits (economic, environmental, social or cultural) from your project, not foreseen at planning stage. Provide a measurement, if applicable. For environmental benefits, include any reduction of harm to the environment.

Press the TAB key on your keyboard to add more rows to the table, if required.

Benefit	Measure

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Risk management

List the main risks your delivery phase is facing. These may be technical, financial, organisational, economic, social, management, legal or environmental risks. Tell us what you are doing to reduce each risk.

If you identified risks during the development of your project plan, please explain how you are monitoring and/or managing these risks.

Please add as many risk tables as required.

Risk:

Potential risk *description of potential risk event*	Procurement and construction of the Fermentation Pilot Plant module takes longer than anticipated.
Project impact *description of impact*	Delay in integrating the 2 stages of the hybrid process at pilot scale causing programme to run behind schedule by approximately 6 weeks.
Likelihood *low – medium – high*	High
Risk level *minor – moderate – severe*	Minor
Strategy to mitigate *description of risk mitigation*	Now in the detailed procurement planning and construction phase, this risk is well understood and is being actively managed to expedite delivery. This involves close and regular liaison with the consultants and contractors undertaking this infrastructure task. Overall the delay in this task is not seen as an impediment to achieving the first major project objective *"To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011"*

Risk:

Potential risk *description of potential risk event*	Commissioning phase overruns in the thermal wet-oxidation plant – causing research delays
Project impact *description of impact*	Significant delay in the real demonstration phase of the thermal wet-oxidation pilot plant.
Likelihood *low – medium – high*	High
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	The implementation and commissioning of the Pilot Plant modules is of the highest priority to the success of this project. This process is being closely monitored and resources are being allocated appropriately in light of this prioritisation. The initial plant delivery delays have now been rolled into the programme and being actively managed.

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Partnership and other funding sources

Give details of your progress towards securing partnership funds and any contingency plans for any funding shortfalls.
Include all cash contributions and other funding listed in your project budget.
Press the TAB key on your keyboard to add more rows to the table, if required.

Partner / funding source	Amount requested	Amount approved	Amount received	Date balance expected
Rotorua District Council	$100,000	$100,000	$100,000	
Scion Investment	$179,762	$179,762	$179,762	

Procurement

Give details of any major goods, work or services you are currently arranging for your project, or which you have purchased since your last report.
You must also attach copies of any relevant briefs and provide a summary of the procurement process followed.
Press the TAB key on your keyboard to add more rows to the table, if required.

Description	Value	Date awarded	Supplier name
Fermentation Pilot Plant procurement	$20,000	19/4/11	AWT Water Limited

Evaluation

Are you evaluating your project according to your agreed Stage II Project Plan? ☒ Yes ☐ No

Please confirm that you are evaluating your project according to your agreed Stage II project plan: Yes or No? If No, please provide an explanation

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Declaration

- I declare that to the best of my knowledge, the information contained in all sections of this report, or supplied by us in support of our report is complete, true and correct.
- I declare that I have the authority to sign this report and to provide this information.
- I understand that the Information presented to the Minister is subject to disclosure under the Official Information Act, 1982.
- I declare that the fund payment request accompanying this report is complete, true and correct.

s 9(2)(a)

electronically signing this form.

Date 09/05/11

Verification

I verify that the fund payment request accompanying this report is complete, true and correct, and:

- costs making up the amount of this request are part of the eligible costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by donation or credit notes.

s 9(2)(a)

Date 09/05/11

Bank account details

If this is the first time you are completing this form, or account details have changed, please provide the bank account details into which the payment should be made. Please also attach a pre-printed deposit slip.

Bank name: The National Bank of New Zealand

Branch name: Rotorua

s 9(2)(b)(ii)

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Once complete, please email the *WMF Milestone Report*, *WMF Claim Form* and supporting evidence as listed below to your Fund Analyst.

The Ministry prefers that all required documents are sent electronically, however, where it is not possible to send documents via email, please send a paper copy to:

Waste Minimisation Fund
Ministry for the Environment
PO Box 10362
Wellington 6143

Report checklist

Use the following checklist to confirm you have included all the required information in your report.

- ☐ Complete all sections of this form.
- ☐ Sign the declaration.
- ☐ Complete a *WMF Milestone Claim Form* for this milestone. If this is the first *WMF Milestone Report* for your project, attach a pre-printed deposit slip.
- ☐ If this is the final *WMF Milestone Report* for your project, complete the *WMF Final Project Report*.
- ☐ Attach evidence of milestone deliverables, for example:
  - photographs of project progress
  - monitoring and/or evaluation data
  - record of activities
  - media coverage or other publicity
  - invoices
  - staff recruitment.
- ☐ Attach a tax invoice containing the words 'Tax Invoice', and showing the following details:
  - your organisation's GST number
  - invoice number
  - deed number
  - total claim amount
  - GST component.
- ☐ Attach a list of invoices for this reporting period, in the standard format that you/your company use to record this type of information. Please ensure the following details are included:
  - invoice number
  - invoice date
  - supplier
  - description
  - total (excluding GST).

Please note, you must request your fund payments at the frequency agreed during your Stage II project planning discussions.

The Ministry will not pay more than 90 per cent of the WMF approved amount until we are satisfied that your project is complete.

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WMF Milestone Claim Form (2010/11)

Project title:	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation			**CMS No:**	
WMF $ approved:	$541,000.00	**WMF% approved:**	33.37%	**Grantee:**	Scion

Milestones and deliverables	Due Date	Estimated total expenditure *(excl. GST)*	Estimated WMF payment *(% est. cost)*	Actual total expenditure *(excl. GST)*	Actual payment due	Comments
Milestone 1						
Laboratory Trial Phase	31.01.11	$491,000.00	$163,846.70	$477,576.00	$159,367.00	
Milestone 2						
Pilot Operation Phase	31.03.11	$414,000.00	$138,151.80	$419,875.00	$140,112.29	
Milestone 3						
Pilot System Integration Phase	30.06.11	$716,000.00	$238,929.20	$0.00	$0.00	
Milestone 4						
			$0.00	$0.00	$0.00	
Milestone 5						
			$0.00	$0.00	$0.00	
Milestone 6						
			$0.00	$0.00	$0.00	
Totals (GST exclusive)		$1,621,000.00	$540,927.70	$897,451.00	$299,479.29	

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Milestone 2	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation	Interim Claim

Milestone estimates:

Estimated total expenditure	$414,000.00
Estimated WMF payment	$138,151.80

Balance and actual:

Balance brought forward	$381,633.00
Actual paid to date	$159,367.00
Actual total expenditure	$419,875.00

Income (non WMF)	**Record cash contributions directly related to this project**
*Include **all** cash contributions from other funding sources (including income not previously listed in project budget)*	
Cash Contribution	$100,000.00
Scion Investment	$179,762.00
Actual total income	**$279,762.00**

Expenditure	**Record all project cash expenditure**
Personnel	$199,605.00
Administration	$2,427.00
Consultants and contractors	$50,766.00
Capital expenditure	$54,147.00
Equipment	$111,575.00
Travel and accommodation	$1,355.00
Promotion and dissemination	
Financial and/or legal expenses	
Other expenses	
Actual total expenditure	**$419,875.00**

Payment calculated using the Interim Payment Calculation	
% of actual total expenditure =	$140,112.29
balance brought forward (less 10% max WMF amount) =	$327,533.00
actual expenditure minus income =	$140,113.00

Payment due	**$140,112.29**	Maximum amount approved	$541,000.00
		Funds remaining after payment made	$241,520.71

For Ministry use only

Milestone assessment

Approved/declined for payment:

Name: _____

Position: _____

Date: _____

Signed:

Payment verified:

Name: _____

Position: _____

Date: _____

Signed:

Payment approved:

Name: _____

Position: _____

Date: _____

Signed:

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Technical Progress

9th May 2011

Inside This Update

1 Progress Summary

2 Tasks Update



The thermal oxidation pilot plant is now onsite undergoing final installation and commissioning…

And the Fermentation pilot plant is complete and ready to tender

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Progress Summary

The second milestone period (March-April) has been completed with a continued focus on the establishment of the pilot plant infrastructure.

Key tasks delivered are summarised as follows:

The **Thermal Oxidation pilot plant module** has been physically delivered to site at RDC Wastewater Treatment Plant. Final installation and commissioning is now underway. In parallel, considerable pilot trial preparation activity has been undertaken. This includes the establishment of site operating and safety systems and a major Hazard and Operability study (HAZOP) of the plant.

The **Biological Nutrient Removal (BNR) pilot plant** module has been successfully operating onsite for over a month now. The plant and process has proven to be very robust in its wastewater treatment capability and initial data is very encouraging. It will continue to be optimised over the coming months with the aim of modelling the full-scale RDC process for evaluation of process product liquors.

The primary **hybrid lab trials** focussed on the development of the process design specification for the fermentation stage were completed. These trials have been successfully completed allowing the detailed design of the Anaerobic Fermentation Pilot Plant module to be done.

An engineering consultant, AWT Water, who is a partner in the Waste 2 Gold programme, was contracted to undertake the detailed **design and procurement of the Anaerobic Fermentation Pilot Plant**. The detailed design element has been completed and tendering is currently underway.

The **process engineering model** continues to progress well and is now at the stage where it can be used for a first generation techno-economic evaluation.

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Task One : *Thermal Oxidation initial pilot trials*

Task One: Thermal Oxidation initial pilot trials

The **thermal oxidation pilot plant** was delivered onsite to the RDC Wastewater Treatment Plant (WWTP) on the 29th April. Final installation is currently underway. Commissioning trials are scheduled for late May. A formal opening for this plant is planned for 31st May. This timing has been communicated to MfE.

In preparation for the delivery of the thermal oxidation pilot plant module, the project team has focused on the establishment of robust site operations and safety systems. As part of this preparation, a major pre-commissioning Hazard and Operability study (HAZOP) was undertaken in April.

An external expert in process safety was used to facilitate this 2-day study which was attended by all staff involved with the design, engineering, and operation of the pilot plant.

The study significantly raised the team's risk awareness of this complex system and produced a considerable number of outputs. These outputs have provided an essential contribution to the pilot trial planning and preparation activities ensuring trial operational risks are minimized.









s 9(2)(a)

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Task Two : *Establish steady-state operation on BNR pilot plant module*

Task Two: Establish steady-state operation on BNR pilot plant

The goal of the BNR pilot plant operation is to provide an appropriately sized biological reactor, capable of receiving liquors generated by the STOP process pilot plant. The response of the BNR plant will thus model the impact of these liquors on process performance.

The BNR plant has been in steady-state operation for over a month. It was set up to run under half the intended design load for the plant, in order to familiarise ourselves with the plant operation, and to iron out inevitable commissioning problems.

The plant has been operating successfully, albeit that the first commissioning phase has taken longer than anticipated.

Initial data from the plant, operated under low hydraulic and organic loading compared with the full-scale plant, and no external ethanol addition, has demonstrated:

- Robust operation of the plant, after a number of initial system problems
- Development of a biomass capable of removing the incoming organic carbon load,
- A high level of oxidation of the incoming ammonia load
- low levels of nitrogen removal, a function of the carbon limitation that the plant has been operated under. This provides clear evidence that external carbon addition, (initially in the form of ethanol as the full-scale plant currently practices, but subsequently targeting the use of wet oxidation liquors) is necessary when operated under the designed configuration.
- Little evidence of phosphorus removal thus far. This may be a result of a lack of fermented acids which this pilot plant is receiving relative to the full-scale plant. Alternatively, it could be an indication that the addition of ethanol at the head of the full-scale plant is having an effect on the overall phosphorus uptake.
- good settling of the cellular biomass within the reactor system, a result critical to the effective operation of the plant

This initial operational phase has now been superseded by new settings, designed to more accurately reflect the full-scale BNR operation. Thus, the reactor is now operating at a more representative organic load, and ethanol dosing has been initiated. We would expect

- the system biomass levels to increase significantly, from currently less than 1g/L cellular solids up to around 2g/L
- evidence of nitrogen removal, to >70% of the incoming nitrogen.



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Task Three : Hybrid lab trial completion and pilot plant design specification

Task Three: Hybrid lab trial completion and pilot plant design specification

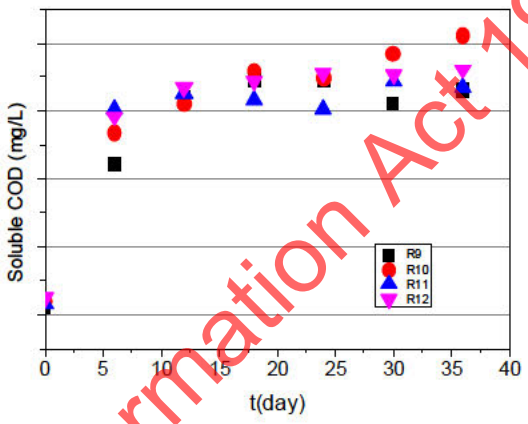
The initial laboratory trials of the hybrid system have been completed. The major results were reported on in the Quarter One technical progress update. The internal reporting for these has been completed for logging into Scion's internal document management system.

These results formed the basis of the Fermentation pilot plant module design brief given to the external consultant for detailed design and procurement. (See Task Four below)

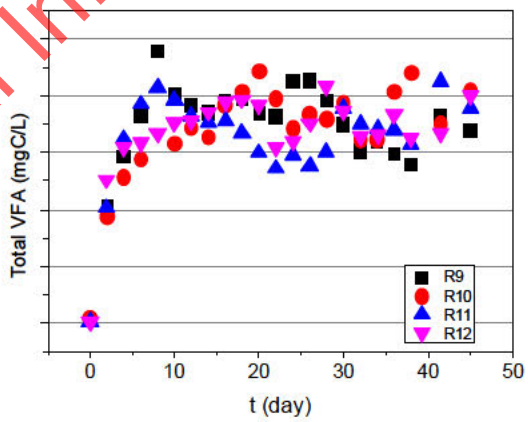
Subsequent to the batch-wise structure of the initial trials, the first continuous trials of one of the reaction stages have now been completed. These have demonstrated the following key results for fermentations which have operated over 45 days:

- stable reactor operation, for the key suspended solids and organic acid production parameters
- good suspended solids destruction
- No significant impact of reactor inoculation, on the steady-state performance of the system
- Some dramatic pH effects, for the production of dissolved organic carbon, and in particular organic acid production.

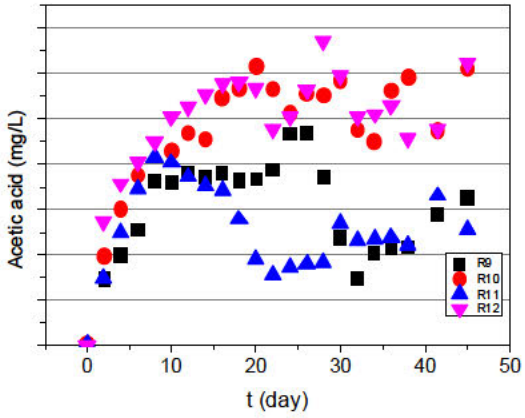
s 9(2)(a)



1. Soluble organic material production within continuous reactor



2. Total acid production within continuous reactor



3. Acetic acid production within continuous reactor

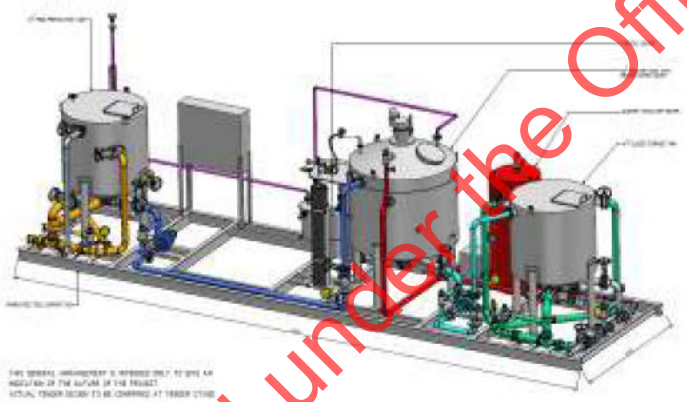
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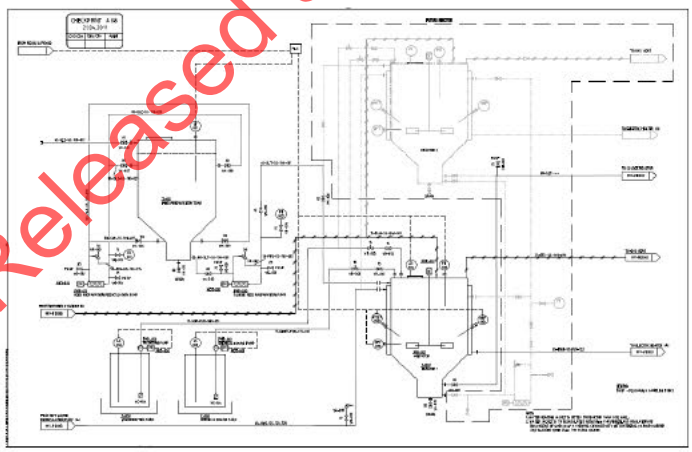
Task Four : *Engage suitably skilled consultant to design and tender fermentation pilot plant module*

Task Four: Engage a suitably skilled consultant to design and tender fermentation pilot plant module.

The **Fermentation Pilot Plant Module** has been designed by the Waste 2 Gold development partner, AWT Water Ltd, as outlined in the project plan and WMF application.

This design is based on the anaerobic fermentation stage process specification, supported by outputs from **Task 3**; *Hybrid lab trial completion and pilot plant design specification.* This output described the critical process parameters and capability required of the pilot plant. The resulting specification was then used by AWT Water to carry out the detailed design and prepare a technical specification for the plant procurement.





The procurement process involves the competitive tendering of the construction of the anaerobic fermentation pilot plant module. In order to optimise the timescales involved and ensure a quality outcome a tenderer pre-qualification exercise was undertaken in parallel with the design phase. This publicly advertised process called for Registrations Of Interest (ROI) from appropriately qualified contractors. The respondants were evaluated against pre-determined criteria which resulted a short list of 3 contractors being selected to tender for the plant construction.

A critical element of the design process has been the undertaking of a major Hazard and Operability study (HAZOP), which was done prior to the final design acceptance. HAZOP studies require the process design to be analysed by multiple disciplines represesnting the design and operations teams. They are considered good practice and essential to minimising potential risks when the plant is finally built and operated.

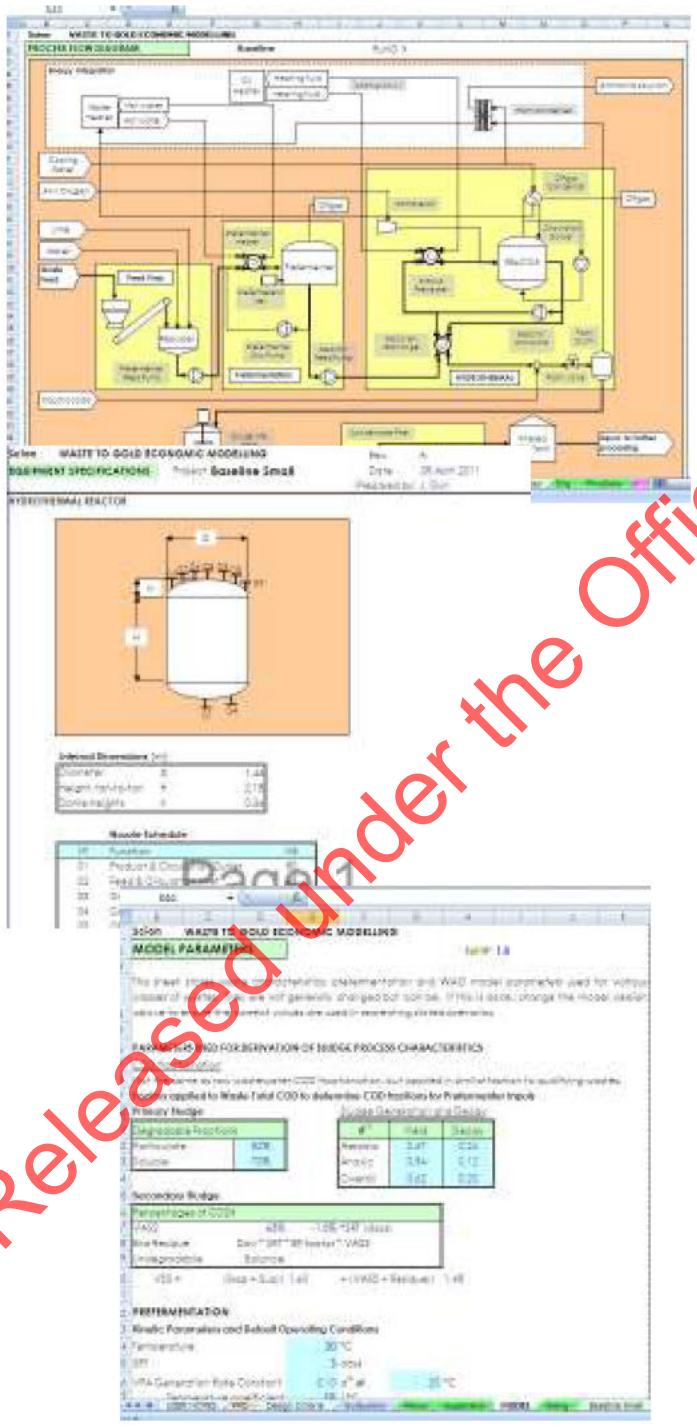
The next phase involves the final tender evaluation followed by appropriate approvals prior to contracting. The current estimates of construction time put the installation of this pilot plant module approximately 6 weeks behind the original project plan target. This will result in the plant being onsite mid-August which is not seen as an impediment to achieving the first major project objective *"To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011"*

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Task Five : *Continue process engineering model development through calibration with live pilot and lab hybrid trial results*

Task Five : Continue process engineering model development through calibration with and lab hybrid trial results



A crucial aspect of the project is development of the process engineering model. This model, contracted out to AWT Water Ltd, will:

- detail mass and energy flows across the individual unit operations and the process as a whole
- provide the basis for evaluating the system performance against the cost of this performance
- describe the scalability of the developed process
- evaluate the cost implications of changes to process flow or unit operations
- provide outputs suitable for inputting into larger, whole system models of wastewater treatment plants.

The process engineering model has been developed to a high level. It is now ready for formal reporting by the contractor.

It has been designed to be calibrated against two plant sizes: for a plant equivalent to the Rotorua condition, and a much larger plant, appropriate for the size of Auckland.

Process parameters can be manipulated to reflect laboratory data, and capital and operating costing structure is complete, to the level appropriate to this first stage model.

This work will be critiqued by Scion and the contractor, and reported in a short formal report.

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Communications Report

5th May 2011

This Communications Report draws on data from a range of communication sources. Scion has an obligation to the Ministry for the Environement (MfE), to provide key communicaiton information on a quarterly basis.

Future Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Comm Status	Date & Progress Update
1	TBC	Alison Balance, Environment & Science Producer for 'Our Changing World', Radio New Zealand is looking for stories to do in April. She's identified W2G, and would look to conversational style interviews with 1-3 people. Can you please pass this request onto the group.	Radio New Zealand	TBC		
2	7-Mar-11	Marianna Tyler - met with s 9(2)(a) at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	24-Mar-11	Pending	

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Future Communications..continued

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Comm Status	Date & Progress Update
4	TBC	Media material for official opening of pilot plant & updated info on Scion (& RDC) websites. New/updated info sheet.	Scion & RDC	31st May 2011	In progress	
5	TBC	Display in Scion booth at PF Olsen Forest Industries 2011 Expo, 5-7 Sept.	Scion	5-7 Sep 2011	To commence	
6	May 2011	s 9(2)(a) be presenting Waste 2 Gold project to Auckland City Council in May as part of an Environlink workshop by CRIs	Scion	May 2011	To commence	
7	TBC	Waste 2 Gold will be part of a Green Chemistry expo in Tauranga that will highlight our activities to BOP schools and community	Scion	TBC	To commence	

Reactive/Responsive Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Comm Status	Date & Progress Update
1	5/4/11	Briefed Waikato/BOP Regional Biosolids summit on Waste 2 Gold project, technology, objectives, and status. This forum was setup to try and facilitate regional approaches to biosolids management where smaller individual producers struggle to resource sustainable solutions for disposal.	Scion & RDC	5/4/11	complete	

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Closed

Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Comm Status	Date & Progress Update
1	14-Oct-10	Questions from Biodiesel & Biorefining Magazine, BBI International	Scion	Answers supplied		Complete
2	18-Nov-10	Request for photos for use in Secondary School textbook on sustainability published by Nelson Cengage Learning NZ	Scion	Photos & captions supplied		Complete
3	12-Mar-11	Science in the Park - Scion held its third biennial Science in the Park held at Scion□s Rotorua campus. The main aim of Science in the Park is to create a greater awareness within the local community of what Scion does. Waste 2 Gold was a significant component of the day. 2800 visitors participated in the day - this has also let to two future display requests for the Water Conference in Rotorua (RDC) and a biowastes day in Tauranga in April.	Scion and RDC	W2G Display Pavillion		Complete

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Special Mention

Wetoxidation Pilot Plant Powhiri/Arrival - The wetoxidation pilot plant was completed on the 28th April and a powhiri was held at the contracting engineers premisis. The pilot plant was then transported to the RDC Wastewater Treatment Plant, where it was installed to carry out the subsequent research programme.













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Potential End User - Opportunity Tracker - Milestone 2

Topic	Company	Date of call/opportunity
Submitted an ROI in response to a Biosolids research programme advertisment. The Waste 2 Gold ROI was selected along with 7 other submitters out of 24, for the next stage of submitting a formal proposal. This is being developed with engineering partner, AWT Water, who have a Melbourne office base. THe final proposal is due 31 May.	Melbourne Water	March/April 2011

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MFE Claim form - People Hours breakdown

Hours by Person

s 9(2)(a)

MS 1 Hours	MS 2 Hours	MS 3 Hours	YTD Hours
184	355		539
67	125		192
45	28		73
160	184		344
11	6		17
6	38		44
141	178		319
77	50		127
3	0		3
159	122		281
133	243		376
2	32		34
28	9		37
47	0		47
33	3		36
305	252		557
107	193		300
4	12		16
25	25		50
9	0		9
24	24		48
1,570	**1,879**		**3,449**

Date generated 11/5/2011

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Ministry for the Environment
Manatū Mō Te Taiao

REDUCE • REUSE • RECYCLE • RECOVER

WMF Milestone Report

This is your opportunity to tell us how the delivery phase of your project is progressing.

Milestone reports should be made on those dates agreed in your funding deed (unless otherwise discussed with your Fund Analyst). If there are any problems or issues, or you wish to make major changes to your project, please discuss with your Fund Analyst **before** completing and submitting this report.

Please read the *Waste Minimisation Fund – Grantee Guide* before you complete this report.

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Project and report details

Organisation name	Scion
Project title	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation
Contract number	WMF-00000137
Project duration *if a multi-year project select the project duration*	Two years
Current year *if a multi-year project select the current project year*	Year One
Total number of milestones *select the total number of project milestones for the current year*	Three
Current milestone *select the current milestone for this report*	Three
Due date *agreed report due date as per your funding deed*	
Date submitted *actual date the report was submitted*	
Report type *select whether this is an interim report or the final milestone report for the project*	Interim

Milestone Three details

Enter the name of the milestone, and then list all of the tasks and deliverables (as agreed in your funding deed) for this milestone in the tables below.

Indicate whether each task and deliverable is complete, and provide a summary of progress in the Comment column. If any task or deliverable is not complete, provide an explanation, and list the actions you plan to take in response.

You will also need to attach evidence of your deliverables to this report.

Press TAB on your keyboard to add a new row, if required.

Milestone name: Pilot System Integration Phase

Tasks *tasks as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Integration of Thermal Oxidation and BNR pilot plant trials	Yes	While the initial pilot trials were delayed due to the late delivery, installation and commissioning of the thermal oxidation pilot plant. Initial trials have now been undertaken. Establishment of biosolids processing at pilot scale has been a substantial task and a significant achievement for the team. Completion of this task has set the foundation for the project pilot operations over the next 12 months. Overall the initial delays in this task have not impacted on achieving the first major project objective *"To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011"* See Technical Progress Statement for further information
Process Engineering Model Calibration v1.0	Yes	The first generation of the process engineering model has been completed and has been delivered by the contractor. It has been calibrated based on lab scale data against two plant sizes: for a plant equivalent to the Rotorua condition, and a much larger plant, appropriate for the size of Auckland. Capital and operating costing is complete, to the level appropriate to this first stage model. See Technical Progress Statement for further information
Carry out review of first years technical progress against project objectives	Yes	The technical progress of first year of the project has been reviewed against the objectives laid out in the WMF Project Plan (Section 4). The majority of these objectives are based on second year dates however, considerable progress towards achieving these has already been made.

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		See attached Year one review for further information.

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Deliverables *deliverables as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Thermal oxidation and BNR pilot trials integrated	Yes	Following successful commissioning of the thermal oxidation pilot plant, this module can be incorporated into the ongoing operation of the BNR pilot plant at the RDC WWTP. We are now in the position of running integrated trials whereby product from the thermal oxidation process is run as a carbon source for the BNR process. These trials will continue to develop over the coming 12 months as pilot trials are refined. This now brings us to a point where 2 of the 3 planned pilot modules are operating onsite. The construction of the 3rd module, the fermentation pilot plant, is currently being expedited. The delay in the 3rd module has not impacted on achieving the first major project objective *"To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011"*
Techno-economic scenario as an output from process engineering model (v1.0) for the technology application based on results to date	Yes	Please see attached
Quarterly technical progress statement describing pilot trial technical results to date, commentary to the process engineering model outputs, and fermentation pilot plant module installation	Yes	Please see attached
Year 1 technical progress statement -providing a comprehensive overview of the first year's technical progress against project objectives, including outcomes and recommendation of Scion technology review processes carried out.	Yes	Please see attached
2011/12 WMF Project Plan	Yes	Submitted June 2011

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Key performance indicators (KPIs)

For each waste type(s) and target annual tonnage you identified in your project plan, please provide the actual values your project reduced, reused, or recycled/recovered during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual tonnages fall short of targets, then please provide a short statement to explain why in the space beneath (eg, the equipment utilised for this project is not yet operating at its maximum capacity).

Press the TAB key on your keyboard to add more rows to the table, if required.

	Quantity of waste (tonnes)					
Waste type	**Reduce**		**Reuse**		**Recover/Recycle**	
	Target	***Actual***	***Target***	***Actual***	***Target***	***Actual***
Rotorua District Council biosolids					Up to 1 tonne per day (pilot-scale process)	Negligible –Initial trials undertaken
Pulp and paper primary and secondary solids					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start on P&P solids
Rotorua District Council Atiamuri Landfill municipal organic wastes					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start on municipal organics

This project is focused on technology development and scale-up of a proprietary waste deconstruction process that will enable significant diversion of municipal and industrial organic wastes in the future. During the course of pilot-scale plant operations the actual diverted volumes are expected to be minimal – but sufficient to demonstrate the scalability and suitability of the Process for the targeted outcomes.

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Objectives, activities and measures

As part of your project plan, you specified SMART objectives for the project, provided detail about the types of activity(ies) required, and set annual target measurements. Please provide the actual measure your project achieved during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual measures fall short of targets, then please provide a short statement to explain why in the space beneath.

Press the TAB key on your keyboard to add more rows to the table, if required.

Objective	Activity	Measure	
		Target	***Actual***
To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process. Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP. Design, construct, install and commission Pre-fermentation Module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids as per the project schedule.	Progress to target is satisfactory with the BNR module operating well, the Thermal oxidation module commissioned, and the Fermentation module procurement well underway.
To demonstrate viable scale up of the complete waste deconstruction process by 31 December 2011.	Carry out pilot trial runs under a range of process conditions and configurations. Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated. Pilot-scale demonstration of product value as a carbon source for WWTP	Project has not yet reached this point as the pilot plant scale up is currently in development.
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to at least three alternative organic waste streams.	This element of the project is primarily the target of the year 2 work plan. However, some preliminary experiments have been conducted, summarised briefly in the first technical progress statement.
To produce a viable commercial scale design basis for application at the Rotorua wastewater treatment	Development of a process engineering and economic model for	Process model in place	The first version of the process

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plant by 30 June 2012.	the full-scale application of the technology. Produce design specifications and costings for a commercial plant.	capable of capital and operating cost estimates for full-scale plant. A viable commercial scale design is produced.	engineering model is largely complete and will be populated with lab and pilot trial data as this becomes generated.

Additional project benefits

Please list any additional benefits (economic, environmental, social or cultural) from your project, not foreseen at planning stage. Provide a measurement, if applicable. For environmental benefits, include any reduction of harm to the environment.

Press the TAB key on your keyboard to add more rows to the table, if required.

Benefit	Measure

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Risk management

List the main risks your delivery phase is facing. These may be technical, financial, organisational, economic, social, management, legal or environmental risks. Tell us what you are doing to reduce each risk.

If you identified risks during the development of your project plan, please explain how you are monitoring and/or managing these risks.

Please add as many risk tables as required.

Risk:

Potential risk *description of potential risk event*	Procurement and construction of the Fermentation Pilot Plant module takes longer than anticipated.
Project impact *description of impact*	Delay in integrating the 2 stages of the hybrid process at pilot scale causing programme to run behind schedule.
Likelihood *low – medium – high*	Medium
Risk level *minor – moderate – severe*	Minor
Strategy to mitigate *description of risk mitigation*	Now in the detailed procurement planning and construction phase, this risk is well understood and is being actively managed to expedite delivery. This involves close and regular liaison with the consultants and contractors undertaking this infrastructure task. Overall the delay in this task is not seen as an impediment to achieving the first major project objective *"To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011"*

Risk:

Potential risk *description of potential risk event*	Commissioning phase overruns in the thermal wet-oxidation plant – causing research delays
Project impact *description of impact*	Significant delay in the real demonstration phase of the thermal wet-oxidation pilot plant.
Likelihood *low – medium – high*	High
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	The implementation and commissioning of the Pilot Plant modules is of the highest priority to the success of this project. This process is being closely monitored and resources are being allocated appropriately in light of this prioritisation. The initial plant delivery delays have now been rolled into the programme and have been actively managed resulting in the successful commissioning being carried out.

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Partnership and other funding sources

Give details of your progress towards securing partnership funds and any contingency plans for any funding shortfalls.
Include all cash contributions and other funding listed in your project budget.
Press the TAB key on your keyboard to add more rows to the table, if required.

Partner / funding source	Amount requested	Amount approved	Amount received	Date balance expected
Rotorua District Council	$100,000	$100,000	$100,000	
Scion Investment	$145,609	$145,609	$145,609	

Procurement

Give details of any major goods, work or services you are currently arranging for your project, or which you have purchased since your last report.
You must also attach copies of any relevant briefs and provide a summary of the procurement process followed.
Press the TAB key on your keyboard to add more rows to the table, if required.

Description	Value	Date awarded	Supplier name

Evaluation

Are you evaluating your project according to your agreed Stage II Project Plan? ☒ Yes ☐ No

Please confirm that you are evaluating your project according to your agreed Stage II project plan: Yes or No? If No, please provide an explanation

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Declaration

- I declare that to the best of my knowledge, the information contained in all sections of this report, or supplied by us in support of our report is complete, true and correct.
- I declare that I have the authority to sign this report and to provide this information.
- I understand that the Information presented to the Minister is subject to disclosure under the Official Information Act, 1982.
- I declare that the fund payment request accompanying this report is complete, true and correct.

s 9(2)(a) [redacted]

space provided you are electronically signing this form.

Date 13/07/11

Verification

I verify that the fund payment request accompanying this report is complete, true and correct, and:

- costs making up the amount of this request are part of the eligible costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by donation or credit notes.

s 9(2)(a) [redacted]

electronically signing this form.

Date 13/07/11

Bank account details

If this is the first time you are completing this form, or account details have changed, please provide the bank account details into which the payment should be made. Please also attach a pre-printed deposit slip.

Bank name	The National Bank of New Zealand
Branch name	Rotorua

s 9(2)(b)(ii) [redacted]

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Once complete, please email the *WMF Milestone Report*, *WMF Claim Form* and supporting evidence as listed below to your Fund Analyst.

The Ministry prefers that all required documents are sent electronically, however, where it is not possible to send documents via email, please send a paper copy to:

Waste Minimisation Fund
Ministry for the Environment
PO Box 10362
Wellington 6143

Report checklist

Use the following checklist to confirm you have included all the required information in your report.

- ☐ Complete all sections of this form.
- ☐ Sign the declaration.
- ☐ Complete a *WMF Milestone Claim Form* for this milestone. If this is the first *WMF Milestone Report* for your project, attach a pre-printed deposit slip.
- ☐ If this is the final *WMF Milestone Report* for your project, complete the *WMF Final Project Report*.
- ☒ Attach evidence of milestone deliverables, for example:
  - photographs of project progress
  - monitoring and/or evaluation data
  - record of activities
  - media coverage or other publicity
  - invoices
  - staff recruitment.
- ☐ Attach a tax invoice containing the words 'Tax Invoice', and showing the following details:
  - your organisation's GST number
  - invoice number
  - deed number
  - total claim amount
  - GST component.
- ☐ Attach a list of invoices for this reporting period, in the standard format that you/your company use to record this type of information. Please ensure the following details are included:
  - invoice number
  - invoice date
  - supplier
  - description
  - total (excluding GST).

Please note, you must request your fund payments at the frequency agreed during your Stage II project planning discussions.

The Ministry will not pay more than 90 per cent of the WMF approved amount until we are satisfied that your project is complete.

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Milestone 3	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation	Interim Claim

Milestone estimates:

Estimated total expenditure	$366,000.00
Estimated WMF payment	$122,134.20

Balance and actual:

Balance brought forward	$700,520.71
Actual paid to date	$299,479.29
Actual total expenditure	$368,617.00

Income (non WMF) — **Record cash contributions directly related to this project**

*Include **all** cash contributions from other funding sources (including income not previously listed in project budget)*

Cash Contribution	$100,000.00
Scion Investment	$145,609.00
Actual total income	**$245,609.00**

Expenditure — **Record all project cash expenditure**

Personnel	$209,561.00
Administration	$5,003.00
Consultants and contractors	$24,775.00
Capital expenditure	
Equipment	$123,675.00
Travel and accommodation	$5,603.00
Promotion and dissemination	
Financial and/or legal expenses	
Other expenses	
Actual total expenditure	**$368,617.00**

Payment calculated using the Interim Payment Calculation

% of actual total expenditure =	$123,007.49
balance brought forward (less 10% max WMF amount) =	$600,520.71
actual expenditure minus income =	$123,008.00

Payment due	**$123,007.49**	Maximum amount approved	$1,000,000.00
		Funds remaining after payment made	$577,513.22

For Ministry use only

Milestone assessment

Approved/declined for payment:

Name: _____

Position: _____

Date: _____

Signed:

Payment verified:

Name: _____

Position: _____

Date: _____

Signed:

Payment approved:

Name: _____

Position: _____

Date: _____

Signed:

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WMF Milestone Claim Form (2010/11)

Project title:	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation			**CMS No:**	
WMF $ approved:	$1,000,000.00	**WMF% approved:**	33.37%	**Grantee:**	Scion

Milestones and deliverables	Due Date	Estimated total expenditure *(excl. GST)*	Estimated WMF payment *(% est. cost)*	Actual total expenditure *(excl. GST)*	Actual payment due	Comments
Milestone 1						
Laboratory Trial Phase	31.01.11	$491,000.00	$163,846.70	$477,576.00	$159,367.00	
Milestone 2						
Pilot Operation Phase	31.03.11	$414,000.00	$138,151.80	$419,875.00	$140,112.29	
Milestone 3						
Pilot System Integration Phase	30.06.11	$366,000.00	$122,134.20	$368,617.00	$123,007.49	
Milestone 4						
			$0.00	$0.00	$0.00	
Milestone 5						
			$0.00	$0.00	$0.00	
Milestone 6						
			$0.00	$0.00	$0.00	
Totals (GST exclusive)		$1,271,000.00	$424,132.70	$1,266,068.00	$422,486.78	

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MILESTONE 3 QUARTERLY TECHNICAL PROGRESS STATEMENT - WASTE 2 GOLD

Technical Progress

July 2011

Inside This Update

1 Progress Summary

2 Tasks Update



The thermal oxidation pilot plant is now complete and undergoing pilot trials

And the Fermentation pilot plant is has been tendered and is under construction

SCION
Next generation biomaterials

Progress Summary

The third milestone period (May-June) has been completed with a continued focus on the establishment of the pilot plant infrastructure.

Key tasks delivered are summarised as follows:

The **Thermal Oxidation and BNR pilot plants are installed** at RDC site, and the first wet oxidation trial has been conducted. We are now in a position to integrate the thermal oxidation plant with the BNR. After some key performance data is obtained during July, one of the BNR reactor trains will be switched from ethanol to wet oxidation liquors.

Version 1 of the process engineering model is now complete. An example techno-economic scenario has been prepared for the base-case of Rotorua. Areas for model improvement have been identified, which will be actioned during the second project year.

An **end of year progress review** has been completed, and forms part of the MfE reporting documentation.

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Task One : *Integration of Thermal Oxidation and BNR pilot plant trials*

Task One: Integration of Thermal Oxidation and BNR pilot plant trials

We now have a functional **Thermal Oxidation pilot plant module** installed at RDC Wastewater Treatment Plant. The plant was formally opened by the Minister for Environment, Hon. Dr Nick Smith, on 31 May 2011.

Finishing work (insulation, and commissioning modification requirements) is in its last stages. Low and high pressure/temperature water commissioning has been conducted.

The first sludge wet oxidation trial has also been completed. This was a low temperature/pressure/solids (160 Centigrade/2MPa/0.5% solids) experiment, designed to test the efficacy of the system under sludge-containing, oxidative environment. The trial ran successfully for over four hours. Despite the low temperature environment, suspended solids were reduced by 50-70%, and soluble organic material was generated up to 600-800 kg COD/tonne dry biosolids input.

Significant delays in delivery of the completed plant have been encountered for this task. Despite these, and acknowledging that such delays are likely in a major capital build containing a significant bespoke aspect to its construction, we have the first major achievement of the project: that of a functional thermal oxidation pilot plant.

The Biological Nutrient Removal (BNR) pilot facility plant module has been successfully operating onsite for over four months.

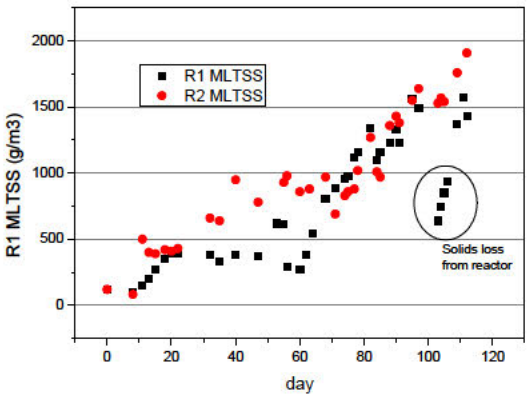
Initial data is very encouraging. Examples of the averaged treatment performance of the two trains, operating as a model of the Rotorua WWTP are:

- Ammonia removal of 88% and >99% for reactors R1 and R2, respectively
- Nitrogen removal (combined ammonia and oxidised nitrogen) of 73% for both reactors
- Phosphate-P removal of 27% and 23% for reactors R1 and R2, respectively
- Good settling of the cellular biomass within the reactor system, a result critical to the effective operation of the plant.





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Demonstration of solids buildup in BNR reactors

The nitrogen removal performance is consistent with the fullscale Bardenpho reactor at RDC, which demonstrates greater than 80% removal. At 50-60%, phosphorus removal in the fullscale is slightly better than the pilot BNR (*unreferenced communications with RDC staff provided fullscale performance data)*.

We are now in a position to integrate the thermal oxidation plant with the BNR. After some key performance data is obtained during July, one of the BNR reactor trains will be switched from ethanol to wet oxidation liquors. This switch may occur via a transition using synthetic VFA solution.

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Task Two : *Process Engineering Model Calibration v1.0*

Task Two: Process Engineering Model Calibration v1.0

Process Engineering Model Calibration v1.0

Version 1 of the the process engineering model is now complete, and the contractor has submitted a formal report back to Scion.

This model, contracted out to AWT Water Ltd:

- details mass and energy flows across the individual unit operations and the process as a whole
- provides the basis for evaluating the system performance against the cost of this performance
- describes the scalability of the developed process
- evaluates the cost implications of changes to process flow or unit operations
- provides outputs suitable for inputting into larger, whole system models of wastewater treatment plants.

The model has been designed to accept the following inputs:

- Waste characteristics relevant to the biological and thermochemical aspects of the proposed STOP technology Other waste characteristics such as heavy metal contents are also accepted but these are not active in this version. Up to three different wastes may be specified.
- All economic environment factors that materially affect the financial performance of a STOP plant. These include all input costs, product values and utility and manpower costs.
- Process parameters for fermentation and wet oxidation, and any other supporting unit operations.

It is to provide the following outputs:

- Process flows for continuous steady processing of any given annual quantities of wastes.
- Equipment sizes for a plant processing these flows
- Estimated capital cost for constructing the plant
- Operating profit schedule

The benchmark for project evaluation is currently internal rate of return (IRR), but cost per tonne of sludge processed is set to be incorporated into the model.

The model has been designed to be calibrated against two plant sizes: for a plant equivalent to the Rotorua condition, and a much larger plant, appropriate for the size of Auckland.

Process parameters can be manipulated to reflect laboratory data, and capital and operating costing structure is complete, to the level appropriate to this first stage model.

A techno-economic scenario has been prepared for the base-case of Rotorua. Key design criteria are have been defined:

- from the waste characterisation (for the input definition)
- from technical work conducted as part of this and earlier projects (for the process performance)
- using NZ-based industry estimates (for utilities, plant operational costs, and financial evaluation)

Two examples of the model analysis are presented below. The results are discussed in terms of the benefit of the STOP process over landfilling, for the Rotorua scenario. In the plots, the y-axis labelling has been removed, as the results are presented as examples only, and not to be used in defining the actual process economics at this stage.

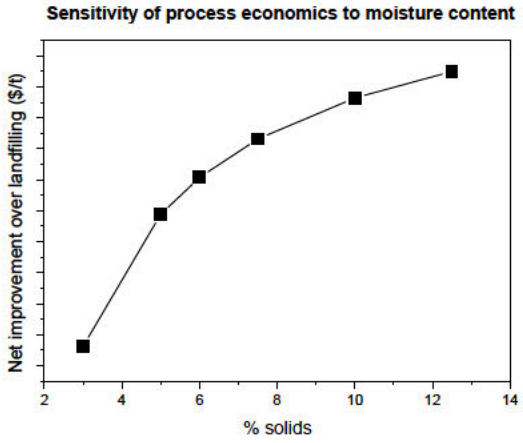
In the first instance, the impact of solids dry weight entering the system was modelled, to

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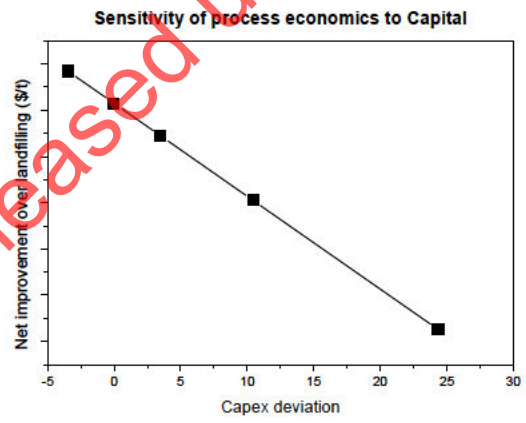
determine the sensitivity to this parameter. Two effects would be expected with increasing biosolids content:

1. Less water to deal with, so lower plant costs (smaller reactors etc)
2. Less water to heat up, so improved energy balance

Indeed, the model does show sensitivity to the dry solids content, with a diminishing return above 10%.



In the second example, the sensitivity of the model to impact of capital expenditure is modelled. The model demonstrates a linear trend with capital cost, with a high sensitivity to this parameter. This result clearly describes the importance of accurately describing the capital requirements of the process.



The process model will be developed significantly over the course of the second project year. In particular, consideration will be given to addressing the following:

- define and incorporate the additional process steps that may be required to deal with certain wastes and to deliver marketable products;
- refine the cost estimation methods;
- Incorporate refinements of the core process (e.g. wet oxidation kinetics) as these become available;
- enhance the overall model for increased flexibility and better energy balance and utilities description;
- provide validation and verification of the model; and
- enhance the user interaction with the model, via provision for graphical analysis.

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Task Three : *Carry out review of first years technical progress against project objectives*

Task Three: Carry out review of first years technical progress against project objectives

The first year review has been completed, and forms part of the reporting to MfE during July, 2011.

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SCION
forests · products · innovation

2011 Waste Minimisation Fund

Scion

Year One Progress Review

Waste 2 Gold – Deconstruction Technologies for Organic Waste Utilisation

Date: July 2011

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"Changing the way New Zealand thinks about waste"

Waste 2 Gold

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End of year Progress Review

Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation - July 2011

Summary of year one activities

The first year of the W2G-RDC project has successfully met all key milestones. Critical achievements include:

1. We have demonstrated the efficacy of the STOP process at the laboratory scale;
2. We have constructed a techno-economic model of the process, which enable evaluation of the technology going-forward and direct the development efforts to maximise the viability of the process;
3. We have constructed the wet oxidation pilot plant facility and located it onsite at the Rotorua wastewater treatment plant. This has had an initial successful commissioning trial using biosolids from the treatment plant;
4. We have commissioned the biological nutrient removal plant, which will allow modelling of the full-scale wastewater treatment plant using the liquors produced by the STOP process; and
5. We have designed an anaerobic fermentation plant, which will be constructed over the following three months to complete the overall system at pilot scale.

With the model and pilot-scale facility in place, a robust techno-economic model can be refined. This will facilitate creation of a business case for continuing the development of the STOP technology in partnership with the Rotorua District Council.

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Contents

Summary of year one activities 3
Introduction 5
Summary of progress towards Project Objectives 5
Communications and reporting 15
Partnership development 15

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Introduction

The Waste 2 Gold project has successfully completed the first funding year of this two year development project. The work of this first year has focussed on three key aspects:

1. Laboratory-scale demonstration of hybrid technology for biosolids deconstruction;
2. Development of pilot scale facilities;
3. Creation of a process engineering model for assessment of techno-economic aspects of the technology.

Each of these aspects has been successfully delivered to the requisite point in the project plan.

This report provides an overview of the progress against the Objectives contained within the project plan for the year ending July 2011,. For each Objective, the work has been described under the relevant Activities identified within the plan.

Summary of progress towards Project Objectives

Objective 1: Establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011

Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process.

We now have a functional **Thermal Oxidation Pilot Plant Module** installed at RDC Wastewater Treatment Plant. Designed by Allan Estcourt Ltd (Rotorua) and fabricated by Longveld Engineering Ltd (Hamilton), the plant was delivered to the site on 29 April, 2009. It was formally opened by the Minister for Environment, Dr Nick Smith, on 31 May 2011.



Finishing work (insulation, and commissioning modification requirements) is in its last stages. Low and high pressure/temperature water commissioning has been conducted. Site operating and safety systems and a major Hazard and Operability study (HAZOP) of the plant have also been completed.

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The first sludge wet oxidation trial has been completed. This was a low temperature/pressure/solids experiment, designed to test the efficacy of the system under a sludge-containing, oxidative environment. The trial ran successfully for over four hours. Despite the low temperature environment, good solids destruction and soluble organics generation was evident.

Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP

The **Biological Nutrient Removal (BNR) pilot plant** module has been successfully operating onsite for over four months.

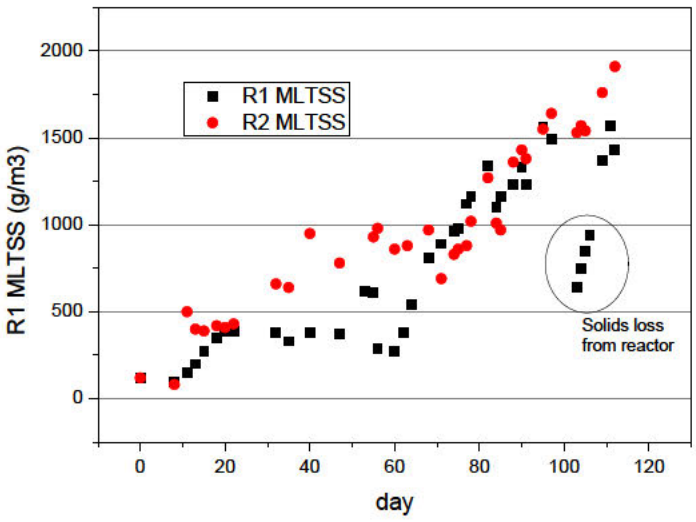
The goal of the BNR module is to provide an appropriately sized biological reactor capable of receiving liquors generated by the STOP process pilot plant. The response of the BNR plant will thus model the impact of these liquors as carbon supplements in the full-scale RDC WWTP process performance.



Despite a number of process disruptions, the plant and process has proven to be very robust in its wastewater treatment capability. Crucially, biosolids are building up within the reactor (see figure below), towards levels (2-3g/L) consistent with the main RDC treatment plant.

Examples of the averaged treatment performance of the two trains, operating as a model of the Rotorua WWTP are:

- ammonia removal of 88% and >99% for reactors R1 and R2, respectively;
- nitrogen removal (combined ammonia and oxidised nitrogen) of 73% for both reactors;
- phosphate-P removal of 27% and 23% for reactors R1 and R2, respectively;



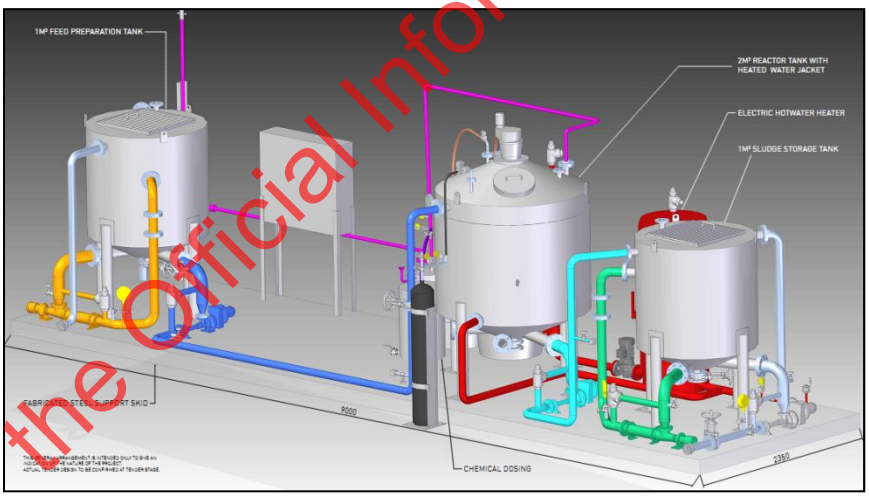
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- good settling of the cellular biomass within the reactor system, a result critical to the effective operation of the plant.

The nitrogen removal performance is consistent with the full-scale Bardenpho process at RDC, which demonstrates greater than 80% removal. At 50-60% decrease, phosphorus removal in the full-scale system is slightly better than the pilot BNR (*unreferenced communications with RDC staff provided full-scale performance data)*.

Detailed studies of equilibrium reactor performance are planned over the next month. Subsequently, one of the reactors will be transitioned over to STOP-generated liquors as the externally-added denitrification carbon source. It will continue to be optimised over the coming months with the aim of modelling performance of the full-scale RDC process when using process product liquors.

Design, construct, install and commission fermentation Module



The **Fermentation Pilot Plant Module** has been designed by the Waste 2 Gold development partner, AWT Water Ltd, as outlined in the project plan and WMF application.

This design is based on a biosolids anaerobic fermentation process specification, supported by outputs from the hybrid system laboratory trials. These described the critical process parameters and capability requirements of the fermentation plant. The resulting specification was then used by AWT Water to carry out the detailed design and prepare a technical specification for the plant procurement.

A formal tendering process was conducted, initiating using a publicly-advertised Registrations Of Interest (ROI) process targeting appropriately qualified contractors. The respondents were evaluated against pre-determined criteria which resulted in a short list of three contractors being selected to tender for the plant construction. Due to higher than anticipated prices received, initial tenders had to be rejected and the technical specification reduced to allow re-pricing by the contractors. This resulted in the completion of the tendering process being delayed by a number of weeks. The successful tenderer was selected - Longveld Engineering Ltd of Hamilton, NZ. Final sign-off to this process now allows full engagement with Longveld, and a rigorous process of detailed project planning and ordering of essential equipment has been immediately initiated.

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Given the challenges experienced with the wet oxidation plant construction, MfE will be kept fully aware of progress towards the required milestones on this aspect of the project.

Objective 2: Demonstrate viable scale-up of the complete waste deconstruction process by 31 December 2011

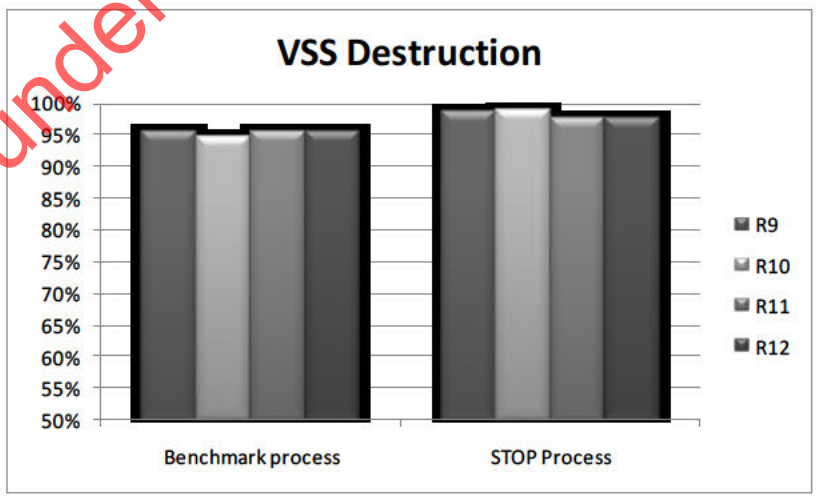
Carry out pilot trial runs under a range of process conditions and configurations.

Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.

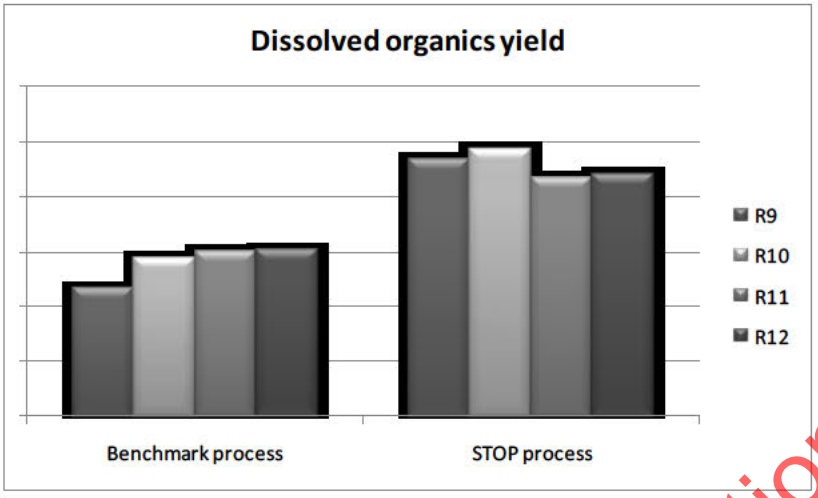
Both of these Activities are contingent upon delivery of the fermentation pilot plant and the detailed experiments which form the second year of the current project. However, the detailed laboratory work which underpins the move towards pilot scale has been rigorously assessed over the past year.

Laboratory-based trials have been undertaken to demonstrate the overall concept of enhancing organic acid production via Scion's proprietary STOP (Scion Thermal Oxidation Process) technology. Compared with benchmark biosolids wet oxidation conditions, our STOP technology has demonstrated (see graphs):

1. Improved volatile suspended solids (VSS) destruction when compared to wet oxidation alone. Whilst the overall destruction was high for both processes, the STOP process resulted in a residual solids product with significantly lower organics content.
2. Production of dissolved organics from the sludge destruction is critical to the usefulness of the produced liquors. The STOP process demonstrated significantly higher organics production (expressed as the yield of dissolved organic carbon) than wet oxidation alone. Almost 50% of the incoming organic carbon was converted to solubilised organics within the STOP process.



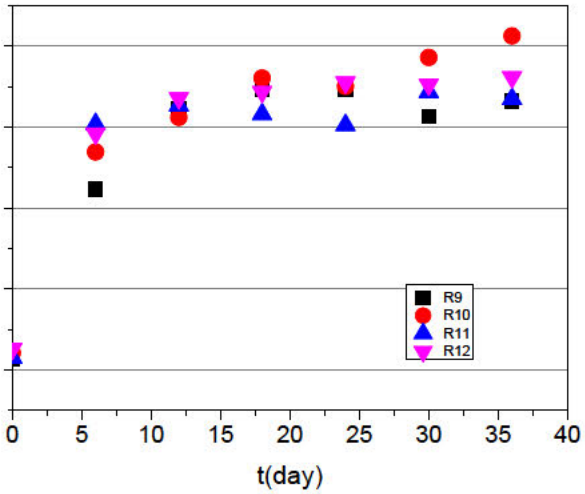
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Subsequent to the batch-wise approach of the initial trials, the first continuous trials of one of the reaction stages have now been completed. For fermentations which operated for over 45 days, the following key results have been demonstrated:

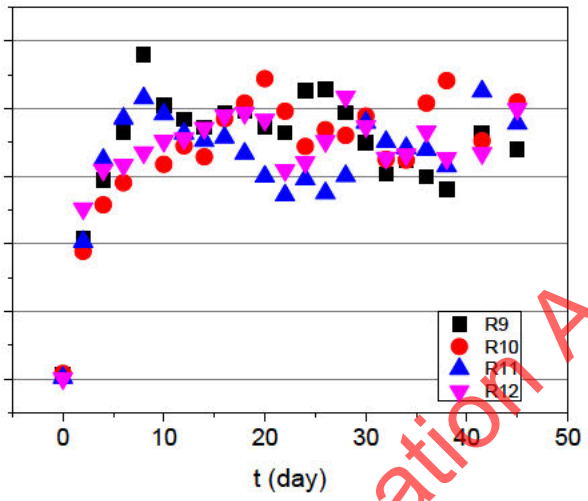
- stable reactor operation for the key suspended solids and organic acid production parameters;
- good suspended solids destruction;
- no significant impact of reactor inoculation on the steady-state performance of the system;
- some significant pH effects on the production of dissolved organic carbon and, in particular, organic acid production.

Soluble organic material production within continuous fermentation

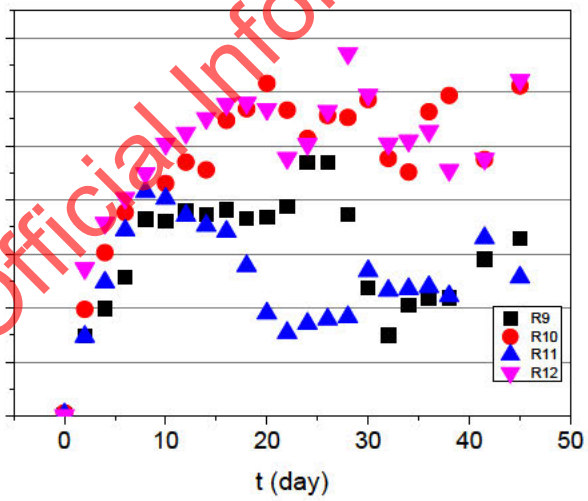


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Total acid production within continuous fermentation



Acetic acid production within continuous fermentation



The liquors for the continuously-operated fermentation system will be subjected to batch wet oxidation, and results reported on completion.

Objective 3: Evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012

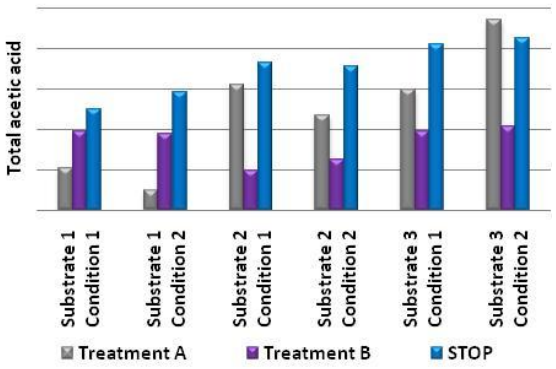
Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.

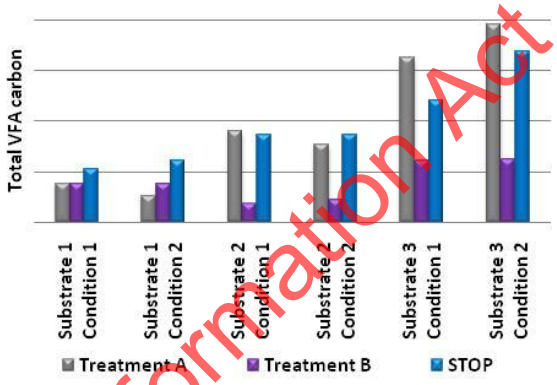
Initial trials have already been completed to determine the efficacy of the STOP process on alternative feedstocks. To date, we have tested three alternative organic feedstocks using an experimental framework comparable with the RDC biosolids work. The preliminary results demonstrate some significant impacts of substrate type, but consistently indicate improvement of

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acetic acid yields via the STOP process when compared to benchmark wet oxidation. (see figure below)

The second year of the project will likely see further laboratory trials on alternative organic waste materials, designed to demonstrate the applicability of the technology beyond municipal biosolids.





Objective 4: Produce viable commercial scale design basis for application at the Rotorua wastewater treatment plant by 30 June 2012

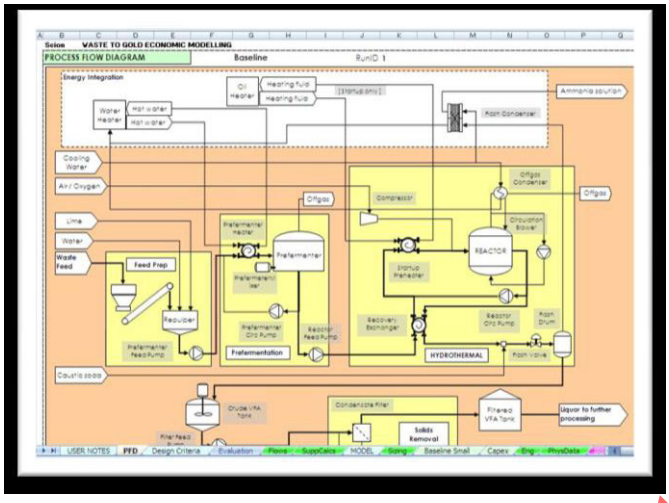
Develop a process engineering and economic model for the full-scale application of the technology.

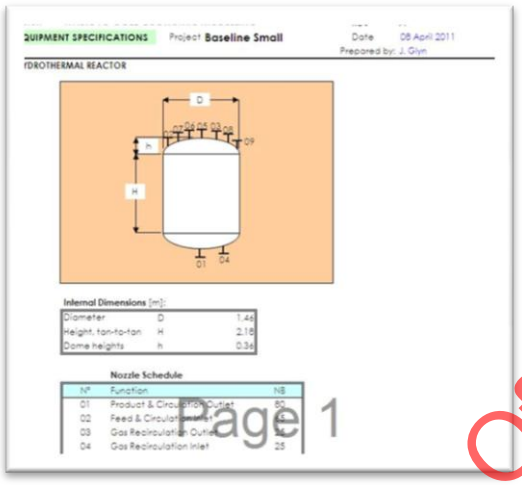
A crucial aspect of the project is development of the process engineering model. This model, being developed in partnership with AWT Water Ltd, will provide the following:

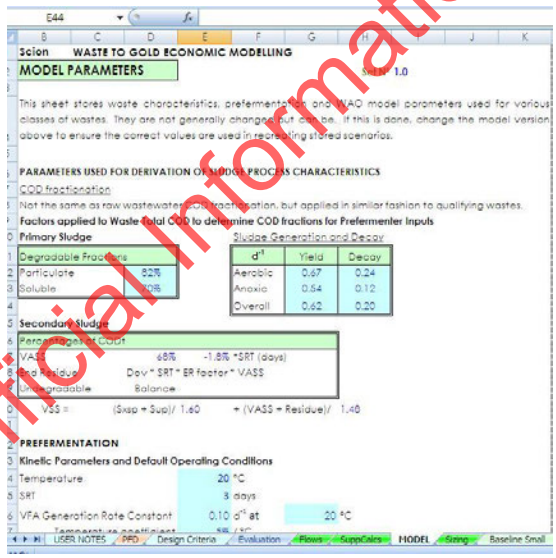
- detail mass and energy flows across the individual unit operations and the process as a whole;
- provide the basis for evaluating the system performance against the cost of this performance;
- describe the scalability of the developed process;
- evaluate the cost implications of changes to process flow or unit operations;
- provide outputs suitable for inputting into larger, whole system models of wastewater treatment plants.

Version 1 of the process engineering model is now complete and AWT has submitted a formal report back to Scion.

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The model has been designed to accept the following inputs:

- Waste characteristics relevant to the biological and thermochemical aspects of the proposed STOP technology Other waste characteristics, such as heavy metal contents, are also accepted but these are not actively used in this version. Up to three different wastes may be specified.
- All economic factors that materially affect the financial performance of a STOP plant. These include all input costs, product values and utility and manpower costs; and
- Process parameters for fermentation and wet oxidation and any other supporting unit operations.

Based on these parameters, the model provides i) Process flows for continuous steady-state processing of any given annual quantities of wastes; ii) Equipment sizing for a plant processing these flows; iii) Estimated capital cost for constructing the plant; and iv) Operating profit schedule.

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The benchmark is currently internal rate of return (IRR) but cost per tonne of sludge processed is also under construction.

The model has been designed to be calibrated against two plant sizes: for a plant equivalent to the Rotorua condition; and for a much larger plant, appropriate for the size of Auckland.

Process parameters can be manipulated to reflect laboratory data and capital and operating costing structure is complete to the level appropriate to this first stage model.

A techno-economic scenario has been prepared for the base case of Rotorua. Key design criteria have been defined:

- from the waste characterisation (for the input definition);
- from technical work conducted as part of this and earlier projects (for the process performance); and
- using NZ-based industry estimates (for utilities, plant operational costs, and financial evaluation).

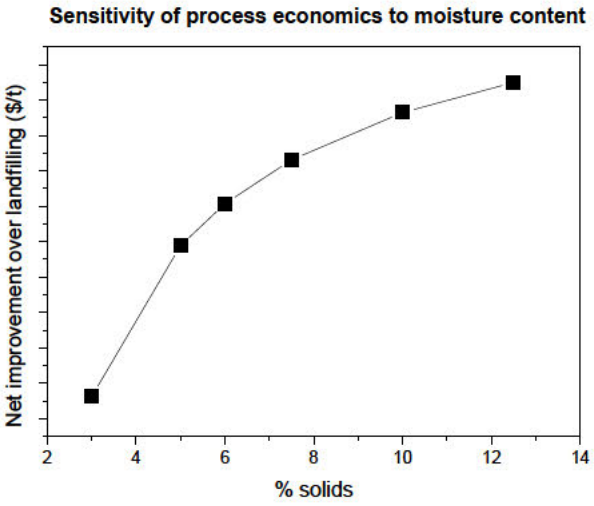
Two examples of the model analysis are presented below. The results are calibrated in terms of the benefit of the STOP process over landfilling for the Rotorua scenario. In the plots, the x-axis labelling has been removed as the results are presented as examples only and not to be used in defining the actual process economics at this stage.

In the first example, the impact of solids dry weight entering the system was modelled to determine the sensitivity to this parameter. Two effects would be expected with increasing biosolids content:

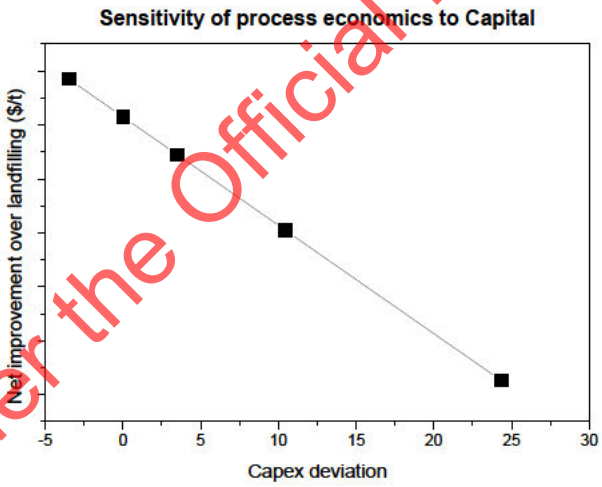
1. Less water to deal with, so lower plant costs (smaller reactors etc.); and
2. Less water to heat up, so improved energy balance.

The model shows the expected sensitivity to the dry solids content with a continued but reducing relative return above 10%.

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In the second example, the sensitivity of the model to capital expenditure is modelled. The model demonstrates a linear trend with capital cost with a high sensitivity to this parameter. This result clearly describes the importance of accurately describing the capital requirements of the process.



This process model will be developed over the course of the second project year. In particular, consideration will be given to addressing the following:

- Define and incorporate the additional process steps that may be required to deal with certain wastes and to deliver marketable products;
- Refine the cost estimation methods;
- Incorporate refinements of the core process (e.g. wet oxidation kinetics) as these become available;
- Enhance the overall model for increased flexibility and better energy balance and utilities description;
- Provide a validation and verification of the model; and
- Enhance the user interaction with the model via provision for graphical analysis.

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Produce design specifications and costings for a commercial plant

The major focus of the second year will be directed towards this end goal. All of the above Activities provide inputs into the justification of the process scale-up and commercialisation.

Communications and reporting

Project records have been kept of all the experimental and modelling work conducted in this project. Currently 15 records related to this project have been logged on Scion's internal reporting system (SIDNEY), either as internal reports, records of external publications or presentations.

Regular inquiries around the technology development have occurred during the latter part of the year. This interest has come from both local TLA's and private companies, as well as a significant lead for an overseas opportunity, which is being pursued in conjunction with AWT Water Ltd. Scion is tracking potential end-user opportunities via a commercialisation database.

Partnership development

Vital to the commercial development of this project is the partnership that Scion has with the Rotorua District Council. The project is formally directed via a governance structure that includes senior executive representation from both parties, including both CEOs. At a second tier, project management includes senior operational staff from each company. At a technical level the Scion project work is coordinated through a Lead Team, which reports to this Project Management team.

A key goal for the partnership is the development of a robust business case for STOP technology commercialisation. Resources from both companies are being directed to this aspect, which are not formally covered by the MfE-funded project.

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Techno-economic model of RDC biosolids conversion using STOP technology. Model version 1.3

14 July 2011

s 9(2)(a)

Summary

The techno-economic model (v1.3) has rapidly produced a number of scenarios, under inputs relevant to the RDC situation. The primary scenario describes a $10/tonne net benefit over landfilling, using discounted cash flow methodology and including cost of capital. All of the modelled examples yield process costs of under $100/tonne (discounted NPV basis, including cost of capital). This is encouraging for the project.

It is emphasised that these scenarios are derived from the first model version, and must not at this stage be taken as definitive of the opportunity afforded to the RDC. Rigorous validation and verification of the model is required to provide confidence in the results thus far.

Introduction

The first version of the Techno-Economic model for STOP technology has been produced. The model was created by s 9(2)(a) of AWT Water Ltd, in conjunction with Scion staff. The model has been submitted with a formal report (Glyn, 2011). This short report forms the first scenario generated from the model.

The model has inputs which are relevant to the scale of the Rotorua District Council site. Scion data has also been utilised to describe process conditions and outputs.

It is important to note that this model scenario presented here is not intended to represent actual evaluations of prospects of the process at Rotorua, as the model requires some important refinements. For example, complete system heat integration has not been accommodated into the model. The exercise does, however, illustrate how the model may be used to explore critical issues.

Model setup and results interpretation

The scenario is processed to treat biosolids as an input with negative value, this being set at the cost of disposal. Therefore, the primary results should be interpreted as improvements over the current practice of landfilling (set here at $80/wet tonne).

In the current scenario, no value is placed on ammonia or phosphate residues. Acetate, produced from the STOP process, is afforded a value, as a substitute for ethanol in a biological nutrient removal plant.

To interpret results IRR is calculated by the model, but this is only useful when there is a net positive cash flow. An NPV calculation has been included, which is presented as value per tonne of biosolids processed. The calculation for this is structured:

1. calculate NPV of the process, over the input lifetime.
2. calculate the total amount of biomass processed over this project lifetime, noting that for a project lifetime of *n* years, there are only *n-1* years of biomass processing
3. divide NPV by total amount of biomass processed to give NPV as $/tonne improvement (over landfilling alternative in this scenario)

Along with the primary scenario, secondary results are also presented in this report, as described within the text below.

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Biosolids inputs for Scenario

1 PLANT CAPACITY [Annual wet ton]

	Waste Description	
W1	Beltpress solids, primary and secondary mix	8,395
W2	—	0
W3	—	0
	TOTAL	8,395

4.2 **Raw Materials**

			W1	W2	W3
Total Dry Solids	TSS		16.0%	0.0%	0.0%
Volatile Solids	VSS	As %TSS	85%	0%	0%
Sludge age	SRT	days	—	0	0
Total COD	CODt	g / wet kg	270	0	0
Filtered COD	CODf	g / wet kg	1	0	0
Kjeldahl Nitrogen	TKN	mg / wet kg	4,000	0	0
Orthophosphate	PO4	As %TSS	2.0%	0.0%	0.0%
Heavy metals	M	mg / kgDS	2,500	0	0
Overall degree of oxidation		Carbohydrates = 1.0	1.0	0.0	0.0
		Weighted average		1.00	

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Results

The results of the **primary scenario** are presented in Table 1

Table 1: Results of primary scenario modelling

Description	Capacity wet tpa	Annual Income ($,000)	Annual Op. Cost ($,000)	IRR p.a.	NPV $/wet tonne
Rotorua plant, Scion data. Biosolids only, $1000/tonne VFA value only, -$80/tonne biosolids value	8,395	700	90	18%	$10.69

The scenario implicates an 18% IRR, and a NPV value over landfilling of $10.69/tonne.

The income ($700,000pa) is the value of the acetate stream generated by the STOP process, calculated on the basis of substituting for ethanol addition in the main plant.

The Operating Cost is low ($90,000), because of the utilisation of negative costs for one of the raw materials-the biosolids.

An alternative process scenario is provided when biosolids values are removed from the process. This is presented in Table 2.

Table 2: Results of scenario modelling- with zero value biosolids

Description	Capacity wet tpa	Annual Income	Annual Op. Cost	IRR p.a.	NPV $/wet tonne
Rotorua plant, Scion data. Biosolids only, $1000/tonne VFA value only, $0/tonne biosolids value	8,395	700	762	na	-$21.33

In this scenario, the actual process operating costs are modelled at $762,000. There is no IRR as the process has net costs ($62,000pa) throughout the project life. The NPV is calculated as $-21/wet tonne.

As a final scenario, the implication of having no value to the acetic acid product is modelled, with results presented in Table 3.

Table 2: Results of scenario modelling- zero value biosolids and no value to acetate product

Description	Capacity wet tpa	Annual Income	Annual Op. Cost	IRR p.a.	NPV $/wet tonne
Rotorua plant, Scion data. Biosolids only, $1000/tonne No acetate value, $0/tonne biosolids value	8,395	0	762	#DIV/0!	-$54.71

Under this more conservative scenario, the NPV of processing is modelled as $54/tonne.

References

s 9(2)(a) (2011) Waste 2 Gold techno-economic scenario report for Rotorua District Council case. Scion Internal report. Output #48118.

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Communications Report

5th July 2011

This Communications Report draws on data from a range of communication sources. Scion has an obligation to the Ministry for the Environement (MfE), to provide key communicaiton information on a quarterly basis.

Future Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Comm Status	Date & Progress Update
1	TBC	Alison Balance, Environment & Science Producer for 'Our Changing World', Radio New Zealand is looking for stories to do in April. She's identified W2G, and would look to conversational style interviews with 1-3 people. Can you please pass this request onto the group.	Radio New Zealand	TBC		
2	7-Mar-11	Marianna Tyler - met with s 9(2)(a) at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	24-Mar-11	Pending	

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Future Communications..continued

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Comm Status	Date & Progress Update
4	TBC	Media material for official opening of pilot plant & updated info on Scion (& RDC) websites. New/updated info sheet.	Scion & RDC	early June TBC	In progress	
5	TBC	Display in Scion booth at PF Olsen Forest Industries 2011 Expo, 5-7 Sept.	Scion	5-7 Sep 2011	To commence	
6	1-May-11	s 9(2)(a) be presenting Waste 2 Gold project to Auckland City Council in May as part of an Environlink workshop by CRIs	Scion	1-May-11	to commence	
7	1-Jun-11	Waste 2 Gold will be part of a Green Chemistry expo in Tauranga that will highlight our activities to BOP schools and community	Scion	27-30 June 2011	Complete	
8	1-May-11	SCION/RDC – waste2Gold team to present at the EDANZ (Economic Development) Conference?	Scion/RDC	29th - 30th June 2011	complete	

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Reactive/Responsive Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Comm Status	Date & Progress Update
1	5/04/2011	Briefed Waikato/BOP Regional Biosolids summit on Waste 2 Gold project, technology, objectives, and status. This forum was setup to try and facilitate regional approaches to biosolids management where smaller individual producers struggle to resource sustainable solutions for disposal.	Scion & RDC	5-Apr-11	complete	
2	16-Jun-11	Presented to joint APPITA/IChemE technical meeting on the waste 2 Gold project, it's development and progress to date.	Scion	16-Jun-11	complete	
3	21-Jun-11	s 9(2) received e-mail enquiry regarding the W2G project from the project manager of the Australia/New Zealand Biosolids Partnership (ANZBP) requesting further information about the project for their members. The latest project updates were forwarded and the ANZBP will be contacted with updates as appropriate.	Scion	20-Jun-11	Ongoing	

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Closed Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Comm Status	Date & Progress Update
1	14-Oct-10	Questions from Biodiesel & Biorefining Magazine, BBI International	Scion	Answers supplied		Complete
2	18-Nov-10	Request for photos for use in Secondary School textbook on sustainability published by Nelson Cengage Learning NZ	Scion	Photos & captions supplied		Complete
3	12-Mar-11	Science in the Park - Scion held its third biennial Science in the Park held at Scion□s Rotorua campus. The main aim of Science in the Park is to create a greater awareness within the local community of what Scion does. Waste 2 Gold was a significant component of the day. 2800 visitors participated in the day - this has also let to two future display requests for the Water Conference in Rotorua (RDC) and a biowastes day in Tauranga in April.	Scion and RDC	W2G Display Pavillion		Complete
4	31-May-11	Official pilot plant opening at Wastewater Treatment Plant Rotorua. Speakers were Minister Smith, Mayor Winters, s 9(2)(a) [redacted] Invited guests included local MPs, councillors, and key people involved with the project.	Scion and RDC	Invitations sent by RDC, event management by Scion		Complete
5	4-Jul-11	Meeting with MPs Steve Chadwick and Charles Chauvel to discuss W2G technologies.	Scion	Scion arranged meeting following request from Steve Chadwick's office		Complete

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Special Mention

Thermal Oxidation Pilot Plant Opening- The thermal oxidation pilot plant located at the Rotorua Wastewater Treatment Plant was officially opened by the Minister for the Environment Hon Dr Nick Smith, on the 31st May, 2011.













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Potential End User - Opportunity Tracker

Topic	Company	Date of call/opportunity
s 9(2)(a) met with Hamilton City Council Biosolids Options meeting group: making decisions on process options which would be of relevance for Hamilton City Council Present: Envt Waikato, Tainui, SKM Consultants representatives, Ham CC representatives plus two other technology providers (Michael Quintern, STERM Ltd) s I presented the developments with the RDC work, going to pilot scale, and has requested the opportunity to be added to the list of process options being considered by HCC. This was met with favourable response	Hamilton City Council	4/03/2011
s 9(2)(a) of RDC had an enqiiry from Queenstown Lakes District Council following the Wasteminz conference regarding the potential for W2G. They have no sustainable long term option for biosolids disposal	Queenstown Lakes District Council	25/02/2011
Marianna Tyler - met with s 9(2)(a) at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	7/03/2011
Successfully through ROI stage of Melbourne Water opportunity and requested to submit a formal proposal. This was undertaken together with our engineering partner AWT Water. Proposal was submitted on 1st of June and a response is expected by the end of July.	Melbourne Water	1/06/2011
s 9(2)(a) from Biorich, a company specialising in organic waste management in the Hawkes Bay made contact to enquire about the project and potential application for his business. Requested updates as available.	BioRich	14/06/2011

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MFE Claim form - People Hours breakdown

Hours by Person

s 9(2)(a)		MS 1 Hours	MS 2 Hours	MS 3 Hours	YTD Hours
		184	355	234	773
		67	125	112	304
		45	28	15	88
		160	184	227	571
				1	1
		11	6	1	18
		6	38	220	264
		141	178	252	571
		77	50	48	175
		3	0	0	3
		159	122	247	528
		133	243	230	606
s 9(2)(a)		2	32	20	54
		28	9	36	73
		47	0	1	48
		33	3	13	49
		305	252	158	715
		107	93	118	418
		4	12	0	16
	P	25	25	3	53
		9	0	0	9
		24	24	4	52
Total Hours		**1,570**	**1,879**	**1,940**	**3,449**

Date generated 11/5/2011

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Invoices - External & Internal Charges - Milestone #3

External Invoices

Task	Reference	Date	Debtor/Employee	Narrative	Amount
A09400	IN296342	11 May 2011	.General	Hep vaccination s 9(2)(a)	60.87
A09400	819+	16 Jun 2011	.General	IChem Meeting s 9(2)(a)	39.13
A09400	9000181707	12 May 2011	.General	Wastewater Sludge Portland Customer A0940041500000	133.36
A09400	00947223	01 Jun 2011	.General	Biological Wastewater Treatment Portland Customer A0940041500000	126.59
A09401	11120198	25 May 2011	.General	Install broadband at RDC pilot plant	1,548.70
A09401	00000791	17 Jun 2011	.General	Logo's and embroidery work completed	265.25
A09401	2689	15 Jun 2011	.General	Remewal of approved handler test cert	100.00
A09402	1453192	11 May 2011	.General	Formic Acid Std Test Method ASTM Fees/ Publications A0940241500000	44.38
A09401	924	03 May 2011	.General	Bio-Solids HAZOP preparation,	5,880.00
A09401	187685	17 May 2011	Rotorua Dist Coun - Other	laboratory analyses as directed	42.00
A09401	188853	24 May 2011	Rotorua Dist Coun - Other	analyses as directed	63.00
A09401	189381	26 May 2011	RDC Environmental Laboratory	analyses	42.00
A09401	190919	31 May 2011	RDC Environmental Laboratory	analyses as directed	105.00
A09402	896539	20 May 2011	R J Hill Laboratories Ltd	Volatile Fatty Acid Profile	1,300.00
A09403	503177=	31 May 2011	AWT New Zealand Ltd	Eng.Economic Model Progress	2,000.00
A09403	503290	30 Jun 2011	AWT New Zealand Ltd	process model Jumw	3,710.00
A09401	503334	30 Jun 2011	AWT New Zealand Ltd	Fermentation HAZOP	8,000.00
A09400	151460	17 Jun 2011	.General	Acrylic cases for W2G reactor display	360.00
A09400	1113000905	14 Mar 2011	.General	Buckets	20.61
A09400	1113000905	14 Mar 2011	.General	8L sealable containers	41.48
A09400	1113000905	14 Mar 2011	.General	Bins on wheels	26.00
A09400	1113000905	14 Mar 2011	.General	5L containers	8.68
A09400	00001424	28 Apr 2011	.General	Hire of room for HAZOP meeting in	275.00
A09400	00001424	28 Apr 2011	.General	Lunch (one vegetarian)	175.50
A09400	00001424	28 Apr 2011	.General	Tea and coffee - 3 times a day	67.50
A09400	00001424	28 Apr 2011	.General	Morning tea	45.00
A09400	00001424	28 Apr 2011	.General	Caraffe of Juice	18.00
A09400	1033475-1	20 Jun 2011	K Simpson Ltd	enclosure 110x180x90	31.35
A09401	14941	26 May 2011	.General	Merck nitrate test strips product code	51.85
A09401	14941	26 May 2011	.General	ammonium test strips product code	63.75
A09401	14941	26 May 2011	.General	ammonium test strips product code A0940120400000	30.00
A09401	00023705	13 Jun 2011	.General	pH standard buffer pH7 1000mL	26.50
A09401	00023705	13 Jun 2011	.General	pH standard buffer pH 10 1000mL	26.50
A09401	00023705	13 Jun 2011	.General	pH standard buffer pH 4 1000mL	26.50
A09401	50536	28 Apr 2011	.General	Standard pack (Qty 185) type No. 1092	450.00
A09401	50536	28 Apr 2011	.General	Standard pack (Qty 185) type No. 1092 A0940120600000	- 8.70

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A09401	313855729	27 May 2011	.General	Air Dry Size G	374.88
A09401	313855729	27 May 2011	.General	LPG Cylinder Size G	199.16
A09401	313855729	27 May 2011	.General	Delivery charges	45.76
A09401	313889269	30 May 2011	.General	Air Dry Size G	281.16
A09401	313889269	30 May 2011	.General	Delivery charge	34.32
A09401	313909008	10 Jun 2011	.General	Zero grade air bottles	503.13
A09401	313910139	13 Jun 2011	.General	Zero grade air bottles	503.13
A09401	8805536	18 May 2011	.General	disposable gauntlet gloves	27.00
A09401	8780329	11 May 2011	.General	workboots	135.74
A09401	8780329	11 May 2011	.General	Yellow raincoats	48.28
A09401	878075	12 May 2011	.General	workboots	135.74
A09401	8790790	13 May 2011	.General	workboots	135.74
A09401	8790790	13 May 2011	.General	Yellow raincoats	144.84
A09401	8805536	18 May 2011	.General	Leather gloves	52.68
A09401	8805536	18 May 2011	.General	Eye protection goggles	167.82
A09401	8805536	18 May 2011	.General	Ear muffs	136.80
A09401	8805536	18 May 2011	.General	ear plugs	41.28
A09401	8805536	18 May 2011	.General	wiping cloths	47.55
A09401	8805536	18 May 2011	.General	Sanitiser dispenser	71.25
A09401	8805536	18 May 2011	.General	Sanitiser gel	44.70
A09401	8852366	02 Jun 2011	.General	High vis vest	111.60
A09401	8882214	14 Jun 2011	.General	workboots	135.74
A09401	8882214	14 Jun 2011	.General	Overalls	470.60
A09401	8858659	03 Jun 2011	.General	Overall	117.65
A09401	00001890	29 Jun 2011	.General	Steelwork for bench	871.00
A09401	6130	23 Jun 2011	GMR Holmac	Painting container at treatment plant	3,293.00
A09401	8897639	16 Jun 2011	.General	Safety shower and eye wash for wetox	1,573.37
A09402	524604756	27 Apr 2011	.General	Valeric Acid	122.33
A09402	524604756	27 Apr 2011	.General	Valeric Acid A0940220400000	25.00
A09402	525025381	17 Jun 2011	.General	Organic acids kit analytical standard	522.00
A09402	525025381	17 Jun 2011	.General	Organic acids kit analytical standard A0940220400000	25.38
A09402	I965448	30 Jun 2011	.General	500g Potassium Sodium Tartrate	16.78
A09402	I965448	30 Jun 2011	.General	500g Potassium Sodium Tartrate A0940220400000	17.50
A09402	525121629	29 Jun 2011	.General	Hexanoic acid	168.00
A09402	I957744	17 May 2011	.General	Test tube rack, 30mm, 24 tubes, green	87.00
A09402	I957744	17 May 2011	.General	Test tube rack, 30mm, 24 tubes, green A0940220500000	9.60
A09402	107877	06 Apr 2011	.General	Do Not enter Floor Stand signs	114.25
A09402	107877	06 Apr 2011	.General	Biological Hazard stickers	319.26
A09402	01105063	13 May 2011	.General	Sensorex Gel Filled pH electrode	1,020.00
A09402	01105063	13 May 2011	.General	Sensorex Gel Filled pH electrode A0940220600000	8.00

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A09402	00057601	17 May 2011	.General	0.45um, 25mm, Nylon syringe filters -	206.25
A09402	00057601	17 May 2011	.General	25mm, Dual layer GFC/PES syringe	97.35
A09402	I959321	26 May 2011	.General	Autoclave Bags, 600x900mm, pk 50	62.12
A09402	I959321	26 May 2011	.General	Autoclave Bags, 600x900mm, pk 50 A0940220600000	3.21
A09402	I960277	01 Jun 2011	.General	15ml graduated centrifuge tubes	40.11
A09402	I960277	01 Jun 2011	.General	15ml graduated centrifuge tubes A0940220600000	16.20
A09401	192730	30 Jun 2011	Rotorua Dist Coun - Other	Waste 2 Gold Thermal Oxidation	100,000.00
				Total External Invoices	**$ 137,780.06**

Internal Charges

Task	Reference	Date	Debtor/Employee	Narrative	Amount
A09400	190411	01 Jul 2011	.General	Travel expenses Apr-Jun PT11021/10954 A0940041900000	10.26
A09400	038108	03 Jun 2011	.General	Copy Center Charges A09400	227.22
A09401	038108	03 Jun 2011	.General	Copy Centre Charges Anderson Aggrey	16.00
A09401	038108	03 Jun 2011	.General	Copy Center Charges A09401	65.80
A09401	038206	05 Jul 2011	.General	Copy Center Charges A09401	58.28
A09402	038115	08 Jun 2011	.General	LMS 4686 C & N on biolsolids A09402 s 9(2)(a)	577.50
A09402	038115	08 Jun 2011	.General	LMS 4734 C & N on biosolids A09402 s 9(2)(a)	341.25
A09402	038115	08 Jun 2011	.General	LMS 4784 C & N on biosolids A09402 s 9(2)(a)	236.25
A09401	2591	20 Jun 2011	.General	Standard Issue FR/STORE/CL165/NA/Ethanol 95% AR STKISS	34.56
A09401	151464	24 Jun 2011	.General	Misc.Works 30/05/-23/6	98.00
A09402	2590	10 May 2011	.General	Standard Issue FR/STORE/CT518/NA/Paper Towels (Hygenex) STKISS	11.73
A09402	2598	09 Jun 2011	.General	Standard Issue FR/STORE/CT528/NA/Snowtex tissues (224) STKISS	6.64
A09402	2592	20 Jun 2011	.General	Standard Issue FR/STORE/CT518/NA/Paper Towels (Hygenex) STKISS	8.80
A09402	2596	20 Jun 2011	.General	Standard Issue FR/STORE/CT527/NA/Soap hand Liquid STKISS	31.74
A09400	23.052011	23 May 2011	.General	Travels Exes A0940015100000	62.17
A09400	00152515	31 May 2011	.General	Airport Shuttle 31/5 A0940015100000	8.26
A09400	038138	15 Jun 2011	.General	s 9(2)(a)	220.00
A09400	19731-1	03 Jun 2011	.General	Accomm s 9(2)(a) PT011021 A0940015100000	151.31
A09400	038094	01 Jun 2011	.General	s 9(2)(a)	
A09401	038094	01 Jun 2011	.General		
A09401	038094	01 Jun 2011	.General		
A09401	038094	01 Jun 2011	.General		
A09401	038094	01 Jun 2011	.General		
A09401	038207	05 Jul 2011	.General		
A09401	038207	05 Jul 2011	.General		
				Total Internal Charges	**$ 5,085.77**
				Total Invoices + Internal Charges	**$ 142,865.83**

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Te Papa Tipu Innovation Park
49 Sala Street, Private Bag 3020, Rotorua, New Zealand
Telephone: + 64 7 343 5899 | Facsimile: + 64 7 348 0952
Email enquiries@scionresearch.com | www.scionresearch.com

TAX INVOICE

Ministry For The Environment
P O Box 10-362
WELLINGTON

Customer Number:	00586	***GST Reg No (NZ):***	59-493-760
Customer Reference:		***ABN No (Australia):***	512-1094-8677
Invoice Number:	**046902**	***Invoice Date:***	14/07/2011
Page :	1 of 1	***Due Date:***	20/08/2011

Particulars	***Amount $***
Milestone 3 Deliverables as per WMF Waste 2 Gold Deconstruction	
Technologies for Organic Waste Utlisation	123,007.49
Attention: Elena Wrelton	
Sub Total:	123,007.49
GST:	18,451.12
Invoice Total:	141,458.61

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s 9(2)(b)(ii)

[redacted]

Security Number: __ __ __ (Three digit number located on the back of your card

Cardholders Name: _____ **Expiry Date:** ___/___

Signature: _____ **Amount to Pay:** $_____

Scion is the trading name of New Zealand Forest Research Institute Limited.

Ministry for the Environment
Manatū Mō Te Taiao

WMF Milestone Report

This is your opportunity to tell us how the delivery phase of your project is progressing.

Milestone reports should be made on those dates agreed in your funding deed (unless otherwise discussed with your Fund Analyst). If there are any problems or issues, or you wish to make major changes to your project, please discuss with your Fund Analyst **before** completing and submitting this report.

Please read the *Waste Minimisation Fund – Grantee Guide* before you complete this report.

Project and report details

Organisation name	Scion
Project title	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation
Contract number	WMF-00000137
Project duration *if a multi-year project select the project duration*	Two years
Current year *if a multi-year project select the current project year*	Year Two
Total number of milestones *select the total number of project milestones for the current year*	Four
Current milestone *select the current milestone for this report*	One
Due date *agreed report due date as per your funding deed*	24/10/11
Date submitted *actual date the report was submitted*	21 October 2011
Report type *select whether this is an interim report or the final milestone report for the project*	Interim

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Milestone One details

Enter the name of the milestone, and then list all of the tasks and deliverables (as agreed in your funding deed) for this milestone in the tables below.

Indicate whether each task and deliverable is complete, and provide a summary of progress in the Comment column. If any task or deliverable is not complete, provide an explanation, and list the actions you plan to take in response.

You will also need to attach evidence of your deliverables to this report.

Press TAB on your keyboard to add a new row, if required.

Milestone name: Pilot Plant Integration

Tasks *tasks as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Fermentation pilot plant module tender and construction	Yes	Fermentation plant delivered onsite to Rotorua District Council wastewater treatment plant
Carry out thermal oxidation pilot plant trials	Yes	Wet oxidation trial completed using RDC biosolids. Trial was successful, yielding good solids destruction, and dissolved organics production which contained significant quantities of acetic acid. Performance of a key pump due to leakage has held up further trials, an issue which is a primary focus for the team to resolve.
Demonstrate thermal oxidation configurations and establish mass & energy balances.	Yes	Mass and energy balances have been completed, for experimental description of the wet oxidation pilot plant. This will ensure that we take the appropriate measurements to fully describe the performance of the system
Process engineering model refinement through interpretation of pilot data	Yes	Techno-economic model has been through a revision, with v2.0 now produced.
Investigate product added-value opportunities	Yes	Plan developed for assessing product added value opportunities, in the coming quarters. In particular, focus will be on demonstration of phosphorus removal via solid phase, identification of most appropriate nitrogen removal technology, and assessment of methanogenesis of the process liquors arising from the process.

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Deliverables *deliverables as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Fermentation pilot plant module successfully installed onsite	Yes	Plant delivered onsite to Rotorua District Council wastewater treatment plant.
Quarterly technical progress statement describing pilot trial operations, results to date, and associated workplan progress.	Yes	Please see attached Quarterly Technical Progress Statement
Update on process model refinements	Yes	Please see attached Quarterly Technical Progress Statement
Outline plan for implementing added-value investigations	Yes	Please see attached Quarterly Technical Progress Statement

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Key performance indicators (KPIs)

For each waste type(s) and target annual tonnage you identified in your project plan, please provide the actual values your project reduced, reused, or recycled/recovered during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual tonnages fall short of targets, then please provide a short statement to explain why in the space beneath (eg, the equipment utilised for this project is not yet operating at its maximum capacity).

Press the TAB key on your keyboard to add more rows to the table, if required.

	Quantity of waste (tonnes)					
Waste type	**Reduce**		**Reuse**		**Recover/Recycle**	
	Target	***Actual***	***Target***	***Actual***	***Target***	***Actual***
Rotorua District Council biosolids					Up to 1 tonne per day (pilot-scale process)	Negligible –Initial trials undertaken
Pulp and paper primary and secondary solids					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start on P&P solids
Rotorua District Council Atiamuri Landfill municipal organic wastes					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start on municipal organics

This project is focused on technology development and scale-up of a proprietary waste deconstruction process that will enable significant diversion of municipal and industrial organic wastes in the future. During the course of pilot-scale plant operations the actual diverted volumes are expected to be minimal – but sufficient to demonstrate the scalability and suitability of the Process for the targeted outcomes.

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Objectives, activities and measures

As part of your project plan, you specified SMART objectives for the project, provided detail about the types of activity(ies) required, and set annual target measurements. Please provide the actual measure your project achieved during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual measures fall short of targets, then please provide a short statement to explain why in the space beneath.

Press the TAB key on your keyboard to add more rows to the table, if required.

Objective	Activity	Measure	
		Target	*Actual*
To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process. Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP. Design, construct, install and commission Pre-fermentation Module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids as per the project schedule.	Progress to target is complete with the BNR module operating well, the Thermal oxidation module commissioned on biosolids, and the Fermentation module delivered to site for full commissioning.
To demonstrate viable scale up of the complete waste deconstruction process by 31 December 2011.	Carry out pilot trial runs under a range of process conditions and configurations. Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated. Pilot-scale demonstration of product value as a carbon source for WWTP	Initial wet oxidation trials at pilot scale are very promising. Delivery of the fermentation plant will allow replication of the full process at pilot scale, in the coming months.
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to at least three alternative organic waste streams.	This element of the project remains a target of the year 2 work plan, to be completed. Some preliminary experiments have been conducted
To produce a viable commercial scale design basis for application at	Development of a process engineering and economic model for the full-scale application of the	Process model in place	The second version of the

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the Rotorua wastewater treatment plant by 30 June 2012.	technology. Produce design specifications and costings for a commercial plant.	capable of capital and operating cost estimates for full-scale plant. A viable commercial scale design is produced.	process engineering model has been completed. This will be populated with lab and pilot trial data as this becomes generated.

Additional project benefits

Please list any additional benefits (economic, environmental, social or cultural) from your project, not foreseen at planning stage. Provide a measurement, if applicable. For environmental benefits, include any reduction of harm to the environment.

Press the TAB key on your keyboard to add more rows to the table, if required.

Benefit	Measure

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Risk management

List the main risks your delivery phase is facing. These may be technical, financial, organisational, economic, social, management, legal or environmental risks. Tell us what you are doing to reduce each risk.

If you identified risks during the development of your project plan, please explain how you are monitoring and/or managing these risks.

Please add as many risk tables as required.

Risk:

Potential risk *description of potential risk event*	Equipment failures in the new pilot plant modules affect our ability to undertake trials in a timely manner.
Project impact *description of impact*	Delay in integrating the 2 stages of the hybrid process at pilot scale causing programme to run behind schedule.
Likelihood *low – medium – high*	Medium
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	The operation of pilot plants inherently involves risks of equipment failure due to the developmental nature of the work, stop start operation, etc. The project team is working closely with contractor and supplier staff to deal with issues as they arise and ensure any downtime is minimised.

Risk:

Potential risk *description of potential risk event*	Commissioning phase overruns in the thermal wet-oxidation plant – causing research delays
Project impact *description of impact*	Significant delay in the real demonstration phase of the thermal wet-oxidation pilot plant.
Likelihood *low – medium – high*	High
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	The implementation and commissioning of the Pilot Plant modules is of the highest priority to the success of this project. This process is being closely monitored and resources are being allocated appropriately in light of this prioritisation. The initial plant delivery delays have now been rolled into the programme and have been actively managed resulting in the successful commissioning being carried out.

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Partnership and other funding sources

Give details of your progress towards securing partnership funds and any contingency plans for any funding shortfalls.
Include all cash contributions and other funding listed in your project budget.
Press the TAB key on your keyboard to add more rows to the table, if required.

Partner / funding source	Amount requested	Amount approved	Amount received	Date balance expected
Rotorua District Council	$275,000	$275,000	$275,000	
Scion Investment	$336,765.07	$336,765.07	$336,765.07	

Procurement

Give details of any major goods, work or services you are currently arranging for your project, or which you have purchased since your last report.
You must also attach copies of any relevant briefs and provide a summary of the procurement process followed.
Press the TAB key on your keyboard to add more rows to the table, if required.

Description	Value	Date awarded	Supplier name
Fermentation Pilot Plant	$422,225	07/07/11	Longveld Engineering Limited
Procurement documentation forwarded under separate cover on 17/06/11			

Evaluation

Are you evaluating your project according to your agreed Stage II Project Plan? ☒ Yes ☐ No

Please confirm that you are evaluating your project according to your agreed Stage II project plan: Yes or No? If No, please provide an explanation

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Declaration

- I declare that to the best of my knowledge, the information contained in all sections of this report, or supplied by us in support of our report is complete, true and correct.
- I declare that I have the authority to sign this report and to provide this information.
- I understand that the Information presented to the Minister is subject to disclosure under the Official Information Act, 1982.
- I declare that the fund payment request accompanying this report is complete, true and correct.

Name	Trevor Stuthridge		
Position	GM - Sustainable Design		
Signature *By typing your name in the space provided you are electronically signing this form.*	Trevor Stuthridge	**Date**	20/10/11

Verification

I verify that the fund payment request accompanying this report is complete, true and correct, and:

- costs making up the amount of this request are part of the eligible costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by donation or credit notes.

Name of verifier	Dr Jeff Seadon		
Position of verifier	Team Leader - Wellington		
Signature *By typing your name in the space provided you are electronically signing this form.*	Jeff Seadon	**Date**	20/10/11

Bank account details

If this is the first time you are completing this form, or account details have changed, please provide the bank account details into which the payment should be made. Please also attach a pre-printed deposit slip.

Bank name	The National Bank of New Zealand
Branch name	Rotorua
Account name	New Zealand Forest Research Institute Limited T/A Scion

Bank	Branch	Account	Suffix
0 6	0 4 1 3	0 2 4 0 0 0 2	0 0 0

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Once complete, please email the *WMF Milestone Report*, *WMF Claim Form* and supporting evidence as listed below to your Fund Analyst.

The Ministry prefers that all required documents are sent electronically, however, where it is not possible to send documents via email, please send a paper copy to:

Waste Minimisation Fund
Ministry for the Environment
PO Box 10362
Wellington 6143

Report checklist

Use the following checklist to confirm you have included all the required information in your report.

- ☐ Complete all sections of this form.
- ☐ Sign the declaration.
- ☐ Complete a *WMF Milestone Claim Form* for this milestone. If this is the first *WMF Milestone Report* for your project, attach a pre-printed deposit slip.
- ☐ If this is the final *WMF Milestone Report* for your project, complete the *WMF Final Project Report*.
- ☒ Attach evidence of milestone deliverables, for example:
  - photographs of project progress
  - monitoring and/or evaluation data
  - record of activities
  - media coverage or other publicity
  - invoices
  - staff recruitment.
- ☐ Attach a tax invoice containing the words 'Tax Invoice', and showing the following details:
  - your organisation's GST number
  - invoice number
  - deed number
  - total claim amount
  - GST component.
- ☐ Attach a list of invoices for this reporting period, in the standard format that you/your company use to record this type of information. Please ensure the following details are included:
  - invoice number
  - invoice date
  - supplier
  - description
  - total (excluding GST).

Please note, you must request your fund payments at the frequency agreed during your Stage II project planning discussions.

The Ministry will not pay more than 90 per cent of the WMF approved amount until we are satisfied that your project is complete.

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Milestone 1 — Interim Claim

This tab is for you to provide details of the cash income received, and the cash expenditure, for this milestone. Complete the Cash Income (non-WMF) and Cash Expenditure sections below (shaded sections only). When you have done this, the payment due for this milestone automatically calculates. Ensure that your figures are accurate and based on actual cash income received and actual cash spent, and then save your changes. Submit the entire claim form to your Fund Analyst with the milestone report and other required documentation for this milestone.

Milestone estimates (Ministry use only)

Estimated total expenditure:	$775,000.00
Estimated WMF payment:	$213,125.00

Balance and actuals (Ministry use only)

Initial balance:	$577,513.00
Actual paid to date:	$0.00
Actual total expenditure:	$843,813.89

Cash income (non-WMF)

As part of your project plan, you estimated the cash income you would receive from other external sources (including partners). Record all actual cash income below, that you have received from other funding sources for this milestone only, excluding GST. This may include cash income not previously listed in your project plan. This page contains formulae to calculate the payment due. Do not add rows to this page. If you have multiple income streams, combine these to fit the rows provided.

Cash income from your organisation:	$336,765.07
[enter the name of the external funding source here]:	$275,000.00
[enter the name of the external funding source here]:	[enter actual amount received]
[enter the name of the external funding source here]:	[enter actual amount received]
Actual total cash income:	**$611,765.07**

Cash expenditure

As part of your project plan, you estimated the cash expenditure for this milestone. Record all actual project costs (cash expenditure) for this milestone in the cost category rows below, excluding GST. You must provide invoices to support your claim. This page contains formulae to calculate the payment due. Do not add rows to this page.

Personnel:	$333,643.33
Administration:	$462.17
Consultants and contractors:	$9,814.09
Purchase of capital assets and other capital costs:	$344,638.00
Venue and equipment:	$143,449.87
Travel and accommodation:	$6,800.00
Promotion and dissemination of information:	$2,566.67
Financial, legal and information technology expenses:	$0.00
Other miscellaneous costs:	$2,439.77
Actual total expenditure:	**$843,813.89**

Payment calculated using the Interim Payment Calculation (Ministry use only)

The Payment due amount is how much the WMF will pay you (excluding GST) after your milestone and its deliverables have been assessed and approved. Your payment due will be the lesser of A, B or C below, as per Section 1 of your funding deed. Contact your Fund Analyst for further information, if required.

Maximum amount approved less 10% (A) =	$519,761.70
% of actual total expenditure (B) =	$232,048.82
Actual expenditure minus income (C) =	$232,048.82
Payment due: *(excl. GST)*	**$232,048.82**
Maximum amount approved:	$577,513.00
Funds remaining after payment made	$345,464.18

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Milestone assessment	
Record the milestone claim assessment below.	
Approved/declined for payment:	
Name:	
Position:	
Date:	
Signed:	
Payment verified:	
Name:	
Position:	
Date:	
Signed:	
Payment approved:	
Name:	
Position:	
Date:	
Signed:	

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Technical Progress

Inside This Update

1 Progress Summary
2 Tasks Update



The Fermentation pilot plant is now complete and and installed at the Plant. Wet oxidation trials are showing encouraging results

Progress Summary

The first milestone period of the second project year (July-October 2011) has been completed. The major outcome of the work has been completion and delivery of the fermentation pilot plant. This completes the infrastructure for the newly named TERAX™ process, which describes the combined fermentation-wet oxidation process being developed by Scion and Rotorua District Council. TERAX™ has been adopted as a brand name for the deconstruction process, differentiating from Waste 2 Gold, which is the overarching research programme.

The key tasks delivered in this quarter are summarised as follows:

The **Fermentation pilot plant has been installed** onsite at RDC. This plant was constructed under extremely tight time deadlines, and is a testament to the fabricators, project management team and communication levels maintained between all parties involved in construction.

A second **wet oxidation trial** has been conducted at pilot scale. This produced very promising results, consistent with those found at laboratory scale. A leaking pump has subsequently held up further testing, an issue which is a primary focus for the team to resolve.

A **detailed mass and energy balance** for the wet oxidation pilot plant has been developed. This will be utilised to determine the pilot plant measurement requirements for complete description of the wet oxidation system performance.

The **techno-economic model** has undergone further development, with version 2.0 of the model now complete. Future work will now focus on model verification/validation.

Plans have been developed to **investigate product added-value opportunities** during the upcoming quarters. This is an important aspect of developing the business case for the TERAX™ process.

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Task One : *Fermentation pilot plant module tender and construction*

The fermentation pilot plant performs the initial pre-treatment role within the TERAX™ process. Its purpose is to improve the economic viability of solids destruction.

The plant was designed for Scion by AWT Water NZ Ltd, and construction let through a publically advertised tender. The tender was won by Longveld Engineering Ltd of Hamilton, NZ.

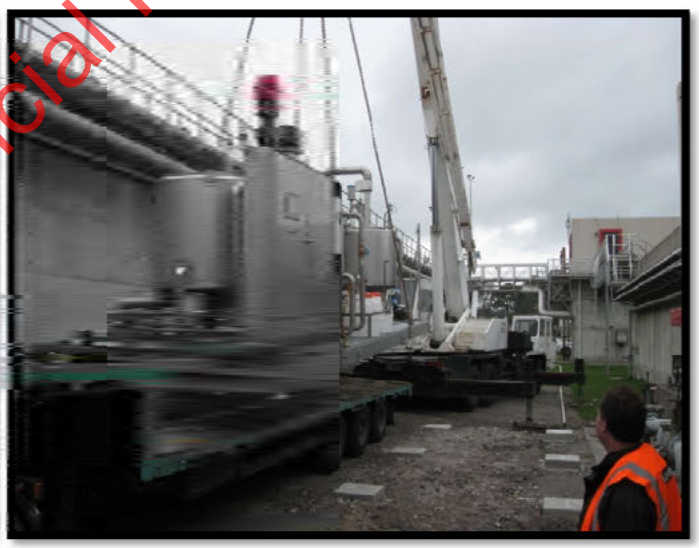
Extremely tight deadlines meant project management was key to this construction. Scion staff were in constant liaison with Longveld Engineering throughout the construction phase.

The plant has been delivered to the Rotorua District Council wastewater treatment plant site, marking a highly successful plant build. Wet commissioning is to begin immediately in order to prepare this plant for operation as part of the TERAX™ process.

Task Leader: Anderson Aggrey – Scion

Project Leader: Robert Lei - Scion





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Task Two : *Carry out thermal oxidation pilot plant trials*

In Quarter 1 of 2011-12, the wet oxidation pilot plant has undergone the following:

- detailed system checks and improvements;
- water commissioning trials;
- a second full biosolids wet oxidation trial.

This second biosolids wet oxidation trial processed 0.5% biosolids slurry, and operated at a temperature up to 220°C, for an operational time of 1.5hrs.

Key results from this trial include demonstration of

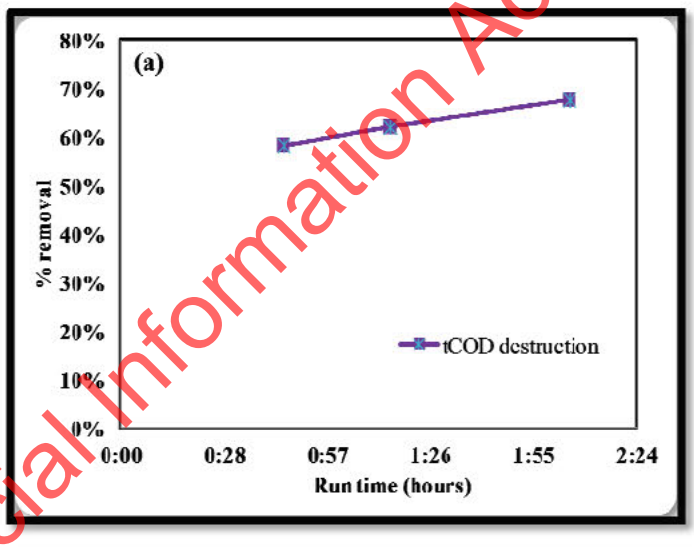
- good solids destruction (around 75%);
- production of organic acids (around 12% yield by weight);
- no solubilisation of phosphorus;

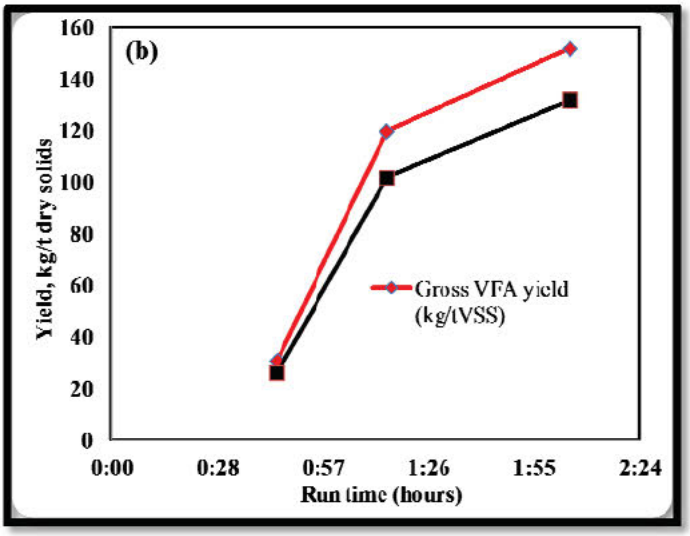
all positive indicators of performance of the process, in stepping up to pilot scale.

These results compare well with the laboratory wet oxidation process, boding well for the plant development at this increased scale.

A leaking pump has held up further trialling on the plant. Efforts to fix this pump have been a source of significant frustration to the progress of this part of the project. The project team is working diligently with the contractor and pump manufacturer to overcome this hurdle, and to minimise any project delays.

Related to the upscaling task, Dr Gapes had an opportunity to visit two full-scale wet oxidation plants during a recent visit to Europe. One plant was of scale relevant to Rotorua (Orbe in Switzerland), whilst the other had relevance to the scale of Auckland (Brussells North wastewater treatment plant, Belgium). Both were impressive facilities, and were observed to operate extremely well. This gives some added confidence that the wet oxidation aspect of the TERAX™ process will definitely perform technically at full scale.





Task Leader: Daniel Gapes – Scion

Project Leader: Robert Lei - Scion

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Task Three : *Demonstrate thermal oxidation configurations and establish mass and energy balances*

The first phase of the framework for pilot plant process engineering model – to establish material and energy balances for different pilot plant configurations – has been completed. The model consists of

- mass and heat transfer kinetic equations
- material and heat balance equations

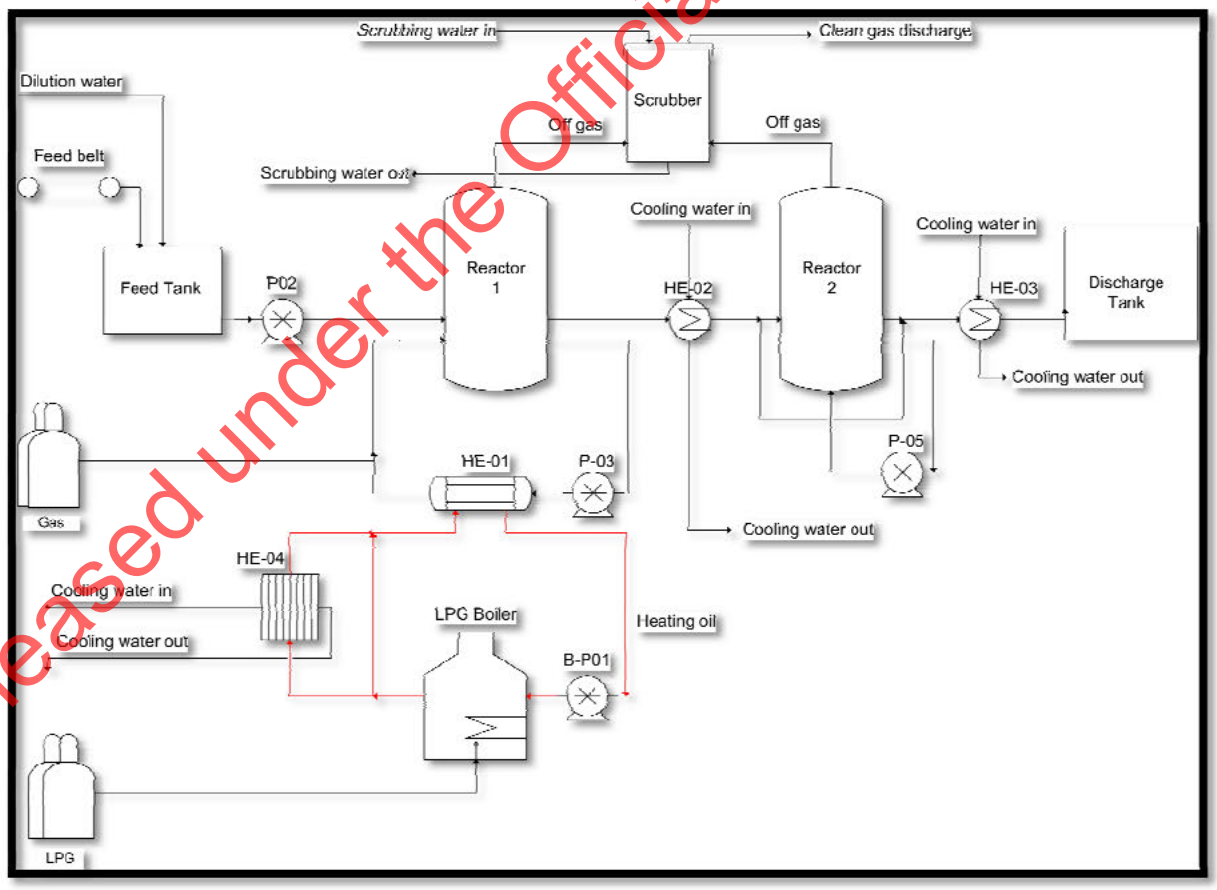
for gas and liquid phases flowing through the pilot plant. The model has been developed in-house, and is aimed at performing the following vital functions for the project:

- Establish inherent safe operating conditions for a full scale plant.
- Account for heat and mechanical losses in the pilot plant.
- Simulate thermal oxidation for different process conditions: flow rates, compositions of the gas and liquid phase, temperature and pressure.
- Provide basis for designing full scale unit process equipment, i.e. reactors, heat exchangers.

Further development of the model will continue with extraction of data from experimentally designed pilot plant operations.

Task Leader: Anderson Aggrey – Scion

Project Leader: Daniel Gapes - Scion



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Task Four : *Process engineering model refinement through interpretation of pilot data*

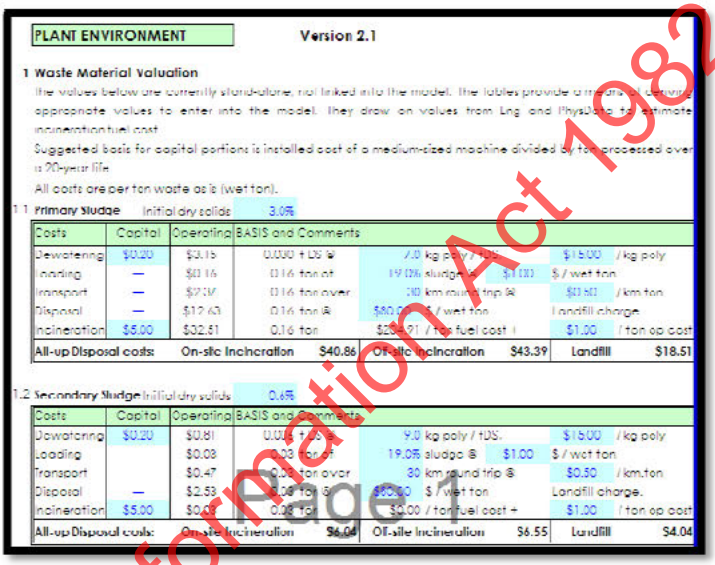
The process engineering model v1.0 was delivered in the first financial year of the project. Produced by subcontractor AWT Water NZ Ltd, this model provides a predicted cost and economic returns of the TERAX™ process, including a breakdown of where these costs and returns appear to lie. The model performs two vital functions for the project:

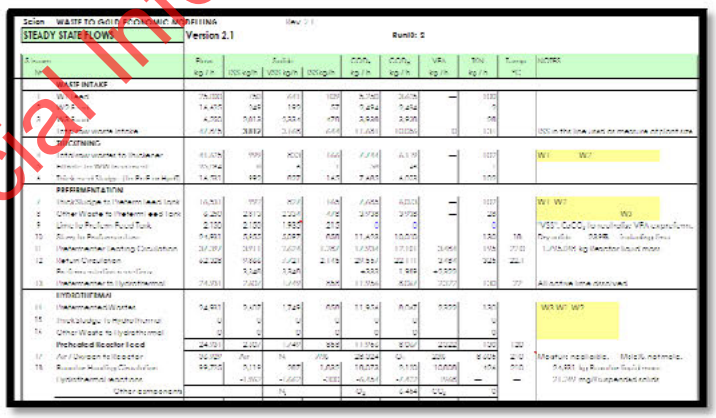
1. it identifies opportunities for lowering costs or enhancing revenues, allowing targeted development of the pilot plant programme.
2. it provides overall cost estimates for comparison with competing technologies, as an economic argument for/against adoption of the new process.

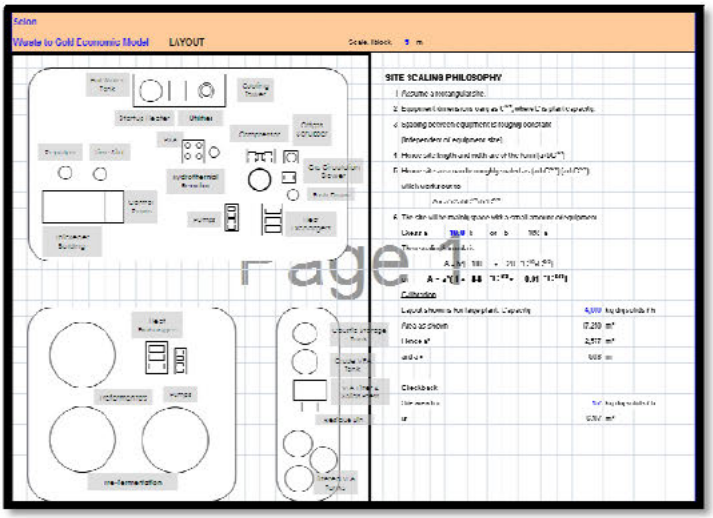
The model has been critically assessed by Scion and AWT staff. A meeting held at Scion 26th August 2011 produced a comprehensive list of model enhancements to be made. These enhancements, adopted in the now completed v2.0 techno-economic model, include:

- Reshape of capture of individual model simulation inputs/outputs
- Improved Civil + Electrical/instrumentation and control into Capex price
- Increased flexibility, to turn key unit operations "on" and "off" within the simulation
- Modification of the initial feed handling concepts, from the original model.
- Improved detail for Modification to cost inputs for biosolids processing

The model now has a very solid structure. Future developments will only be refinements to this structure, with increased attention being paid to model validation and verification against real-world data.







Task Leader: Daniel Gapes
Project Leader Robert Lei

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Task Five: *Investigate product added-value opportunities*

The TERAX™ process involves a combined biochemical-hydrothermal process by which complex biomass polymers are deconstructed into simple compounds. These include acetic acid, ammonia, and high phosphate ash. A plan has been developed to guide Scion's approach to effectively extract the most value from the process.
The key essentials of the plan are described below:

Sub-Task 1: Phosphorus separation processes.
Phosphorus is largely associated with the solid product. We will demonstrate the separability of this material, using a combination of laboratory test methods, and larger scale demonstrations on pilot plant liquors.

Sub-Task 2: Nitrogen separation processes.
We will confirm the most useful conventional approach to ammonia removal for our process. A test rig concept will be developed, to allow proof of concept of this approach for the TERAX™ process, A larger system will be used to produce enough liquid for long-term denitrification trials in the BNR pilot plant.

Sub-Task 3: Investigate methanogenesis.
Methane production offers significant energy production advantages, and is well placed within many municipal wastewater treatment plants, which have access to anaerobic digestion facilities. We will describe, to proof-of-concept stage, the methanogenic productivity of the TERAX™ liquors.

Sub-Task 4: Product knowledge and information

There is significant need to improve knowledge of both product value and costs of production. To assist in achieving this, we will likely access the skills available at AWT Water Ltd, our engineering consultancy partner in this project. This work aligns well with the verification/validation requirements for the techno-economic model which we have developed for the TERAX™ process.



Task Leader: Daniel Gapes – Scion

Project Leader: Robert Lei - Scion

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Communications Report

September 2011

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This Communications Report draws on data from a range of communication sources. Scion has an obligation to the Ministry for the Environement (MfE), to provide key communicaiton information on a quarterly basis.

Future Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
2	7-Mar-11	Marianna Tyler - met with Daniel from at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	24-Mar-11	Presentation	Future	Pending
5	TBC	Display in Scion booth at PF Olsen Forest Industries 2011 Expo, 5-7 Sept.	Scion	5-7 Sep 2011	Display	Future	to commence
6	1-May-11	Dr Trevor Stuthridge be presenting Waste 2 Gold project to Auckland City Council in May as part of an Environlink workshop by CRIs	Scion	1-May-11	Presentation	Future	to commence

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
11	21-Jun-11	Rob Lei received e-mail enquiry regarding the W2G project from the project manager of the Australia/New Zealand Biosolids Partnership (ANZBP) requesting further information about the project for their members. The latest project updates were forwarded and the ANZBP will be contacted with updates as appropriate.	Scion	20-Jun-11	Email	Reactive/ Responsive	Ongoing
12	13-Jun-11	Daniel Gapes received e-mail enquiry regarding the W2G project from Mike Glazebrook, owner of BioRich Ltd in Hawkes Bay. Phone conversation around STOP technology, and what it could offer followed this. Mike interested in a follow-up visit to the pilot plant in Aug/Sept. Exploring potential investments.	Scion	13-Jun-11	Email	Reactive/ Responsive	Ongoing
13	11-Jul-11	Daniel Gapes received enquiry from RDC to present STOP technology to Ingenium Northern Branch meeting in August, and to host a tour to the pilot plant.	RDC	11-Jul-11	Email	Reactive/ Responsive	
18	19-Jul-11	Christl McMillan received a call from writer for NZ Local Government Magazine scoping a story possibility for a bioenergy feature (from downstream processing)	NZ Local Government Magazine			Reactive/ Responsive	Pending
23		Display of W2G (TERAX) reactor and info sheet at FOMA (Federation of Maori Authorities), Tauranga, 10-13 November.	Scion	10-13 Nov 2011	Display		Upcoming
	18-Jul-11	Christl McMillan received invitation from the Economic Development Association NZ to provide an article (for their annual connecting the regions publication) on the pilot plant development with an angle on the partnership between Scion & RDC	EDA		Print & web	Reactive/ Responsive	Awaiting publication

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Closed Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Date & Progress Update
1	14-Oct-10	Questions from Biodiesel & Biorefining Magazine, BBI International	Scion	Answers supplied			Complete
3	18-Nov-10	Request for photos for use in Secondary School textbook on sustainability published by Nelson Cengage Learning NZ	Scion	Photos & captions supplied			Complete
4	12-Mar-11	Science in the Park - Scion held its third biennial Science in the Park held at Scion"s Rotorua campus. The main aim of Science in the Park is to create a greater awareness within the local community of what Scion does. Waste 2 Gold was a significant component of the day. 2800 visitors participated in the day - this has also let to two future display requests for the Water Conference in Rotorua (RDC) and a biowastes day in Tauranga in April.	Scion and RDC	W2G Display Pavillion			Complete
7	31-May-11	Official pilot plant opening at Wastewater Treatment Plant Rotorua. Speakers were Minister Smith, Mayor Winters, Tony Nowell Peter Guerin and Mauriora Kingi (RDC), Warren Parker and Trevor Stuthridge. Invited guests included local MPs, councillors, and key people involved with the project.	Scion and RDC	Invitations sent by RDC, event management by Scion			Complete
8	4-Jul-11	Meeting with MPs Steve Chadwick and Charles Chauvel to discuss W2G technologies.	Scion	Scion arranged meeting following request from Steve Chadwick's office			Complete
9	During May 2011	Media material for official opening of pilot plant & updated info on Scion (& RDC) websites. New/updated info sheet.	Scion & RDC	31-May-11	Media	Future	Info sheets available as required & can be printed on demand
10	1-May-11	Media advisory (media invitation to opening)		24-May-11	Media	Future	

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Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Date & Progress Update
14	1-Jun-11	Waste 2 Gold will be part of a Green Chemistry expo in Tauranga that will highlight our activities to BOP schools and community	Scion	27-30 June 2011	Manned Display	Future	Post event visitor questions passed to relevant team members
15	1-May-11	SCION/RDC – waste2Gold team to present at the EDANZ (Economic Development) Conference?	Scion/RDC	29th - 30th June 2011	Presentation	Future	
16	5/04/2011	Briefed Waikato/BOP Regional Biosolids summit on Waste 2 Gold project, technology, objectives, and status. This forum was setup to try and facilitate regional approaches to biosolids management where smaller individual producers struggle to resource sustainable solutions for disposal.	Scion & RDC	5-Apr-11	Presentation	Reactive/ Responsive	
17	16-Jun-11	Presented to joint APPITA/IChemE technical meeting on the waste 2 Gold project, it's development and progress to date.	Scion	16-Jun-11	Presentation	Reactive/ Responsive	
19	8-Jul-11	Daniel Gapes, Trevor Stuthridge, Robert Lei discussed STOP technology with Peter Campbell of PanPac Ltd of Hawkes Bay. Interest around solid waste disposal	Scion	8-Jul-11	Other	Reactive/ Responsive	
20	6-Jul-11	STOP technology overview sent to Steve Couper of AWT Ltd, to provide to WaterCare Services Ltd of Auckland.	Scion	6-Jul-11	Collateral provided	Reactive/ Responsive	
21	12-Jul-11	Amendments on draft article for DEMM Magazine provided to journalist based on interviews with T Struthridge and D Gapes. Photos supplied	Scion	12-Jul-11	Article	Reactive/ Responsive	Awaiting copy of published article

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Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Date & Progress Update
22	TBC	Alison Balance, Environment & Science Producer for 'Our Changing World', Radio New Zealand is looking for stories to do in April. She's identified W2G, and would look to conversational style interviews with 1-3 people. Can you please pass this request onto the group.	Radio New Zealand	Dependent on RNZ's "Our changing world" programme schedule, likely to be October/November 2011	Radio	Future	Pre-recorded long format Interview conducted with Robert Lei at Scion on 2 Sept on thermal deconstruction pilot plant.
23	28-Jun-11	Christl McMillan received call from DEMM (Engineering & Manufacturing Magazine) writer wanting to do a story on the pilot plant. This was facilitated, resulting in 3-page cover feature article in August 2011 issue. Story is also available online at www.demm.co.nz	DEMM Magazine	1-Aug-11	Print magazine and web article	Reactive/ Responsive	
24	1-Sep-11	Pilot plant launch featured promiently in Scion's Annual Report and Highlights 2011	Scion	30-Sep-11	Print	Reactive/ Responsive	
25	Oct	Display of W2G reactor and info sheet in Scion booth at WasteMINZ Conference 4-7 Oct.	Scion	4-7 Oct 2011	Display		
26		Display of W2G reactor and info sheet at Green Chemistry Expo, Tauranga, 28-30 June.	Scion	28-30 June 2011	Display		
27		Display of W2G reactor and info sheet at Clean Energy Expo, Taupo, 14 October.	Scion	14-Oct	Display		

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Potential End User - Opportunity Tracker

Topic	Company	Date of call/opportunity
Daniel Gapes met with Hamilton City Council Biosolids Options meeting group: making decisions on process options which would be of relevance for Hamilton City Council Present: Envt Waikato, Tainui, SKM Consultants representatives, Ham CC representatives plus two other technology providers (Michael Quintern, STERM Ltd) Daniel presented the developments with the RDC work, going to pilot scale, and has requested the opportunity to be added to the list of process options being considered by HCC. This was met with favourable response	Hamilton City Council	4/03/2011
Peter Dine of RDC had an enqiiry from Queenstown Lakes District Council following the Wasteminz conference regarding the potential for W2G. They have no sustainable long term option for biosolids disposal	Queenstown Lakes District Council	25/02/2011
Marianna Tyler - met with Daniel from at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	7/03/2011
Successfully through ROI stage of Melbourne Water opportunity and requested to submit a formal proposal. This was undertaken together with our engineering partner AWT Water. Proposal was submitted on 1st of June and a response is expected by the end of July.	Melbourne Water	1/06/2011
Mike Glazenbrook from Biorich, a company specialising in organic waste management in the Hawkes Bay made contact to enquire about the project and potential application for his business. Requested updates as available.	BioRich	14/06/2011
Bill Skudd from Windsor Engineering is also a Director/Owner (part?) of a start-up company working in the agricultural effluent/dairy farm area .. he has indicated he'd like to talk to us.	Windsor Engineering	13/10/2011
MWH Report - A preliminary list of of potential/alternative Territorial Local Authorities for the application of the TERAX™ has been identified.	Watercare Services LTD Tauranga City Council Thames Coromandel District Council Hamilton City Council Porirua City Council Palmerston North City Council Wellington City Council Selwyn City Council New Plymouth District Council	22/09/2011

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Invoices - External & Internal Charges -Year 2 - Milestone #1

SCION

Task	Reference	Date	MFE Category	Debtor/Employee	Narrative	Amount
A09401	2179	40816	Consultants & Contractors	No Customer Recorded	8 concrete pads for fermentation plant Goodrick Contacting Ltd	900
A09401	28082011	40783	Consultants & Contractors	Unknown Supplier	Contract work by John Manzano John Manzano	27
A09401	16092011	40802	Consultants & Contractors	John Manzano	Contract work by John Manzano John Manzano	702
A09401	28082011	40783	Consultants & Contractors	Unknown Supplier	Contract work by John Manzano John Manzano	27
A09402	110811	40773	Venue & Equipment	No Customer Recorded	Batteries Strong J (James)	86.37
A09401	2604	40742	Venue & Equipment	No Customer Recorded	Standard Issue FR/STORE/CT518/NA/Paper Towels (Hygenex) STKISS	5.86
A09401	2604	40742	Venue & Equipment	No Customer Recorded	Standard Issue FR/STORE/HW225/NA/BROOM C/W HANDLE STKISS	19.1
A09401	2604	40742	Venue & Equipment	No Customer Recorded	Standard Issue FR/STORE/CT521/NA/Mtork Plus (Refill) STKISS	29.18
A09401	2604	40764	Venue & Equipment	No Customer Recorded	Standard Issue FR/STORE/CT518/NA/Paper Towels (Hygenex) STKISS	8.8
A09401	2604	40764	Venue & Equipment	No Customer Recorded	Standard Issue FR/STORE/HW225/NA/BROOM C/W HANDLE STKISS	19.09
A09401	2605	40793	Venue & Equipment	No Customer Recorded	Standard Issue FR/STORE/LC616/NA/Glasses Safety STKISS	34.82
A09401	2604B	40798	Venue & Equipment	No Customer Recorded	Standard Issue FR/STORE/LC621/NA/Glove Leather STKISS	16.67
A09401	2604B	40798	Venue & Equipment	No Customer Recorded	Standard Issue FR/STORE/OC106/NA/Batteries AAA STKISS	11.67
A09401	4822794=	40764	Venue & Equipment	No Customer Recorded	sodium acetate extra bag supplied Orica Chemnet	228.8
A09402	525480822	40767	Venue & Equipment	No Customer Recorded	Valeric acid standard - 5mL Sigma - Aldrich NZ Ltd PO Box 106 406	114.98
A09402	11005172	40785	Venue & Equipment	No Customer Recorded	RNALater-ICE (25ml) Invitrogen NZ Limited Auckland	84
A09402	11005172	40785	Venue & Equipment	No Customer Recorded	RNALater-ICE (25ml) Invitrogen NZ Limited Auckland	70
A09402	11005172=	40785	Venue & Equipment	No Customer Recorded	RNALater ICe 25 ml Invitrogen NZ Limited Auckland	85
A09402	367801-01	40799	Venue & Equipment	No Customer Recorded	Sodium Salicylate, reagent grade - Global Science & Technology Ltd P.O.Box	45.66
A09402	367801-01.	40799	Venue & Equipment	No Customer Recorded	L(+)-Ascorbic Acid, reagent grade, Global Science & Technology Ltd P.O.Box	83.81
A09402	INV-007734	40801	Venue & Equipment	No Customer Recorded	magnesium sulphate heptahydrate 25 kg Aps Chemicals (NZ) Ltd P.O.Box 62005	115
A09402	INV-007734	40801	Venue & Equipment	No Customer Recorded	magnesium sulphate heptahydrate 25 kg Aps Chemicals (NZ) Ltd P.O.Box 62005	30.42
A09401	210711	40750	Venue & Equipment	No Customer Recorded	Swage lock fittings for P3 Estcourt G (George)	24.51
A09401	313991733	40738	Venue & Equipment	No Customer Recorded	G size zero grade air bottles BOC Gases NZ Ltd	335.42
A09401	314000364	40744	Venue & Equipment	No Customer Recorded	Air manifold for WETOX plant BOC Gases NZ Ltd P.O.Box 587	1000
A09401	314010704	40751	Venue & Equipment	No Customer Recorded	Dilution gas mixture MB 84997 BOC Gases NZ Ltd P.O.Box 587	314.21
A09401	314010704	40751	Venue & Equipment	No Customer Recorded	Dilution gas mixture MB 84997 BOC Gases NZ Ltd P.O.Box 587	5.72
A09401	00024230	40766	Venue & Equipment	No Customer Recorded	2ml clear vial - pk100 Microanalytix Pty Ltd	196
A09401	00024230	40766	Venue & Equipment	No Customer Recorded	blue pre assembled caps - pk100 Microanalytix Pty Ltd	146.8
A09401	14237	40763	Venue & Equipment	No Customer Recorded	Glass fibre	1 um nominal prefilter Micronz Limited	142.56
A09401	14237	40763	Venue & Equipment	No Customer Recorded	Sediment Filter Micronz Limited	10.8
A09401	314054020	40758	Venue & Equipment	No Customer Recorded	Calibration gas mixture MA 84995 BOC Gases NZ Ltd P.O.Box 587	697.55
A09401	314054020=	40758	Venue & Equipment	No Customer Recorded	Calibration gas mixture MA 84994 BOC Gases NZ Ltd P.O.Box 587	697.55
A09401	314054020=	40758	Venue & Equipment	No Customer Recorded	Calibration gas mixture MA 84994 BOC Gases NZ Ltd P.O.Box 587	0
A09401	28062011	40714	Venue & Equipment	No Customer Recorded	LPG gas delivered to WETOX plant, Elgas New Zealand Limited	721.02
A09401	31072011	40755	Venue & Equipment	No Customer Recorded	LPG delivered to WETOX plant, 2nd and Elgas New Zealand Limited	466.42
A09401	00024231	40770	Venue & Equipment	No Customer Recorded	blue pre assembled caps - pk100 Microanalytix Pty Ltd	115.2
A09401	00024273	40778	Venue & Equipment	No Customer Recorded	Glass fibre filter papers 55mm Microanalytix Pty Ltd	508.51
A09401	NT058059	40779	Venue & Equipment	No Customer Recorded	thermometer Cat. QM7216 Jaycar Electronics P.O.Box 97132	28.61
A09401	367191-00	40777	Venue & Equipment	No Customer Recorded	one litre polypropylene measuring Global Science & Technology Ltd P.O.Box	170.48
A09401	64350	40785	Venue & Equipment	No Customer Recorded	1.5 litre stainless steel jug with Food Equipment (NZ) Ltd P O Box 10067	33.55
A09401	64350	40785	Venue & Equipment	No Customer Recorded	1.5 litre stainless steel jug with Food Equipment (NZ) Ltd P O Box 10067	0.02
A09401	000033	40786	Venue & Equipment	No Customer Recorded	Cylinder broken in Transit CR908559-00 Inv 367191-00 Global Science	-25.51
A09401	10082011	40765	Venue & Equipment	No Customer Recorded	LPG for WETOX plant Elgas New Zealand Limited	105.21
A09401	51292	40778	Venue & Equipment	No Customer Recorded	standard pack (185) 'cream bottles' Passion Plastics EPI Ltd	450
A09401	51292	40778	Venue & Equipment	No Customer Recorded	standard pack (185) 'cream bottles' Passion Plastics EPI Ltd	-28.2
A09401	0890170677	40801	Venue & Equipment	No Customer Recorded	14mm Hex key wd5038 Repco Limited P.O.Box 1144	15
A09401	0890170677	40801	Venue & Equipment	No Customer Recorded	17mm Hex Key WD5039 Repco Limited P.O.Box 1144	25
A09401	0890170677	40801	Venue & Equipment	No Customer Recorded	9 piece hex key set metric RTK2440 Repco Limited P.O.Box 1144	15
A09401	0890170677	40801	Venue & Equipment	No Customer Recorded	9 piece hex key set imperial RTK2445 Repco Limited P.O.Box 1144	15
A09401	0890170677	40801	Venue & Equipment	No Customer Recorded	28 pc combination spanner set WC7030 Repco Limited P.O.Box 1144	250
A09401	0890170677	40801	Venue & Equipment	No Customer Recorded	Large spanner set 27 - 36mm WAT0048PRO Repco Limited P.O.Box 1144	95
A09401	0890170677	40801	Venue & Equipment	No Customer Recorded	1/2 inch drive comination socket set Repco Limited P.O.Box 1144	210
A09401	00015367	40809	Venue & Equipment	No Customer Recorded	Non return valve for seal water line Finnco Pneumatics Ltd 21 Waters St	111.54
A09401	314164142	40808	Venue & Equipment	No Customer Recorded	regulator, brass body, hi-purity, 50 BOC Gases NZ Ltd P.O.Box 587	1620
A09401	314164142	40808	Venue & Equipment	No Customer Recorded	regulator, brass body, hi-purity, 50 BOC Gases NZ Ltd P.O.Box 587	7.88
A09401	633513	40813	Venue & Equipment	No Customer Recorded	Swagelok 1/8 PTFE ferrule set T-200-set Fluid System Technologies Nz Ltd (Former	38.5
A09401	633513	40813	Venue & Equipment	No Customer Recorded	stainless plug 1/8 SS-200-P Fluid System Technologies Nz Ltd (Former	55.25
A09401	633513	40813	Venue & Equipment	No Customer Recorded	stainless plug 1/8 SS-200-P Fluid System Technologies Nz Ltd (Former	4
A09401	900015341'	40786	Venue & Equipment	No Customer Recorded	Precision Locker Offset 375W Deep Sea Corporate Express NZ Limited	1720
A09401	9210696	40813	Venue & Equipment	No Customer Recorded	05641865 five metres of 25 mm layflat Blackwoods Paykels Private Bag 92232	7.5
A09401	9210696	40813	Venue & Equipment	No Customer Recorded	08751212 five metres of 40 mm layflat Blackwoods Paykels Private Bag 92232	9.23
A09402	00023611	40722	Venue & Equipment	No Customer Recorded	Glass Fibre filters 55mm pkt 100 Microanalytix Pty Ltd	339
A09402	I966819	40731	Venue & Equipment	No Customer Recorded	Insert 0.1ml 29x5.7mm with plastic Thermo Fisher Scientific NZ Ltd	149.7
A09402	I966819	40731	Venue & Equipment	No Customer Recorded	Insert 0.1ml 29x5.7mm with plastic Thermo Fisher Scientific NZ Ltd	9.6
A09402	540477	40725	Venue & Equipment	No Customer Recorded	Elite airline tubing 76m Petware Distributors Ltd	47.97
A09402	00023932	40749	Venue & Equipment	No Customer Recorded	2ml screw thread clear plain vial pkt Microanalytix Pty Ltd	155
A09402	00023932	40749	Venue & Equipment	No Customer Recorded	Blue pre-assembled screw cap Microanalytix Pty Ltd	160
A09402	1115	40757	Venue & Equipment	No Customer Recorded	DB-FFAP 30m,0.53mm,0.5u Analytical Consumables Ltd	1038
A09402	00024230	40766	Venue & Equipment	No Customer Recorded	2ml clear vial - pk100 Microanalytix Pty Ltd	196
A09402	00024230	40766	Venue & Equipment	No Customer Recorded	blue pre assembled caps - pk100 Microanalytix Pty Ltd	146.8
A09402	14237	40763	Venue & Equipment	No Customer Recorded	Glass fibre	1 um nominal prefilter Micronz Limited	121.44
A09402	14237	40763	Venue & Equipment	No Customer Recorded	Sediment Filter Micronz Limited	9.2
A09402	00024231	40770	Venue & Equipment	No Customer Recorded	blue pre assembled caps - pk100 Microanalytix Pty Ltd	115.2
A09402	00024273	40778	Venue & Equipment	No Customer Recorded	Glass fibre filter papers 55mm Microanalytix Pty Ltd	56.49
A09402	00023291	40781	Venue & Equipment	No Customer Recorded	equal leg couplers CO8 Connect 2 Control Ltd	23.8
A09402	00023291	40781	Venue & Equipment	No Customer Recorded	reducing couplers Connect 2 Control Ltd	34.75
A09402	LSI1108015	40781	Venue & Equipment	No Customer Recorded	25' of platinum cured silicone tube Bio-Logic Solutions Ltd	208.05
A09402	LSI1108015	40781	Venue & Equipment	No Customer Recorded	25' of platinum cured silicone tube Bio-Logic Solutions Ltd	20
A09402	I976846	40791	Venue & Equipment	No Customer Recorded	15ml centrifuge tubes. Graduated, Thermo Fisher Scientific NZ Ltd	93.59
A09402	367801-00	40791	Venue & Equipment	No Customer Recorded	Boiling Stones 250g Tamer-Tabs Anti Global Science & Technology Ltd P.O.Box	15.12
A09402	367801-00	40791	Venue & Equipment	No Customer Recorded	Cylinder Measuring 50ml TPX Blue Grad Global Science & Technology Ltd P.O.Box	17.12
A09402	367801-00	40791	Venue & Equipment	No Customer Recorded	Cylinder Measuring 250ml PP Blue Grad Global Science & Technology Ltd P.O.Box	25.12
A09402	367860-00	40792	Venue & Equipment	No Customer Recorded	Pasteur pipettes 150mm pk 250 Global Science & Technology Ltd P.O.Box	28.72
A09402	367860-00	40792	Venue & Equipment	No Customer Recorded	Pasteur pipettes 230mm pk 250 Global Science & Technology Ltd P.O.Box	40.44
A09402	367860-00	40792	Venue & Equipment	No Customer Recorded	Transfer pipettes 3ml pk 500 Global Science & Technology Ltd P.O.Box	5.4
A09402	519188	40800	Venue & Equipment	No Customer Recorded	90ml PET sample jars Stowers Containment Solutions Ltd PO Box	108
A09402	519188	40800	Venue & Equipment	No Customer Recorded	Lids for 6260 Stowers Containment Solutions Ltd PO Box	40
A09402	519188	40800	Venue & Equipment	No Customer Recorded	Lids for 6260 Stowers Containment Solutions Ltd PO Box	9.85
A09402	00059692	40800	Venue & Equipment	No Customer Recorded	0.45um Nylon syringe filters 25mm pk500 Raylab Ltd PO Box 69132	295
A09402	00059692	40800	Venue & Equipment	No Customer Recorded	0.45um Nylon syringe filters 25mm pk500 Raylab Ltd PO Box 69132	17
A09402	00024447	40793	Venue & Equipment	No Customer Recorded	Nylon Membrane 30mm Diameter, PP Microanalytix Pty Ltd	138.6
A09401	8968021	40731	Venue & Equipment	No Customer Recorded	Pair of fire shield overalls. NZ Safety Ltd	117.65
A09401	8986525	40737	Other miscellaneous costs	No Customer Recorded	Health and Safety signage for WETOX NZ Safety Ltd	40.1
A09401	9012826	40745	Other miscellaneous costs	No Customer Recorded	Health and Safety signage for WETOX NZ Safety Ltd Private Bag 92100	72.85
A09401	9012826=	40745	Other miscellaneous costs	No Customer Recorded	Safety signs and stickers NZ Safety Ltd Private Bag 92100	253.07
A09401	9019362	40749	Venue & Equipment	No Customer Recorded	401156 First Aid Kit NZ Safety Ltd Private Bag 92100	68.53
A09401	9019362	40749	Venue & Equipment	No Customer Recorded	402177 4.5kg fire ext NZ Safety Ltd Private Bag 92100	84.07
A09401	9019362	40749	Venue & Equipment	No Customer Recorded	185744L First Aid Sign NZ Safety Ltd Private Bag 92100	12.89
A09401	9117187	40780	Venue & Equipment	No Customer Recorded	Full face shield WETOX plant. 403373 NZ Safety Ltd Private Bag 92100	16.54

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A09401	9120229	40781	Venue & Equipment	No Customer Recorded	yellow jacket NZ Safety Ltd Private Bag 92100	30.45
A09402	9120229	40781	Venue & Equipment	No Customer Recorded	yellow jacket NZ Safety Ltd Private Bag 92100	43.83
A09400	205832	40815	Licence Fees	Rotorua Dist Coun - Other	021 Rotorua Dist Coun - Other Private Bag 30	100000
A09401	196183	40724	Venue & Equipment	Rotorua Dist Coun - Other	RDC lab analyses as directed Rotorua Dist Coun - Other	440
A09401	199955	40755	Venue & Equipment	Rotorua Dist Coun - Other	analyses Charges Rotorua Dist Coun - Other Private Bag 30	1180.5
A09401	203423	40786	Venue & Equipment	Rotorua Dist Coun - Other	nutrient analyses Rotorua Dist Coun - Other Private Bag 30	3375
A09401	206283	40816	Venue & Equipment	Rotorua Dist Coun - Other	analyses as directed Rotorua Dist Coun - Other Private Bag 30	778.5
A09403	503516	40786	Consultants & Contractors	AWT NZ Ltd	Engineering Model -August Invoice AWT NZ Ltd	7176.68
A09402	00024447	40793	Venue & Equipment	No Customer Recorded	Delivery Microanalytix Pty Ltd	3
A09401	5585	40720	Venue & Equipment	No Customer Recorded	Electrical Services June Innovative Electrical Solutions Ltd	260
A09401	00005530	40805	Venue & Equipment	Unknown Supplier	purchase and install 12 volt power TN Electrical	438.51
A09401	553010	40745	Venue & Equipment	Emc Industrial Group	PMC131-A12F1D12 pressure transducer Emc Industrial Group P.O.Box 101444	445
A09401	15515	40785	Venue & Equipment	Orca Engineering And Marine	Make ally brackets for signage as drawn Orca Engineering And Marine 2003 Ltd 81	121.78
A09401	489388	40742	Venue & Equipment	Total Trade Supplies Ltd	14mm Allen Key Total Trade Supplies Ltd P O Box 112114	13.96
A09401	06072011	40730	Venue & Equipment	No Customer Recorded	Tools equipment and other accessories Gapes D J (Daniel)	615.19
A09401	13267	40723	Venue & Equipment	No Customer Recorded	Bench top and Cabinets for WTG Lee Bros, Joinery Ltd PO Box 1170	2955
A09401	038545	40816	Other miscellaneous costs	No Customer Recorded	LB10775 Saeid Baroutian	14
					Total Invoices	135282.62

Task	Reference	Date	MFE Category	Debtor/Employee	Narrative	Amount
A09400	038354	40756	Travel & Accommodation	No Customer Recorded	VB13643 Robert Lei A09400 Mazda GSX (Silver) EQB859 8/07/2011 Hamilton meeting	40
A09400	038483	40788	Travel & Accommodation	No Customer Recorded	VB13768 Alex Chambers A09400 Mazda GSX (Silver) EFD885 17/08/2011 RDC visit	40
A09400	038483	40788	Travel & Accommodation	No Customer Recorded	VB13768 Robert Lei A09400 Nissan X-Trail (Silver) EBE697 19/08/2011 Rotorua - RDC	80
A09400	038541	40819	Travel & Accommodation	No Customer Recorded	VB13836 Robert Lei A09400 Mazda GSX (Silver) EQB859 21/09/2011 Local	40
A09400	038541	40819	Travel & Accommodation	No Customer Recorded	VB13851 Alex Chambers A09400 Subaru Forester (Silver) ERK387 27/09/2011 RDC	40
A09401	038354	40756	Travel & Accommodation	No Customer Recorded	VB13695 George Estcourt A09401 Nissan X-Trail (Silver) EBE697 25/07/2011 Local	80
A09401	038354	40756	Travel & Accommodation	No Customer Recorded	VB13698 George Estcourt A09401 Toyota Hilux (White) EZN363 26/07/2011 Local	80
A09401	038354	40756	Travel & Accommodation	No Customer Recorded	VB13697 George Estcourt A09401 Nissan X-Trail (Silver) EBE697 26/07/2011 Field	160
A09401	038354	40756	Travel & Accommodation	No Customer Recorded	VB13570 George Estcourt A09401 Toyota Hilux (Silver) FYC270 20/06/2011 Local	2640
A09401	038483	40788	Travel & Accommodation	No Customer Recorded	VB13696 George Estcourt A09401 Toyota Hilux (White) EZN363 1/08/2011 local	400
A09401	038483	40788	Travel & Accommodation	No Customer Recorded	VB13728 George Estcourt A09401 Nissan X-Trail (Silver) EBE697 8/08/2011 local	400
A09401	038541	40819	Travel & Accommodation	No Customer Recorded	VB13771 Richard Dandoroff A09401 Toyota Hilux (White) EZN363 5/09/2011 local	40
A09401	038541	40819	Travel & Accommodation	No Customer Recorded	VB13827 Anderson Aggrey A09401 Mazda GSX (Blue) DLS408 19/09/2011 RDC site	40
A09400	038360	40757	Administration	No Customer Recorded	Copy Center Charges A09400	26.89
A09400	038490	40793	Administration	No Customer Recorded	Copy Center Charges A09400	15.75
A09400	038559	40821	Administration	No Customer Recorded	Copy Center Charges A09400	5
A09400	038561	40822	Administration	No Customer Recorded	Copy Centre Charges	130.56
A09401	038490	40793	Administration	No Customer Recorded	Copy Center Charges A09401	47.06
A09401	038559	40821	Administration	No Customer Recorded	Copy Center Charges A09401	21.28
A09401	0026322	40724	Other miscellaneous costs	No Customer Recorded	4 Staff Workbased First Aid Training Life Care Consultants Ltd	752
A09401	IN307823	40820	Other miscellaneous costs	No Customer Recorded	Blood test for Hep screening G Durbin Lakes Primecare P.O.box 2168	78.26
A09400	WANZ11/407	40806	Promotion and Dissemenati	No Customer Recorded	Reg WANZ Conf Daniel Gapes Avenues Event Management PO Box 10 612	385
A09400	WANZ11/408	40806	Promotion and Dissemenati	No Customer Recorded	Reg WANZ Conf Anderson Aggrey Avenues Event Management PO Box 10 612	385
A09400	WANZ11/409	40806	Promotion and Dissemenati	No Customer Recorded	Reg WANZ Conf Robert Lei Avenues Event Management PO Box 10 612	385
A09400	WANZ11/411	40806	Promotion and Dissemenati	No Customer Recorded	Reg WANZ Conf Ben McDonald Avenues Event Management PO Box 10 612	385
A09400	1AY617IA00	40741	Other miscellaneous costs	No Customer Recorded	Catering 11/7 - 17/7 A09400500000	8.7
A09400	1AYI19QE00	40811	Other miscellaneous costs	No Customer Recorded	cATERING19/9 - 25/9 Compass Group NZ Ltd P.O.Box 12080	111.31
A09403	1AYR18TD00	40783	Other miscellaneous costs	No Customer Recorded	Catering 23/8 - 26/8 Compass Group NZ Ltd P.O.Box 12080	133.57
A09400	BK000181	40771	Administration	No Customer Recorded	Library Interloans Jul 11	14.8
A09401	038487	40792	Administration	No Customer Recorded	Library Interloans May 11 late inv	15.96
					Total Invoices	6981.14
Total Invoices + Internal Charges						142263.76

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SCION
Next generation biomaterials

MFE Claim form - People Hours breakdown

Hours by Person

Name	MS 1 Hours	MS 2 Hours	MS 3 Hours	YTD Hours
Aggrey A	427			
Chambers A	122			
Dandoroff R	37			
Dare P	356			
Dennis M	4			
Eason KL	4			
Estcourt G	341			
Gapes DJ	309			
Gielen GJH	2			
Lei R	270			
McDonald B	331			
McGrouther K	10			
Miliken P	57			
Robinson M	24			
Seadon J	1			
Smit A	211			
Sohel M	7			
Strong J	136			
Tutt K	261			
Unsworth D	25			
van Leeuwen MP	31			
Walker K	2			
Zaayman M	46			
Total Hours	**3,014**	**0**	**0**	**0**

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Te Papa Tipu Innovation Park
49 Sala Street, Private Bag 3020, Rotorua, New Zealand
Telephone: + 64 7 343 5899 | Facsimile: + 64 7 348 0952
Email enquiries@scionresearch.com | www.scionresearch.com

TAX INVOICE

Ministry For The Environment
P O Box 10-362
WELLINGTON

Customer Number:	00586	***GST Reg No (NZ):***	59-493-760
Customer Reference:		***ABN No (Australia):***	512-1094-8677
Invoice Number:	**047632**	***Invoice Date:***	21/10/2011
Page :	1 of 1	***Due Date:***	20/11/2011

Particulars	***Amount $***
Milestone 1 - Year 2 Deliverables as per WMF Waste 2 Gold Deconstruction Technologies for Organic Waste Utlisation	232,048.82
Attention: Elena Wrelton	
Sub Total:	232,048.82
GST:	34,807.32
Invoice Total:	266,856.14

For any queries relating to this invoice, please contact Alex Chambers
For any payment queries, please contact accounts.receivable@scionresearch.com

Please detach and return with your remittance to Scion, Private Bag 3020, Rotorua, New Zealand or make payment to Scion, Account Number 06 - 0413 - 0240002 - 00 , The National Bank of New Zealand, 209 Queen Street, Auckland Swift Number ANZBNZ22. Please quote your customer number

Customer Number: 00586
Min For Environment - Wellington
Invoice Number: 047632
Amount: 266,856.14
Card Number: __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __
Card Type: Visa__ Mastercard__
Security Number: ___ (Three digit number located on the back of your card
Cardholders Name: _____
Expiry Date: ___/___
Signature: _____
Amount to Pay: $_____

Scion is the trading name of New Zealand Forest Research Institute Limited.

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Ministry for the Environment
Manatū Mō Te Taiao

REDUCE • REUSE • RECYCLE • RECOVER

WMF Milestone Report

This is your opportunity to tell us how the delivery phase of your project is progressing.

Milestone reports should be made on those dates agreed in your funding deed (unless otherwise discussed with your Fund Analyst). If there are any problems or issues, or you wish to make major changes to your project, please discuss with your Fund Analyst **before** completing and submitting this report.

Please read the *Waste Minimisation Fund – Grantee Guide* before you complete this report.

Project and report details

Organisation name	Scion
Project title	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation
Contract number	WMF-00000137
Project duration *if a multi-year project select the project duration*	Two years
Current year *if a multi-year project select the current project year*	Year Two
Total number of milestones *select the total number of project milestones for the current year*	Four
Current milestone *select the current milestone for this report*	Two
Due date *agreed report due date as per your funding deed*	31/12/11
Date submitted *actual date the report was submitted*	21 January 2012
Report type *select whether this is an interim report or the final milestone report for the project*	Interim

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Milestone Two details

Enter the name of the milestone, and then list all of the tasks and deliverables (as agreed in your funding deed) for this milestone in the tables below.

Indicate whether each task and deliverable is complete, and provide a summary of progress in the Comment column. If any task or deliverable is not complete, provide an explanation, and list the actions you plan to take in response.

You will also need to attach evidence of your deliverables to this report.

Press TAB on your keyboard to add a new row, if required.

Milestone name: Integrated Trials

Tasks *tasks as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Planning alternative organic waste feedstock evaluation	Yes	Planning has been undertaken for next phase of alternative waste feedstock evaluation. Staff member to begin masters project on model lignocellulosic biosolids, which will be exposed to TERAX™ processing
Integration of fermentation and thermal oxidation pilot trials	Yes	Both the Fermentation and Wet Oxidation pilot plants are now commissioned and operational providing the full TERAX™ process demonstration.
Process engineering model refinement and RDC scenario evaluation	Yes	Second full version techno-economic model has been produced, verified and used for development of RDC scenario.
Carry out laboratory scale investigations into added value opportunities	Yes	Laboratory studies on ammonia stripping completed successfully.
Partner workshop to evaluate technology feasibility, and development criteria.	Yes	Completed partner workshop 19 December 2011. Successful description of status of the technoeconomic modelling, and fruitful discussions on areas for increased attention for the coming quarter

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Deliverables *deliverables as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Outline workplan for alternative organic waste evaluations	Yes	Please see attached Quarterly Technical Progress Statement
Quarterly technical progress statement describing pilot trial operations, results to date, and associated workplan progress.	Yes	Please see attached Quarterly Technical Progress Statement
Techno-economic scenario as an output from process engineering model (v2.0)	Yes	Please see attached Quarterly Technical Progress Statement
Summary report on added-value opportunity investigations	Yes	Please see attached Quarterly Technical Progress Statement

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Key performance indicators (KPIs)

For each waste type(s) and target annual tonnage you identified in your project plan, please provide the actual values your project reduced, reused, or recycled/recovered during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual tonnages fall short of targets, then please provide a short statement to explain why in the space beneath (eg, the equipment utilised for this project is not yet operating at its maximum capacity).

Press the TAB key on your keyboard to add more rows to the table, if required.

	Quantity of waste (tonnes)					
Waste type	**Reduce**		**Reuse**		**Recover/Recycle**	
	Target	***Actual***	***Target***	***Actual***	***Target***	***Actual***
Rotorua District Council biosolids					Up to 1 tonne per day (pilot-scale process)	Negligible –Initial trials undertaken
Pulp and paper primary and secondary solids					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start on P&P solids
Rotorua District Council Atiamuri Landfill municipal organic wastes					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start on municipal organics

This project is focused on technology development and scale-up of a proprietary waste deconstruction process that will enable significant diversion of municipal and industrial organic wastes in the future. During the course of pilot-scale plant operations the actual diverted volumes are expected to be minimal – but sufficient to demonstrate the scalability and suitability of the Process for the targeted outcomes.

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Objectives, activities and measures

As part of your project plan, you specified SMART objectives for the project, provided detail about the types of activity(ies) required, and set annual target measurements. Please provide the actual measure your project achieved during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual measures fall short of targets, then please provide a short statement to explain why in the space beneath.

Press the TAB key on your keyboard to add more rows to the table, if required.

Objective	Activity	Measure	
		Target	*Actual*
To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process. Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP. Design, construct, install and commission Pre-fermentation Module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids as per the project schedule.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and have been successfully commissioned on biosolids
To demonstrate viable scale up of the complete waste deconstruction process by 31 December 2011.	Carry out pilot trial runs under a range of process conditions and configurations. Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated. Pilot-scale demonstration of product value as a carbon source for WWTP	The complete pilot scale waste deconstruction process, TERAX™, is now in place and fully operational. Further demonstration is currently underway.
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to at least three alternative organic waste streams.	Preliminary work on a number of alternative organic waste streams has been undertaken and pulp mill biosolids will be evaluated during the next quarter.
To produce a viable commercial scale design basis for application at the Rotorua wastewater treatment plant by 30 June 2012.	Development of a process engineering and economic model for the full-scale application of the technology.	Process model in place capable of capital and	The second version of the process engineering

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	Produce design specifications and costings for a commercial plant.	operating cost estimates for full-scale plant. A viable commercial scale design is produced.	model has been completed and is undergoing validation.

Additional project benefits

Please list any additional benefits (economic, environmental, social or cultural) from your project, not foreseen at planning stage. Provide a measurement, if applicable. For environmental benefits, include any reduction of harm to the environment.

Press the TAB key on your keyboard to add more rows to the table, if required.

Benefit	Measure

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Risk management

List the main risks your delivery phase is facing. These may be technical, financial, organisational, economic, social, management, legal or environmental risks. Tell us what you are doing to reduce each risk.

If you identified risks during the development of your project plan, please explain how you are monitoring and/or managing these risks.

Please add as many risk tables as required.

Risk:

Potential risk *description of potential risk event*	Equipment failures in the new pilot plant modules affect our ability to undertake trials in a timely manner.
Project impact *description of impact*	Delay in integrating the 2 stages of the hybrid process at pilot scale causing programme to run behind schedule.
Likelihood *low – medium – high*	Medium
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	The operation of pilot plants inherently involves risks of equipment failure due to the developmental nature of the work, stop start operation, etc. The project team is working closely with contractor and supplier staff to deal with issues as they arise and ensure any downtime is minimised.

Risk:

Potential risk *description of potential risk event*	Commissioning phase overruns in the thermal wet-oxidation plant – causing research delays
Project impact *description of impact*	Significant delay in the real demonstration phase of the thermal wet-oxidation pilot plant.
Likelihood *low – medium – high*	High
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	The implementation and commissioning of the Pilot Plant modules is of the highest priority to the success of this project. This process is being closely monitored and resources are being allocated appropriately in light of this prioritisation. The initial plant delivery delays have now been rolled into the programme and continue to be actively managed.

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Partnership and other funding sources

Give details of your progress towards securing partnership funds and any contingency plans for any funding shortfalls.
Include all cash contributions and other funding listed in your project budget.
Press the TAB key on your keyboard to add more rows to the table, if required.

Partner / funding source	Amount requested	Amount approved	Amount received	Date balance expected
Rotorua District Council	$275,000	$275,000	$275,000	
Scion Investment	$39,497.62	$39,497.62	$39,497.62	

Procurement

Give details of any major goods, work or services you are currently arranging for your project, or which you have purchased since your last report.
You must also attach copies of any relevant briefs and provide a summary of the procurement process followed.
Press the TAB key on your keyboard to add more rows to the table, if required.

Description	Value	Date awarded	Supplier name

Evaluation

Are you evaluating your project according to your agreed Stage II Project Plan? ☒ Yes ☐ No

Please confirm that you are evaluating your project according to your agreed Stage II project plan: Yes or No? If No, please provide an explanation

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Declaration

- I declare that to the best of my knowledge, the information contained in all sections of this report, or supplied by us in support of our report is complete, true and correct.
- I declare that I have the authority to sign this report and to provide this information.
- I understand that the Information presented to the Minister is subject to disclosure under the Official Information Act, 1982.
- I declare that the fund payment request accompanying this report is complete, true and correct.

s 9(2)(a) [redacted]

space provided you are electronically signing this form.

Date 20/10/11

Verification

I verify that the fund payment request accompanying this report is complete, true and correct, and:

- costs making up the amount of this request are part of the eligible costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by donation or credit notes.

s 9(2)(a) [redacted]

electronically signing this form.

Date 20/10/11

Bank account details

If this is the first time you are completing this form, or account details have changed, please provide the bank account details into which the payment should be made. Please also attach a pre-printed deposit slip.

Bank name	The National Bank of New Zealand
Branch name	Rotorua
s 9(2)(b)(ii)	[redacted]

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Once complete, please email the *WMF Milestone Report*, *WMF Claim Form* and supporting evidence as listed below to your Fund Analyst.

The Ministry prefers that all required documents are sent electronically, however, where it is not possible to send documents via email, please send a paper copy to:

Waste Minimisation Fund
Ministry for the Environment
PO Box 10362
Wellington 6143

Report checklist

Use the following checklist to confirm you have included all the required information in your report.

- ☐ Complete all sections of this form.
- ☐ Sign the declaration.
- ☐ Complete a *WMF Milestone Claim Form* for this milestone. If this is the first *WMF Milestone Report* for your project, attach a pre-printed deposit slip.
- ☐ If this is the final *WMF Milestone Report* for your project, complete the *WMF Final Project Report*.
- ☒ Attach evidence of milestone deliverables, for example:
  - photographs of project progress
  - monitoring and/or evaluation data
  - record of activities
  - media coverage or other publicity
  - invoices
  - staff recruitment.
- ☐ Attach a tax invoice containing the words 'Tax Invoice', and showing the following details:
  - your organisation's GST number
  - invoice number
  - deed number
  - total claim amount
  - GST component.
- ☐ Attach a list of invoices for this reporting period, in the standard format that you/your company use to record this type of information. Please ensure the following details are included:
  - invoice number
  - invoice date
  - supplier
  - description
  - total (excluding GST).

Please note, you must request your fund payments at the frequency agreed during your Stage II project planning discussions.

The Ministry will not pay more than 90 per cent of the WMF approved amount until we are satisfied that your project is complete.

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Milestone 2 — Interim Claim

*This tab is for you to provide details of the cash income received, and the cash expenditure, for this milestone. Complete the **Cash Income (non-WMF)** and **Cash Expenditure** sections below (shaded sections only). When you have done this, the payment due for this milestone automatically calculates. Ensure that your figures are accurate and based on actual cash income received and actual cash spent, and then save your changes. Submit the entire claim form to your Fund Analyst with the milestone report and other required documentation for this milestone.*

Milestone estimates (Ministry use only)

Estimated total expenditure:	$435,000.00
Estimated WMF payment:	$119,625.00

Balance and actuals (Ministry use only)

Initial balance:	$345,464.18
Actual paid to date:	$0.00
Actual total expenditure:	$433,789.82

Cash income (non-WMF)

*As part of your project plan, you estimated the cash income you would receive from other external sources (including partners). Record **all actual** cash income below, that you have received from other funding sources for this milestone only, excluding GST. This may include cash income not previously listed in your project plan. This page contains formulae to calculate the payment due. Do not add rows to this page. If you have multiple income streams, combine these to fit the rows provided.*

Cash income from your organisation:	$39,497.62
[enter the name of the external funding source here]:	$275,000.00
[enter the name of the external funding source here]:	[enter actual amount received]
[enter the name of the external funding source here]:	[enter actual amount received]
Actual total cash income:	**$314,497.62**

Cash expenditure

*As part of your project plan, you estimated the cash expenditure for this milestone. Record **all actual** project costs (cash expenditure) for this milestone in the cost category rows below, excluding GST. You must provide invoices to support your claim. This page contains formulae to calculate the payment due. Do not add rows to this page.*

Personnel:	$242,931.67
Administration:	$376.70
Consultants and contractors:	$42,914.68
Purchase of capital assets and other capital costs:	$20,388.14
Venue and equipment:	$105,484.80
Travel and accommodation:	$20,202.28
Promotion and dissemination of information:	$0.00
Financial, legal and information technology expenses:	$0.00
Other miscellaneous costs:	$1,491.55
Actual total expenditure:	**$433,789.82**

Payment calculated using the Interim Payment Calculation (Ministry use only)

*The **Payment due** amount is how much the WMF will pay you (excluding GST) after your milestone and its deliverables have been assessed and approved. Your payment due will be the lesser of A, B or C below, as per Section 1 of your funding deed. Contact your Fund Analyst for further information, if required.*

balance brought forward less 10% max WMF amount (A) =	$287,712.88
% of actual total expenditure (B) =	$119,292.20
Actual expenditure minus income (C) =	$119,292.20
Payment due: *(excl. GST)*	**$119,292.20**
Maximum amount approved:	$577,513.00
Funds remaining after payment made	$226,171.98

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Ministry use only	
Milestone assessment	
Record the milestone claim assessment below.	
Approved/declined for payment:	
Name:	
Position:	
Date:	
Signed:	
Payment verified:	
Name:	
Position:	
Date:	
Signed:	
Payment approved:	
Name:	
Position:	
Date:	
Signed:	

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Technical Progress

Inside This Update

1 Progress Summary

2 Tasks Update



The Fermentation pilot plant has been commissioned, and is functioning 24/7. The economic model has reached a second level of development, and is capable of detailed scenario analysis of the RDC opportunity

Progress Summary

The second milestone period of year 2 of the project has now been completed. The major outcomes were the successful commissioning of the fermentation pilot plant and significant mechanical modifications completed on the wet oxidation pilot plant. All three pilot plants are now operational.

The key tasks delivered in this quarter are summarised as follows:

- The fermentation pilot plant was successfully commissioned and is now operating in continuous mode, 24/7.
- The wet oxidation pilot plant underwent a significant modification, with the design and construction of a high pressure/temperature recirculation pump. The completion of the design, build, and installation of this pump within a 6 week period was a significant achievement and provides invaluable scale-up knowledge which is a key output of pilot plant work. Delays in the trial programme will be recovered over the coming months as we ramp up pilot operations.
- A plan has been made for investigating a further alternative feedstock which could be the next input to the TERAX™ process. This will take the form of a lignocellulosic biomass, and laboratory tests are targeted for the third quarter of this year.
- The second version of the Technoeconomic model was delivered and has been reported on. The model scenario for RDC indicated that the TERAX™ process has the potential to compete with conventional landfilling as a method for solid waste disposal from the Rotorua WWTP site.
- Opportunities for added-value were investigated. The results from these laboratory trials were encouraging, and will be a continued focus of development during the final quarters of this research programme.

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Task One : *Planning alternative organic waste feedstock evaluation*

The TERAX™ process has been developed on municipal biosolids. This short proposal identifies the planned approach to initiating the broadening of the feedstock suite to which this process is applicable. Significant work has already been completed on assessing the efficacy of the TERAX™ process on the following:

1. Yeast biomass
2. Algal biomass
3. Lakeweed
4. Municipal treatment plant (activated sludge process) biosolids

Planned Approach

From Scion's perspective, one outstanding resource which is missing is wastes derived from the lignocellulosic industries. These are large emitters of organic waste, and a key industry for New Zealand. Thus it is proposed that this be evaluated for the extension of TERAX™ in the coming six months.

s 9(2)(a) , a Scion employee, is initiating his Masters project on fermentation of lignocellulosic industry solid organic wastes. This is fully aligned to the goals of the TERAX™ work. We propose the use of this postgraduate research activity to complete initial description of the two-stage TERAX™ process on on a relevant alternative feedstock.

The Masters project has been initiated, with fermentation experiments to be started during January-February 2012. The feedstock will likely be a model of the organic solid waste discharges which arise from a modern biological wastewater treatment system that was treating lignocellulosic wastewaters. Because of the likelihood of limited access to real examples of such wastes, we will generate an appropriate analogue, using municipal biosolids (mimicking the biological cell material produced in the treatment plant) and augment this appropriately to reflect losses from a suitable lignocellulosic industry (e.g. pulp and paper mill). The augmentations will likely be in the form of fibres, resin and extractives, added at levels which represent discharges from such industrial sites.

This work will demonstrate the initial potential for the TERAX™ process to function as a viable alternative to solid waste disposal at lignocellulosic industries.

Personnel and Timing

Key personnel which are identified for this work will be s 9(2)(a)
s 9(2)(a)

The work should be feasibly conducted and reported during Q3 of 2011/12.

Outcomes and next steps

A short confidential report will be completed. Subject to confidentiality, outcomes from the work should be published in a peer reviewed article.

The next step beyond this exploratory work will be to identify specific sources within New Zealand's lignocellulosic industry where real biomass could be utilised in laboratory and pilot scale testing of the TERAX™ process.

s 9(2)(a)

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Task Two : *Integration of fermentation and thermal oxidation trials*

The pilot scale work during this quarter was characterised by two things:

1. Wet oxidation plant-troubleshooting
2. Fermentation plant-commissioning and experimental initiation

As highlightedin the last reporting period, the **wet oxidation plant** encountered the failure of a key piece of equipment, this being one of the high pressure recirculation pumps. The failure was traced to the pump not being able to meet the design specification. In order to mitigate this, numerous activities were undertaken. Unfortunately "off-the-shelf" options for replacement were frustrated by the high specification required and pump delivery would have taken a minimum of 18 weeks for this option. Thus the decision to build our own pump was taken. A design team was set up comprising of Scion staff, s 9(2)(a) (design engineer responsible for the wet oxidation design), Longveld Engineering Ltd (wet oxidation plant construction firm) and local engineering firm Dynamic Engineering Ltd. The design was peer reviewed by an external pump supply expert. Design and Construction was achieved within a 6 week period.

Commissioning of the pump has now been completed to the satisfaction of the project team. Despite the delays that have been caused by this, the work has identified the extreme environment under which we are working when conducting wet oxidation. It has provided a pump design which may well be carried through to the next, fullscale, phase of operations. Resolving this challenging issue has provided invaluable scale-up knowledge to the project which is a key output of pilot plant work.

The **fermentation plant** underwent extensive commissioning during the quarter, and the first experimental trials were undertaken. This was extremely satisfying for the project team, and the plant has operated essentially without a hitch since startup.

In summary, the past quarter has had some frustrations, but also some significant succcess. Delays in the wet oxidation work make it more critical that success is forthcoming during the 3rd quarter. Thus, our workplanning has this as a key focus for January/February of 2012.

Task s 9(2)(a)

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Task Three : *Process Engineering model refinement and RDC scenario evaluation*

The second version of the Techno-Economic model for TERAX™ technology has been produced. The model was created by s 9(2)(a) of AWT Water Ltd, in conjunction with s 9(2)(a)

The first formal scenario has been generated from the model. The model has inputs which are relevant to the scale of the Rotorua District Council site. Scion data has been utilised to describe the wet oxidation conditions and outputs.

Developments of the current version, over v1.0

- Design basis has been moved to dry solids, for the calculations
- Process starts at unthickened sludge. Previous model started at dewatered sludge, thus requiring a dilution step which was deemed a spurious model assumption
- provision has been made for a basic comparison against a number of alternative technologies, including landfilling, on- and off-site incineration. Of these, landfilling is the only provision which we have current capability for validation of the input numbers.
- Utilities, electrical, instrumentation and control has been upgraded significantly
- Contingency is standardised on 35% on works cost
- Options are available for choosing to not to thicken any or all of the three waste types
- Option is available to turn off prefermentation
- Run Record is substantially upgraded, to include many of the process outputs for each individual scenario. Provision is also made to add in user defined outputs to the scenario row.
- Different yield parameters are used for the wet oxidation step, based on whether wet oxidation only, or TERAX™ process is chosen

A significant amount of checking and verification tasks has been conducted.

A method of extreme value checking was used as part of this verification, where very high and very low numbers were input into the model parameters. As a result of the model simplifications which occurred under these conditions, it was possible to predict model outcomes, and check against actual model outcomes.

Little validation (comparison against real-world proesses) of the model has been conducted thus far. A number of validation tasks will be developed in the following quarter.

A base-case scenario for RDC was constructed. The relevant input parameters were exposed to variation, appropriate to the parameters in question. Thus a sensitivity analysis was described for these parameters.

The model scenario for RDC indcated that the TERAX™ process has the potential to compete with conventional landfilling as a method for solid waste disposal from the Rotorua WWTP site. This is an encouraging result, and this message has been communicated to our partners at the RDC.

The sensitivity analysis is presented below. The scenario numbers relate to the parameter of interest, and the plot provides the range of percentage cost increase, across the defined parameter range. Thus a negative cost increase indicates potential to lower the cost of biosolids treatment.

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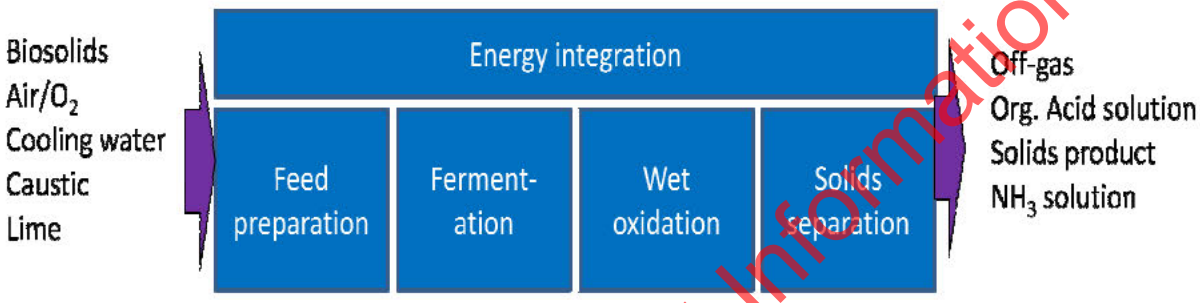
From this, a number of areas for further investigation have been identified. In particular, some areas within the process where optimisation or modification may result in considerable cost reduction are apparent from the modelling.

The next steps for the model include

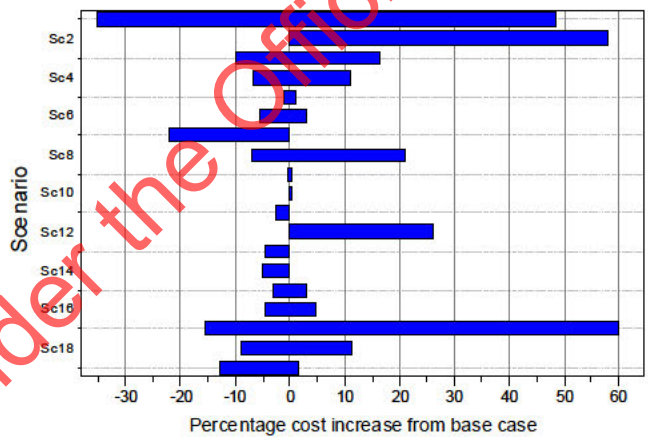
1. Continued verification activities
2. Model validation against real world process operation
3. Peer review of the model structure and cost methodology
4. Refinement of input parameters to better approximate the specific RDC situation
5. Cross comparison of results against competing technologies.

s 9(2)(a) – Scion

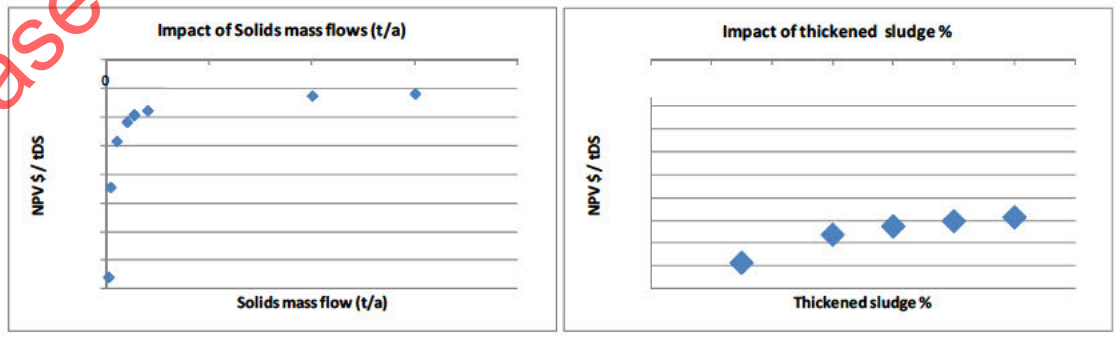
– Scion



Block diagram of model



Sensitivity of TERAX™ costs to individual parameter variations



Sensitivity of process costs to changes in two selected individual parameters

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Task Four : *Carry out lab scale investigations into added-value opportunities*

The TERAX™ process involves a combined biochemical-hydrothermal process, by which complex biomass polymers are deconstructed into simple compounds. Part of the project is to target these compounds for value-added opportunities.

During this project quarter, laboratory-scale investigations into these added –value opportunities were focused on a number of areas.

The results from these laboratory trials were encouraging, and will be a continued focus of development during the final quarters of this research programme.

There are some significant intellectual property components associated with this aspect of the work. Thus, we have not included any discussion for Task 4 in this progress statement.

The work has been completed and filed as an internal Scion report.

Should this report be required for assessment of Task completion, Scion would be happy to disclose this under conditions of confidentiality.

s 9(2)(a) s 9(2)(a)

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Task Five: *Partner workshop to evaluate technology feasibility, and development criteria*

The RDC and Scion partners in the TERAX™ process development met in late December (19th) to discuss the technology development.
Specifically, the goals of the meeting were to

- Provide an update on technoeconomic (TE) model overview and status
- Discuss in detail the TE scenario analysis for the RDC case
- Agree on TE modelling direction
- Agree on metrics for success for the project

The meeting was attended by technical project leaders, technical staff from RDC and senior executives (including both CEOs) from both organisations.

s 9(2)(a) presented the model overview, and extensive discussion was entered into around this. Following this discussion, the group workshopped through a number of questions, based on the goals described above.

One critical outcome that was communicated during this presentation was that the TERAX™ process is predicted to compete favourably as a method for Rotorua's biosolids disposal. Clearly this is positive for continued process development.

Agreement was reached that the model was appropriate for the tasks it was set for the current work. Further development that should be undertaken should be focussed on continued model verification (debugging), peer review and validation tasks.

Metrics for success were discussed, with substantial agreement being reached on the required environmental and economic parameters which will describe success for the technology.

As a result of the workshop, significant attention has been placed analysis and understanding of nutrient flows through the system.

Further planning for undertaking peer review of the model is pending, with an aim of achieving this by the end of Q3 of this second project year.

Task Leader: s 9(2)(a)

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Communications Report

January 2012

This Communications Report draws on data from a range of communication sources. Scion has an obligation to the Ministry for the Environement (MfE), to provide key communicaiton information on a quarterly basis.

Open Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
2	7-Mar-11	Marianna Tyler - met with s 9(2)(a) at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	24-Mar-11	Presentation	Future	Pending
5	TBC	Display in Scion booth at PF Olsen Forest Industries 2011 Expo, 5-7 Sept.	Scion	5-7 Sep 2011	Display	Future	to commence
6	1-May-11	s 9(2)(a) be presenting Waste 2 Gold project to Auckland City Council in May as part of an Environlink workshop by CRIs	Scion	1-May-11	Presentation	Future	to commence

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Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
11	21-Jun-11	s 9(2) received e-mail enquiry regarding the W2G project from the project manager of the Australia/New Zealand Biosolids Partnership (ANZBP) requesting further information about the project for their members. The latest project updates were forwarded and the ANZBP will be contacted with updates as appropriate.	Scion	20-Jun-11	Email	Reactive/ Responsive	Ongoing
12	13-Jun-11	s 9(2)(a) received e-mail enquiry regarding the W2G project from s 9(2) Hawkes Bay. Phone conversation around STOP technology, and what it could offer followed this. s interested in a follow-up visit to the pilot plant in Aug/Sept. Exploring potential investments.	Scion	13-Jun-11	Email	Reactive/ Responsive	Ongoing
13	11-Jul-11	s 9(2)(a) received enquiry from RDC to present STOP technology to Ingenium Northern Branch meeting in August, and to host a tour to the pilot plant.	RDC	11-Jul-11	Email	Reactive/ Responsive	
18	19-Jul-11	s 9(2)(a) received a call from writer for NZ Local Government Magazine scoping a story possibility for a bioenergy feature (from downstream processing)	NZ Local Government Magazine			Reactive/ Responsive	Pending

Closed Communications

Comm s Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
1	14-Oct-10	Questions from Biodiesel & Biorefining Magazine, BBI International	Scion	Answers supplied			Complete
3	18-Nov-10	Request for photos for use in Secondary School textbook on sustainability published by Nelson Cengage Learning NZ	Scion	Photos & captions supplied			Complete

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Comm s Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
4	12-Mar-11	Science in the Park - Scion held its third biennial Science in the Park held at Scion"s Rotorua campus. The main aim of Science in the Park is to create a greater awareness within the local community of what Scion does. Waste 2 Gold was a significant component of the day. 2800 visitors participated in the day - this has also let to two future display requests for the Water Conference in Rotorua (RDC) and a biowastes day in Tauranga in April.	Scion and RDC	W2G Display Pavillion			Complete
7	31-May-11	Official pilot plant opening at Wastewater Treatment Plant Rotorua. Speakers were Minister Smith, Mayor Winters, s 9(2)(a) [redacted]. Invited guests included local MPs, councillors, and key people involved with the project.	Scion and RDC	Invitations sent by RDC, event management by Scion			Complete
8	4-Jul-11	Meeting with MPs Steve Chadwick and Charles Chauvel to discuss W2G technologies.	Scion	Scion arranged meeting following request from Steve Chadwick's office			Complete
9	During May 2011	Media material for official opening of pilot plant & updated info on Scion (& RDC) websites. New/updated info sheet.	Scion & RDC	31-May-11	Media	Future	complete
10	1-May-11	Media advisory (media invitation to opening)		24-May-11	Media	Future	complete
14	1-Jun-11	Waste 2 Gold will be part of a Green Chemistry expo in Tauranga that will highlight our activities to BOP schools and community	Scion	27-30 June 2011	Manned Display	Future	Complete
15	1-May-11	SCION/RDC – waste2Gold team to present at the EDANZ (Economic Development) Conference?	Scion/RDC	29th - 30th June 2011	Presentation	Future	complete

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Comm s Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
16	5/04/2011	Briefed Waikato/BOP Regional Biosolids summit on Waste 2 Gold project, technology, objectives, and status. This forum was setup to try and facilitate regional approaches to biosolids management where smaller individual producers struggle to resource sustainable solutions for disposal.	Scion & RDC	5-Apr-11	Presentation	Reactive/ Responsive	complete
17	16-Jun-11	Presented to joint APPITA/IChemE technical meeting on the waste 2 Gold project, it's development and progress to date.	Scion	16-Jun-11	Presentation	Reactive/ Responsive	complete
19	8-Jul-11	s 9(2)(a) of Hawkes Bay. Interest around solid waste disposal	Scion	8-Jul-11	Other	Reactive/ Responsive	Complete
20	6-Jul-11	STOP technology overview sent to s 9(2) d, to provide to WaterCare Services Ltd of Auckland.	Scion	6-Jul-11	Collateral provided	Reactive/ Responsive	complete
21	12-Jul-11	Amendments on draft article for DEMM Magazine provided to journalist based on interviews with s 9(2)(a) Photos supplied	Scion	12-Jul-11	Article	Reactive/ Responsive	complete
22	TBC	Alison Balance, Environment & Science Producer for 'Our Changing World', Radio New Zealand is looking for stories to do in April. She's identified W2G, and would look to conversational style interviews with 1-3 people. Can you please pass this request onto the group.	Radio New Zealand	Dependent on RNZ's "Our changing world" programme schedule, likely to be October/November 2011	Radio	Future	Completed

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Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
23	28-Jun-11	s 9(2)(a) received call from DEMM (Engineering & Manufacturing Magazine) writer wanting to do a story on the pilot plant. This was facilitated, resulting in 3-page cover feature article in August 2011 issue. Story is also available online at www.demm.co.nz	DEMM Magazine	1-Aug-11	Print magazine and web article	Reactive/ Responsive	Completed
24	1-Sep-11	Pilot plant launch featured promiently in Scion's Annual Report and Highlights 2011	Scion	30-Sep-11	Print	Reactive/ Responsive	Completed
25	Oct	Display of W2G reactor and info sheet in Scion booth at WasteMINZ Conference 4-7 Oct.	Scion	4-7 Oct 2011	Display		Completed
21		Display of W2G reactor and info sheet at Green Chemistry Expo, Tauranga, 28-30 June.	Scion	28-30 June 2011	Display		Completed
22		Display of W2G reactor and info sheet at Clean Energy Expo, Taupo, 14 October.	Scion	14-Oct	Display		Completed
23		Display of W2G (TERAX) reactor and info sheet at FOMA (Federation of Maori Authorities), Tauranga, 10-13 November.	Scion	10-13 Nov 2011	Display		Complete
29	18-Jul-11	s 9(2)(a) received invitation from the Economic Development Association NZ to provide an article (for their annual connecting the regions publication) on the pilot plant development with an angle on the partnership between Scion & RDC	EDA		Print & web	Reactive/ Responsive	Complete
30	1-Nov-11	New page created for TERAX pilot plant on Scion website. Contains links to info published by 3rd parties	Scion	40848	Web	Responsive	Complete
31	1-Nov-11	Two short videos produced: TERAX at pilot scale presented by s 9(2)(a)	Scion	40878	Web	Responsive	Complete
32	1-Nov-11	TERAX is feature story in "Scion Connections" newsletter	Scion	40878	Print & web	Responsive	Complete

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Comm s Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
33	16/11/2011	s 9(2)(a)	SKM	Nov 11	Visit	Responsive	Complete
34	15/11/11	s 9(2)(a)	GM Ngati Whakaue	Nov 11	Visit	Responsive	Complete
	21/11/11	s 9(2)(a)		Nov 11	Visit	Responsive	Complete

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Potential End User - Opportunity Tracker

Topic	Company	Date of call/opportunity
s 9(2)(a) met with Hamilton City Council Biosolids Options meeting group: making decisions on process options which would be of relevance for Hamilton City Council Present: Envt Waikato, Tainui, SKM Consultants representatives, Ham CC representatives plus two other technology providers s 9(2)(a), STERM Ltd) s presented the developments with the RDC work, going to pilot scale, and has requested the opportunity to be added to the list of process options being considered by HCC. This was met with favourable response	Hamilton City Council	4/03/2011
s 9(2)(a) of RDC had an enqiiry from Queenstown Lakes District Council following the Wasteminz conference regarding the potential for W2G. They have no sustainable long term option for biosolids disposal	Queenstown Lakes District Council	25/02/2011
Marianna Tyler - met with s 9(2) from at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	7/03/2011
Successfully through ROI stage of Melbourne Water opportunity and requested to submit a formal proposal. This was undertaken together with our engineering partner AWT Water. Proposal was submitted on 1st of June and a response is expected by the end of July.	Melbourne Water	1/06/2011
s 9(2)(a), a company specialising in organic waste management in the Hawkes Bay made contact to enquire about the project and potential application for his business. Requested updates as available.	BioRich	14/06/2011
s 9(2)(a) is also a Director/Owner (part?) of a start-up company working in the agricultural effluent/dairy farm area .. he has indicated he'd like to talk to us.	Windsor Engineering	13/10/2011
MWH Report - A preliminary list of of potential/alternative Territorial Local Authorities for the application of the TERAX™ has been identified.	Watercare Services LTD Tauranga City Council Thames Coromandel District Council Hamilton City Council Porirua City Council Palmerston North City Council Wellington City Council Selwyn City Council New Plymouth District Council	22/09/2011

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Invoices - External & Internal Charges -Year 2 - Milestone #1

External Invoices

Task	Reference	Date	MFE Category	Debtor/Employee	Narrative	Amount
A09401	9120229	26 Aug 2011	Venue & Equipment	No Customer Recorded	Swanndri bush shirt s to pay upon NZ Safety Ltd Private Bag 92100	$ 88.32
A09401	27092011	29 Jul 2011	Consultants & Contractors	No Customer Recorded	Webnar connection - s 9(2)(a) Information Forecasr Purvis, W Visa A/c	$ 322.96
A09403	503633	30 Sep 2011	Consultants & Contractors	AWT NZ Ltd	W2G techno-economic modelling AWT NZ Ltd	$ 12,471.63
A09401	314215959	05 Oct 2011	Venue & Equipment	No Customer Recorded	Nitrogen bottle G size BOC Gases NZ Ltd P.O.Box 587	$ 31.03
A09401	314217537	06 Oct 2011	Venue & Equipment	No Customer Recorded	G size bottles of zero grade air for BOC Gases NZ Ltd P.O.Box 587	$ 670.84
A09401	00015441	07 Oct 2011	Venue & Equipment	No Customer Recorded	1/4 inch swagelock ss mini valve Finnco Pneumatics Ltd 21 Waters St	$ 268.75
A09401	201141	14 Oct 2011	Other miscellaneous costs	No Customer Recorded	freight 148127770/781-183345341	$ 38.72
A09401	4859607	18 Oct 2011	Venue & Equipment	No Customer Recorded	25 kg bag anhydrous sodium acetate Orica Chemnet	$ 230.00
A09401	4859607=	18 Oct 2011	Venue & Equipment	No Customer Recorded	'adjust PU063983 Sodium acetate Orica Chemnet	$ 44.43
A09401	150911	25 Oct 2011	Travel & Accommodation	No Customer Recorded	Travel expenses Sep PT11508 s 9(2)(a)	$ 75.91
A09402	00060378	26 Oct 2011	Venue & Equipment	No Customer Recorded	15 Greiner centrifuge tubes, and caps. Raylab Ltd PO Box 69132	$ 50.00
A09402	00060378	26 Oct 2011	Venue & Equipment	No Customer Recorded	15 Greiner centrifuge tubes, and caps. Raylab Ltd PO Box 69132	$ 1.75
A09401	00005775	28 Oct 2011	Consultants & Contractors	TN Electrical	Electrical work and equipment for TN Electrical	$ 3,924.36
A09401	000045	08 Jul 2011	Venue & Equipment	No Customer Recorded	8 Air Dry Cylinders returned ex Rotorua Waste Treatment Plant *** Unknown ***	-$ 374.88
A09400	205832	31 Dec 2011	Licence Fees	Rotorua Dist Coun - Other	021 Rotorua Dist Coun - Other Private Bag 30	$ 100,000.00
A09401	000046	30 Jul 2011	Venue & Equipment	No Customer Recorded	6 Air Dry 2 LPG Cylinder returned ex Rotorua waste Treatment Plant BOC Gases N	-$ 480.32
A09401	2623	28 Oct 2011	Consultants & Contractors	Allan Estcourt Ltd	Professional Engineering Services Allan Estcourt Ltd P.O.Box 1988	$ 2,989.50
A09401	2191	31 Oct 2011	Consultants & Contractors	Goodrick Contracting Ltd	Trenching for data cable for Goodrick Contracting Ltd	$ 180.00
A09401	31/10/11	31 Oct 2011	Venue & Equipment	No Customer Recorded	LPG for WETOX plant Elgas New Zealand Limited	$ 116.28
A09401	208772	31 Oct 2011	Consultants & Contractors	Rotorua Dist Coun - Other	analyses as directed Rotorua Dist Coun - Other Private Bag 30	$ 692.00
A09401	IN309949	01 Nov 2011	Other miscellaneous costs	No Customer Recorded	Hepatitis vacc. s 9(2)(a) Lakes Primecare P.O.box 2168	$ 106.10
A09401	I988187	04 Nov 2011	Venue & Equipment	No Customer Recorded	Phos Ver 3 sachets - 10ml, pack 100 Thermo Fisher Scientific NZ Ltd	$ 99.60
A09401	I988187	04 Nov 2011	Venue & Equipment	No Customer Recorded	Phos Ver 3 sachets - 10ml, pack 100 Thermo Fisher Scientific NZ Ltd	$ 9.60
A09401	041111	10 Nov 2011	Venue & Equipment	No Customer Recorded	Field supplies/travel s 9(2)(a)	$ 177.57
A09401	314306388	14 Nov 2011	Venue & Equipment	No Customer Recorded	4 x G size bottles of zero grade air. BOC Gases NZ Ltd P.O.Box 587	$ 670.84
A09401	4520905391	15 Nov 2011	Venue & Equipment	No Customer Recorded	Materials for building pallet for O2 Bunnings Rotorua PO Box 14436	$ 157.66
A09402	00003392	16 Nov 2011	Venue & Equipment	No Customer Recorded	PROD,COL ACCLAIM OA 4X150MM Dionex Pty Ltd (NZ) PO Box 62 613	$ 645.00
A09401	9366131	18 Nov 2011	Venue & Equipment	No Customer Recorded	Health and Safety signage, Custom sign NZ Safety Ltd Private Bag 92100	$ 73.62
A09401	IN311477	22 Nov 2011	Other miscellaneous costs	No Customer Recorded	Hep screening s 9(2)(a) Lakes Primecare P.O.box 2168	$ 82.61
A09401	241245	23 Nov 2011	Venue & Equipment	No Customer Recorded	0.75 kW Exe motor for ferm plant CMG Electric Motors (NZ) Ltd PO Box 7114	$ 480.90
A09401	241245	23 Nov 2011	Other miscellaneous costs	No Customer Recorded	Freight CMG Electric Motors (NZ) Ltd PO Box 7114	$ 16.50
A09400	IN311804	25 Nov 2011	Other miscellaneous costs	No Customer Recorded	Hep vaccination (#3) for s 9(2)(a) Lakes Primecare P.O.box 2168	$ 64.35
A09401	201147	25 Nov 2011	Other miscellaneous costs	No Customer Recorded	Freight Rot- Akl 249535650 Mainfreight Ltd PO Box 14-038	$ 99.50
A09401	IN312100	30 Nov 2011	Other miscellaneous costs	No Customer Recorded	Hepatitis vacc s 9(2)(a) Lakes Primecare P.O.box 2168	$ 103.48
A09401	0891080598	30 Nov 2011	Venue & Equipment	No Customer Recorded	Tools for TERAX and Ferm plant Repco Limited P.O.Box 1144	$ 199.44
A09402	01128639	30 Nov 2011	Venue & Equipment	No Customer Recorded	250 ml FFD6 Hach Pacific NZ	$ 17.00
A09402	01128639	30 Nov 2011	Venue & Equipment	No Customer Recorded	250 ml FFD6 Hach Pacific NZ	$ 1.45
A09403	503703	31 Oct 2011	Consultants & Contractors	AWT NZ Ltd	W2G model -Oct invoice AWT NZ Ltd	$ 7,803.00
A09401	2630	25 Nov 2011	Consultants & Contractors	Allan Estcourt Ltd	Engineering Services -November Allan Estcourt Ltd P.O.Box 1988	$ 3,510.00
A09401	2636	25 Nov 2011	Consultants & Contractors	Allan Estcourt Ltd	Engineering Services -November Allan Estcourt Ltd P.O.Box 1988	$ 972.00
A09401	00006047	30 Nov 2011	Consultants & Contractors	TN Electrical	Electrcial inspection and COC of ferm TN Electrical	$ 1,646.32
A09401	211713	30 Nov 2011	Consultants & Contractors	Rotorua Dist Coun - Other	analyses as directed Rotorua Dist Coun - Other Private Bag 30	$ 601.00
A09403	503828	30 Nov 2011	Consultants & Contractors	AWT NZ Ltd	W2G Model -Nov Invoice AWT NZ Ltd	$ 2,727.44
A09409	7036	30 Nov 2011	Consultants & Contractors	TOP TEN Productions	Piece to camera s 9(2)(a) Waste TOP TEN Productions	$ 195.00
A09400	28618	09 Dec 2011	Consultants & Contractors	Trevor Robson Signs Ltd	Replace existing signage and supply Trevor Robson Signs Ltd PO Box 1668	$ 588.00
A09401	121211	15 Dec 2011	Venue & Equipment	No Customer Recorded	Tie downs s 9(2)(a)	$ 112.00
A09402	BK000282	16 Dec 2011	Other miscellaneous costs	No Customer Recorded	Library Interloans Nov 11	$ 14.80
					Total external invoices	**142516.06**

Internal Invoices

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Task	Reference	Date	MFE Category	Debtor/Employee	Narrative	Amount
A09401	06092011	06 Sep 2011	Travel & Accommodation	No Customer Recorded	Lunches x 4 s 9(2)(a)	$ 60.69
A09401	1AYI1AHC00	16 Oct 2011	Other miscellaneous costs	No Customer Recorded	Catering 10/10 - 16/10 Compass Group NZ Ltd P.O.Box 12080	$ 6.61
A09400	1AY71AVD00	30 Oct 2011	Other miscellaneous costs	No Customer Recorded		
A09400	038601	01 Nov 2011	Travel & Accommodation	No Customer Recorded	s 9(2)(a)	
A09400	038601	01 Nov 2011	Travel & Accommodation	No Customer Recorded		
A09400	038601	01 Nov 2011	Travel & Accommodation	No Customer Recorded		
A09400	038601	01 Nov 2011	Travel & Accommodation	No Customer Recorded		
A09400	038601	01 Nov 2011	Travel & Accommodation	No Customer Recorded		
A09401	038628	03 Nov 2011	Administration	No Customer Recorded	Copy Center Charges A09401	$ 5.32
A09400	1AYKQ1B7D0	06 Nov 2011	Other miscellaneous costs	No Customer Recorded	Catering 31/10 - 6/11 Compass Group NZ Ltd P.O.Box 12080	$ 95.13
A09401	041111	10 Nov 2011	Travel & Accommodation	No Customer Recorded	Field supplies/travel s 9(2)(a)	$ 27.39
A09409	038663	16 Nov 2011	Travel & Accommodation	No Customer Recorded	Xfer travel cost from s 9(2)(a)	$ 1,197.38
A09400	038701	05 Dec 2011	Travel & Accommodation	No Customer Recorded	s 9(2)(a)	
A09400	038701	05 Dec 2011	Travel & Accommodation	No Customer Recorded		
A09400	038701	05 Dec 2011	Travel & Accommodation	No Customer Recorded		
A09400	038705	05 Dec 2011	Administration	No Customer Recorded		
A09401	038701	05 Dec 2011	Travel & Accommodation	No Customer Recorded		
A09401	038701	05 Dec 2011	Travel & Accommodation	No Customer Recorded		
A09401	038701	05 Dec 2011	Travel & Accommodation	No Customer Recorded		
A09401	038701	05 Dec 2011	Travel & Accommodation	No Customer Recorded		
A09401	038705	05 Dec 2011	Administration	No Customer Recorded		
A09400	038768	10 Jan 2012	Travel & Accommodation	No Customer Recorded		
A09401	038768	10 Jan 2012	Travel & Accommodation	No Customer Recorded		
A09401	038773	11 Jan 2012	Administration	No Customer Recorded	Copy Center Charges A09401	$ 151.00
					Total internal invoices	**12640.35**
					Total external and internal invoices combined	**155156.41**

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Hours by Person

s 9(2)(a)

	MS 1 Hours	MS 2 Hours	MS 3 Hours	YTD Hours
	427	472		
		2		
	122	115		
	37	55		
	356	211		
	4	5		
		12		
	4	1		
	341	230		
	309	247		
	2	69		
	270	198		
	331	208		
	10	1		
	57	52		
	24	14		
	1	1		
	211	176		
	7	0		
	136	0		
	261	31		
	25	0		
		6		
	31	0		
	2	0		
	46	4		
Total Hours	**3,014**	**2,110**	**0**	**0**

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Te Papa Tipu Innovation Park
49 Sala Street, Private Bag 3020, Rotorua, New Zealand
Telephone: + 64 7 343 5899 | Facsimile: + 64 7 348 0952
Email enquiries@scionresearch.com | www.scionresearch.com

TAX INVOICE

Ministry For The Environment
P O Box 10-362
WELLINGTON

Customer Number:	00586	***GST Reg No (NZ):***	59-493-760
Customer Reference:		***ABN No (Australia):***	512-1094-8677
Invoice Number:	**048202**	***Invoice Date:***	20/01/2012
Page :	1 of 1	***Due Date:***	20/02/2012

Particulars	Milestone 2 - Year 2 Deliverables as per WMF Waste 2 Gold Deco	***Amount $***
Milestone 2 - Year 2 Deliverables as per WMF Waste 2 Gold Deconstruction Technologies for Organic Waste Utlisation		119,292.20
Attention: Elena Wrelton	***Sub Total:***	119,292.20
	GST:	17,893.83
	Invoice Total:	137,186.03

For any queries relating to this invoice, please contact Alex Chambers
For any payment queries, please contact accounts.receivable@scionresearch.com

s 9(2)(b)(ii)

Min For Environment - Wellington **Amount:** 137,186.03

Card Number: __ __ __ __ - __ __ __ __ - __ __ __ __ - __ __ __ __ **Card Type:** Visa__ Mastercard__

Security Number: __ __ __ (Three digit number located on the back of your card

Cardholders Name: _____ **Expiry Date:** ___/___

Signature: _____ **Amount to Pay:** $_____

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MFE Claim form calculation Spreadsheet - Year 2 - Quarter 2

Sum of Amount	
MFE Category	Total
Administration	226.02
Consultants & Contractors	38623.21
Other miscellaneous costs	894.93
Travel & Accommodation	12121.37
Venue & Equipment	3290.88
Licence Fees	100000
Grand Total	155156.41

Pasted Pivot for calculations

Sum of Amount				
MFE Category	**Total**	**Margin**	**Calc**	**Exp+Marg**
Administration	226	40%	0.6	377
Consultants and Contractors	38,623	10%	0.9	42,915
Licence Fees	100,000	0%	1	100,000
Other miscellaneous costs	895	40%	0.6	1,492
Promotion and Dissemination	0	40%	0.6	0
Travel & Accommodation	12,121	40%	0.6	20,202
Financial, legal and informati	0	40%	0.6	0
Venue & Equipment	3,291	40%	0.6	5,485
Capex	20,388			20,388
Grand Total	**175,545**			**190,858**

MFE Table **Year 2**

Sum of Amount	**Q1**
MFE Category	**Exp+Marg**
Personnel	242,932
Administration	377
Consultants and Contractors	42,915
Venue and Equipment (includ	105,485
Other miscellaneous costs	1,492
Promotion and dissemination	0
Travel & Accommodation	20,202
Financial, legal and informati	0
Capex	20,388
Grand Total	**433,789.82**

Calculations for Scion Investr	**Q1**
MFE %	27.50%
Total = 27.5% of exps total	119292.2
RDC Payment	275,000
Total MFE contribution + RD	394,292
Total Scion Investment	**39,497.62**

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Ministry for the Environment
Manatū Mō Te Taiao

REDUCE • REUSE • RECYCLE • RECOVER

WMF Milestone Report

This is your opportunity to tell us how the delivery phase of your project is progressing.

Milestone reports should be made on those dates agreed in your funding deed (unless otherwise discussed with your Fund Analyst). If there are any problems or issues, or you wish to make major changes to your project, please discuss with your Fund Analyst **before** completing and submitting this report.

Please read the *Waste Minimisation Fund – Grantee Guide* before you complete this report.

Project and report details

Organisation name	Scion
Project title	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation
Contract number	WMF-00000137
Project duration *if a multi-year project select the project duration*	Two years
Current year *if a multi-year project select the current project year*	Year Two
Total number of milestones *select the total number of project milestones for the current year*	Four
Current milestone *select the current milestone for this report*	Three
Due date *agreed report due date as per your funding deed*	31/03/12
Date submitted *actual date the report was submitted*	20 April 2012
Report type *select whether this is an interim report or the final milestone report for the project*	Interim

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Milestone Three details

Enter the name of the milestone, and then list all of the tasks and deliverables (as agreed in your funding deed) for this milestone in the tables below.

Indicate whether each task and deliverable is complete, and provide a summary of progress in the Comment column. If any task or deliverable is not complete, provide an explanation, and list the actions you plan to take in response.

You will also need to attach evidence of your deliverables to this report.

Press TAB on your keyboard to add a new row, if required.

Milestone name	System Optimisation

Tasks *tasks as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Laboratory trials on alternative organic waste streams	Yes	Planned trials on ligno-cellulosic biomass as an alternative organic feedstock have been successfully completed.
Integrated pilot plant trials focussed on process optimisation	Yes	The complete TERAX™ process has been demonstrated at pilot scale and significant optimisation activities undertaken. Despite a number of engineering challenges, the feed concentrations have been able to be increased to the target 6-8%DS level.
Process Engineering model refinement through interpretation of pilot data	Yes	Learning's, arising from both pilot plant operations and increased operational intelligence, have been translated to the process engineering model. In particular, we have significantly improved the options for oxidant and nutrient handling.
Full-scale design and costing initiated	Yes	One of our engineering partners -AWT Water- have begun this element of the project whereby an initial design scope workshop has been completed with the RDC site staff. AWT are also heavily involved in the process modelling work which is a key input to the final design.

Deliverables *deliverables as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Summary report on alternative organic waste trials.	Yes	Please see attached Quarterly Technical Progress Statement
Quarterly technical progress statement describing pilot trial operations, results to date, and associated workplan progress.	Yes	Please see attached Quarterly Technical Progress Statement
Update on process model refinements	Yes	Please see attached Quarterly Technical Progress Statement

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Key performance indicators (KPIs)

For each waste type(s) and target annual tonnage you identified in your project plan, please provide the actual values your project reduced, reused, or recycled/recovered during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual tonnages fall short of targets, then please provide a short statement to explain why in the space beneath (eg, the equipment utilised for this project is not yet operating at its maximum capacity).

Press the TAB key on your keyboard to add more rows to the table, if required.

	Quantity of waste (tonnes)					
Waste type	**Reduce**		**Reuse**		**Recover/Recycle**	
	Target	***Actual***	***Target***	***Actual***	***Target***	***Actual***
Rotorua District Council biosolids					Up to 1 tonne per day (pilot-scale process)	Negligible –Initial trials undertaken
Pulp and paper primary and secondary solids					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start on P&P solids
Rotorua District Council Atiamuri Landfill municipal organic wastes					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible –Yet to start on municipal organics

This project is focused on technology development and scale-up of a proprietary waste deconstruction process that will enable significant diversion of municipal and industrial organic wastes in the future. During the course of pilot-scale plant operations the actual diverted volumes are expected to be minimal – but sufficient to demonstrate the scalability and suitability of the Process for the targeted outcomes.

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Objectives, activities and measures

As part of your project plan, you specified SMART objectives for the project, provided detail about the types of activity(ies) required, and set annual target measurements. Please provide the actual measure your project achieved during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual measures fall short of targets, then please provide a short statement to explain why in the space beneath.

Press the TAB key on your keyboard to add more rows to the table, if required.

Objective	Activity	Measure	
		Target	*Actual*
To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process. Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP. Design, construct, install and commission Pre-fermentation Module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids as per the project schedule.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and have been successfully commissioned on biosolids
To demonstrate viable scale up of the complete waste deconstruction process by 31 December 2011.	Carry out pilot trial runs under a range of process conditions and configurations. Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated. Pilot-scale demonstration of product value as a carbon source for WWTP	The complete pilot scale waste deconstruction process, TERAX™, is now in place and fully operational. Further demonstration is currently underway.
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to at least three alternative organic waste streams.	Preliminary work on a number of alternative organic waste streams has been completed. In particular, the TERAX™ process has been tested on pulp mill solid waste.
To produce a viable commercial scale design basis for application at the Rotorua wastewater treatment	Development of a process engineering and economic model for the full-scale application of the technology.	Process model in place capable of	The process engineering model has

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plant by 30 June 2012.	Produce design specifications and costings for a commercial plant.	capital and operating cost estimates for full-scale plant. A viable commercial scale design is produced.	been further refined and is undergoing 3rd party peer review. Full-scale design & costing initiated.

Additional project benefits

Please list any additional benefits (economic, environmental, social or cultural) from your project not foreseen at planning stage. Provide a measurement, if applicable. For environmental benefits, include any reduction of harm to the environment.

Press the TAB key on your keyboard to add more rows to the table, if required.

Benefit	Measure

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Risk management

List the main risks your delivery phase is facing. These may be technical, financial, organisational, economic, social, management, legal or environmental risks. Tell us what you are doing to reduce each risk.

If you identified risks during the development of your project plan, please explain how you are monitoring and/or managing these risks.

Please add as many risk tables as required.

Risk:

Potential risk *description of potential risk event*	Equipment failures in the new pilot plant modules affect our ability to undertake trials in a timely manner.
Project impact *description of impact*	Delay in integrating the 2 stages of the hybrid process at pilot scale causing programme to run behind schedule and/or limiting the breadth of trial work possible.
Likelihood *low – medium – high*	High
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	The operation of pilot plants inherently involves risks of equipment failure due to the developmental nature of the work, stop start operation, etc. The project team is working closely with contractor and supplier staff to deal with issues as they arise and ensure any downtime is minimised. Specific engineering expertise is also being sought as required.

Risk:

Potential risk *description of potential risk event*	Loss of key staff during final phases of project delivery.
Project impact *description of impact*	Restricted ability to run trials or deliver work.
Likelihood *low – medium – high*	Low
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	Actively manage key resources to ensure adequate knowledge depth and cover for absences in critical programme stages.

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Partnership and other funding sources

Give details of your progress towards securing partnership funds and any contingency plans for any funding shortfalls.
Include all cash contributions and other funding listed in your project budget.
Press the TAB key on your keyboard to add more rows to the table, if required.

Partner / funding source	Amount requested	Amount approved	Amount received	Date balance expected
Rotorua District Council	$275,000	$275,000	$275,000	
Scion Investment	$17,787.62	$17,787.62	$17,787.62	

Procurement

Give details of any major goods, work or services you are currently arranging for your project, or which you have purchased since your last report.
You must also attach copies of any relevant briefs and provide a summary of the procurement process followed.
Press the TAB key on your keyboard to add more rows to the table, if required.

Description	Value	Date awarded	Supplier name

Evaluation

Are you evaluating your project according to your agreed Stage II Project Plan? ☒ Yes ☐ No

Please confirm that you are evaluating your project according to your agreed Stage II project plan: Yes or No? If No, please provide an explanation

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Declaration

- I declare that to the best of my knowledge, the information contained in all sections of this report, or supplied by us in support of our report is complete, true and correct.
- I declare that I have the authority to sign this report and to provide this information.
- I understand that the Information presented to the Minister is subject to disclosure under the Official Information Act, 1982.
- I declare that the fund payment request accompanying this report is complete, true and correct.

s 9(2)(a)

By ty
space provided you are electronically signing this form.

Date 20/4/12

Verification

I verify that the fund payment request accompanying this report is complete, true and correct, and:

- costs making up the amount of this request are part of the eligible costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by donation or credit notes.

s 9(2)(a)

By
space provided you are electronically signing this form.

Date 20/4/12

Bank account details

If this is the first time you are completing this form, or account details have changed, please provide the bank account details into which the payment should be made. Please also attach a pre-printed deposit slip.

Bank name: The National Bank of New Zealand

Branch name: Rotorua

s 9(2)(a)

Bank Branch Account Suffix

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Once complete, please email the *WMF Milestone Report*, *WMF Claim Form* and supporting evidence as listed below to your Fund Analyst.

The Ministry prefers that all required documents are sent electronically, however, where it is not possible to send documents via email, please send a paper copy to:

Waste Minimisation Fund
Ministry for the Environment
PO Box 10362
Wellington 6143

Report checklist

Use the following checklist to confirm you have included all the required information in your report.

- ☐ Complete all sections of this form.
- ☐ Sign the declaration.
- ☐ Complete a *WMF Milestone Claim Form* for this milestone. If this is the first *WMF Milestone Report* for your project, attach a pre-printed deposit slip.
- ☐ If this is the final *WMF Milestone Report* for your project, complete the *WMF Final Project Report*.
- ☒ Attach evidence of milestone deliverables, for example:
  - photographs of project progress
  - monitoring and/or evaluation data
  - record of activities
  - media coverage or other publicity
  - invoices
  - staff recruitment.
- ☐ Attach a tax invoice containing the words 'Tax Invoice', and showing the following details:
  - your organisation's GST number
  - invoice number
  - deed number
  - total claim amount
  - GST component.
- ☐ Attach a list of invoices for this reporting period, in the standard format that you/your company use to record this type of information. Please ensure the following details are included:
  - invoice number
  - invoice date
  - supplier
  - description
  - total (excluding GST).

Please note, you must request your fund payments at the frequency agreed during your Stage II project planning discussions.

The Ministry will not pay more than 90 per cent of the WMF approved amount until we are satisfied that your project is complete.

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WMF Milestone Claim Form

Projects may have up to six milestones, and a separate tab has been created for each in this spreadsheet. This summary page is completed by your Fund Analyst, and the information populates the other tabs in this spreadsheet. Open the tab that corresponds with the current project milestone and complete the relevant sections.

Project name:	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation	**Funding deed no:**	13554
WMF $ approved:	$577,513.00	**WMF% approved:**	27.50%
Grantee name:	Scion		

Name of milestone	Due date	Estimated total cash expenditure *(excl. GST)*	Estimated WMF cash payment *(% est. cost)*	Actual total cash expenditure *(excl. GST)*	Actual payment due	Grantee comments
Milestone 1						
Pilot Plant Integration	24.10.11	$775,000.00	$213,125.00	$843,813.89	$232,048.82	
Milestone 2						
Integrated Trials	31.12.11	$435,000.00	$119,625.00	$433,789.82	$119,292.20	
Milestone 3						
System Optimisation	31.03.12	$425,000.00	$116,875.00	$403,845.00	$111,057.38	
Milestone 4						
Commercial System Design	30.06.11	$465,000.00	$127,875.00	$0.00	$0.00	
Totals *(excl. GST) :*		$2,100,000.00	$577,500.00	$1,681,448.71	$462,398.39	

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Milestone 3

Interim Claim

*This tab is for you to provide details of the cash income received, and the cash expenditure, for this milestone. Complete the **Cash Income (non-WMF)** and **Cash Expenditure** sections below (shaded sections only). When you have done this, the payment due for this milestone automatically calculates. Ensure that your figures are accurate and based on actual cash income received and actual cash spent, and then save your changes. Submit the entire claim form to your Fund Analyst with the milestone report and other required documentation for this milestone.*

Milestone estimates (Ministry use only)

Estimated total expenditure:	$425,000.00
Estimated WMF payment:	$116,875.00

Balance and actuals (Ministry use only)

Initial balance:	$226,171.98
Actual paid to date:	$0.00
Actual total expenditure:	$403,845.00

Cash income (non-WMF)

*As part of your project plan, you estimated the cash income you would receive from other external sources (including partners). **Record all actual** cash income below, that you have received from other funding sources for this milestone only, excluding GST. This may include cash income not previously listed in your project plan. This page contains formulae to calculate the payment due. Do not add rows to this page. If you have multiple income streams, combine these to fit the rows provided.*

Cash income from your organisation:	$17,787.62
[enter the name of the external funding source here]:	$275,000.00
[enter the name of the external funding source here]:	[enter actual amount received]
[enter the name of the external funding source here]:	[enter actual amount received]
Actual total cash income:	**$292,787.62**

Cash expenditure

*As part of your project plan, you estimated the cash expenditure for this milestone. **Record all actual** project costs (cash expenditure) for this milestone in the cost category rows below, excluding GST. You must provide invoices to support your claim. This page contains formulae to calculate the payment due. Do not add rows to this page.*

Personnel:	$221,897.00
Administration:	$281.00
Consultants and contractors:	$34,696.00
Purchase of capital assets and other capital costs:	$25,841.00
Venue and equipment:	$119,254.00
Travel and accommodation:	$754.00
Promotion and dissemination of information:	$83.00
Financial, legal and information technology expenses:	$0.00
Other miscellaneous costs:	$1,039.00
Actual total expenditure:	**$403,845.00**

Payment calculated using the Interim Payment Calculation (Ministry use only)

*The **Payment due** amount is how much the WMF will pay you (excluding GST) after your milestone and its deliverables have been assessed and approved. Your payment due will be the lesser of A, B or C below, as per Section 1 of your funding deed. Contact your Fund Analyst for further information, if required.*

balance brought forward less 10% max WMF amount (A) =	$168,420.68
% of actual total expenditure (B) =	$111,057.38
Actual expenditure minus income (C) =	$111,057.38
Payment due: *(excl. GST)*	$111,057.38
Maximum amount approved:	$577,513.00
Funds remaining after payment made	$115,114.61

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Ministry use only

Milestone assessment

Record the milestone claim assessment below.

Approved/declined for payment:

Name:	
Position:	
Date:	
Signed:	

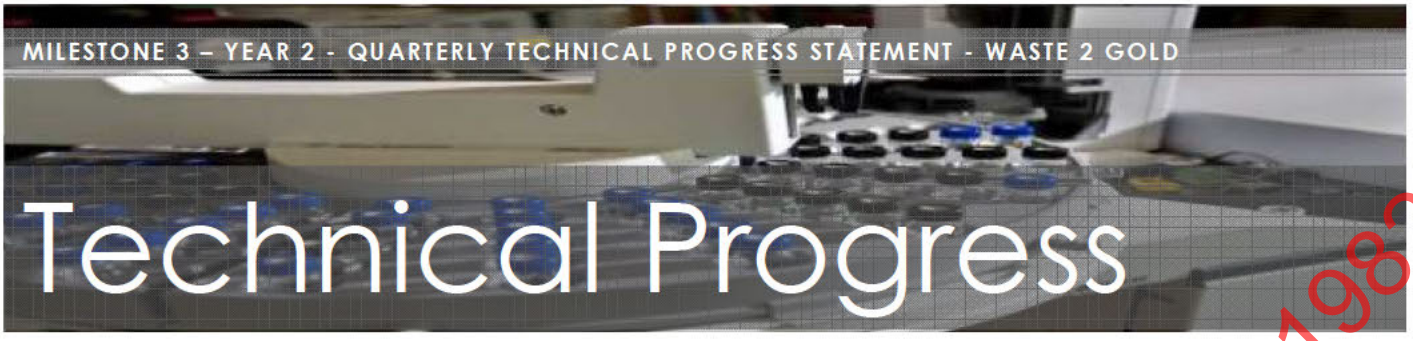
Payment verified:

Name:	
Position:	
Date:	
Signed:	

Payment approved:

Name:	
Position:	
Date:	
Signed:	

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MILESTONE 3 – YEAR 2 - QUARTERLY TECHNICAL PROGRESS STATEMENT - WASTE 2 GOLD

Technical Progress

April 2012

Inside This Update

1 Progress Summary

2 Tasks Update



Full implementation of the TERAX™ process at pilot scale has been achieved

Progress Summary

In this quarter, we have achieved

1. Implementation of the full TERAX™ process, at pilot scale. This is a significant achievement for the project.
2. Assessment of the TERAX™ process on an alternative waste stream. This was a lignocellulosic waste biomass, sourced from a full-scale pulp mill operation.
3. Refinement of the techno-economic model, further enhancing its capability to model the TERAX™ process and economics.
4. Initiated the full-scale design and costing for a TERAX™ plant to treat the Rotorua District municipal biosolids.

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Task One : *Laboratory trials on alternative wastes*

Task 1: Laboratory trials on alternative organic waste streams

We have completed the planned trials on lignocellulosic biomass as an alternative feedstock. Semi-continuous fermentation of the material, sourced as an organic waste derived from a full-scale pulp mill, was conducted. Batch-scale wet oxidation was conducted on fermentation liquor samples.

Key results of the trials were that

- The two-stage TERAX™ process (fermentation followed by wet oxidation) demonstrated high volatile solids removal, at greater than 90%
- Biochemical degradation was more modest than when using domestic biosolids, implicating the presence of more recalcitrant organics, and/or inhibitory compounds in this material
- Small-molecule organic acid (e.g. acetic acid) yields through the wet oxidation were good, similar to those produced by municipal biosolids. Due to the relatively poor fermentation performance, overall TERAX™ process yields were lower than those of municipal biosolids. Ongoing work to improve this response has been undertaken, and will continue as part of another project within Scion.

The work has been completed and a summary report is attached at the end of this Progress Statement.



s 9(2)(a)

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Task Two : *Integrated Trials*

Task Two: Integrated pilot plant trials focussed process optimisation

TERAX™ pilot plant operation has had three focus areas, associated with the different unit operations.

1. Fermentation pilot plant

The plant has been in continuous operation since November 2011. After an initial operational learning curve, operation has been highly successful. Notable results of the work have included:

- Increases in feed biosolids concentration from 2% solids (February), through 3-4% solids (Mar), up to a current operation of 6-7%, which is the target operational level
- a consistent increase in production of soluble organic compounds, across this period (see Figure 1). This provides strong evidence of favourable fermentation performance.
-

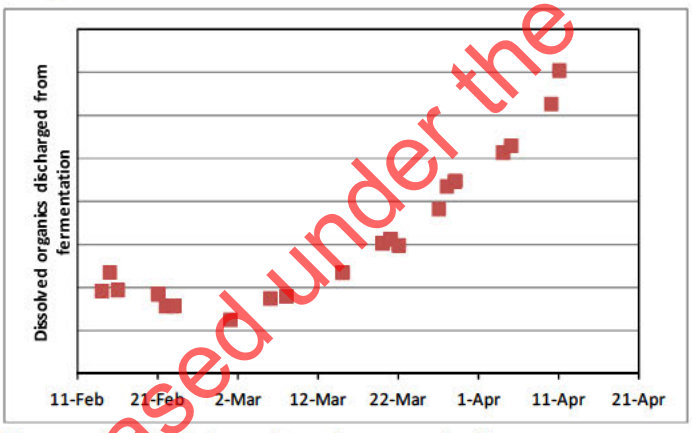


Figure 1: Plot showing fermentation performance for organics production

2. Hydrothermal (wet oxidation) pilot plant

Some significant milestones have been achieved at the wet oxidation plant in this quarter. In particular, we are now processing liquors from the pilot plant fermenter, thus demonstrating the full TERAX™ process at pilot scale.

In doing so, the initial performance of the plant (under batch operation) shows excellent promise. Degradation of VSS and production of soluble organics is comparable with that of the laboratory work. Specific production of acetic acid, and reduction in mass transfer limitations, have been identfied for optimisation and improvement in the coming quarter.

Further advancements include:

- We have moved up to the target of taking fermentation liquors resulting from an initial 6% solids feed
- We have transitioned from air oxidant only, through to processing with pure oxygen
- We are now capable of performing batch (example data shown in Figure 2), semi-batch and continuous processing modes
- Our gas analysis system (the TOGA) has been through initial commissioning, and is proving capable of measuring key gas components (O_2 and CO_2)



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As highlighted in the previous Progress Statement, we have identified a number of challenges associated with operation at the extreme temperatures and pressures of wet oxidation. This challenge has continued throughout the quarter, with a large amount of equipment maintenance being required. Efforts are underway in the final quarter to increase the resiliance of the plant. We highlight this as a positive outcome of the pilot plant operation, as it has identified this aspect of equipment specification and plant design as critical, on scale-up of the technology.

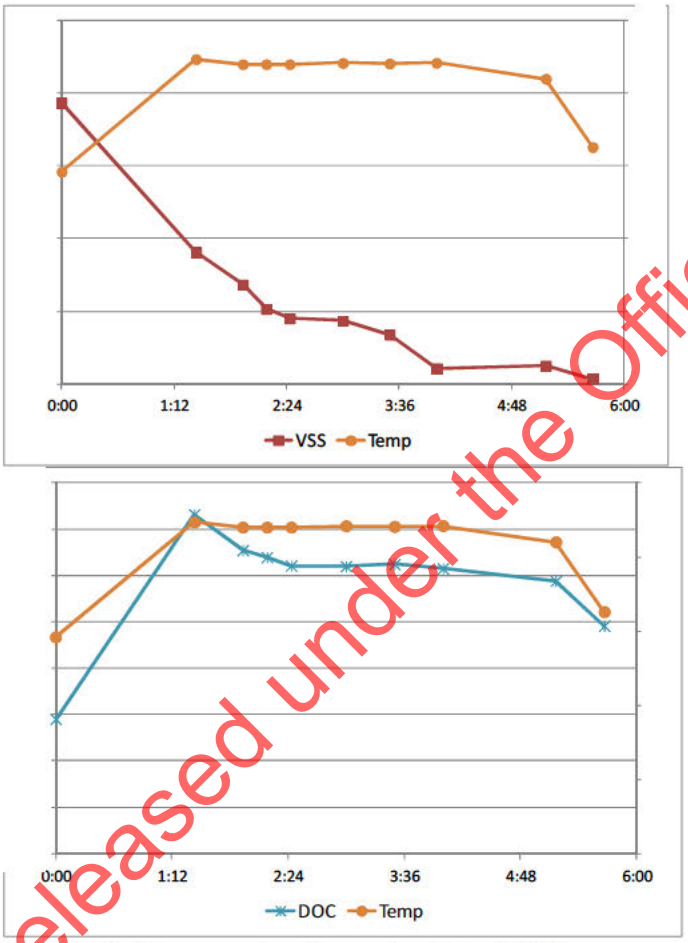


Figure 2: Demonstration of solids (VSS) destruction and organics (DOC) production in a batch wet oxidation experiment

3. Nutrient removal (BNR) plant.

The nutrient removal plant has been set up to demonstrate the impact of addition of TERAX™ liquor within a biological wastewater treatment plant. Our pilot plant has been in operation throughout the entire quarter, and has been used to treat a synthetic TERAX™ liquor, made up of an appropriate mixture of acetic acid, ammonium-nitrogen and phosphate. A worst-case scenario has been tested, this being addition of the TERAX™ liquor without any ammonia removal. Performance of the plant has been monitored, and the results of this experiment will be forthcoming in the final quarter. Final quarter work for this plant will focus on the utilisation of TERAX™ pilot plant liquor. The impact on nitrogen and phosphorus removal performance will be a key indicator of performance.

s 9(2)(a)

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Task Three and Four : *Engineering model refinement and Fullscale design*

Task Three: Process engineering model refinement through interpretation of pilot data

The technoeconomic model has undergone further refinement. The aims of these refinements were to improve the model performance and give ability to model different process scenarios. The model changes have been undertaken by AWT Water Ltd through consultation with Scion. The changes which have been made since January 2012 are as follows:

- Option for purchase or lease of oxidant generation equipment
- Increased options for ammonia removal-ranging from no removal, through to 100% removal.
- Partitioning of phosphate between soluble and solid streams
- Resolution of model errors which occur at low temperature conditions

A scenario analysis for RDC has been conducted using the refined model. No major problems were identified, as a result of including these refinements.

A third party engineering company have been contracted to undertake a validation of the model, anticipated to be completed in early May 2012. This will validate the model calculations, assumptions used and the most important costs used in the model.



Task 4: Full-scale design and costing initiated
One of our engineering partners -AWT Water- have begun this element of the project. An initial design scope workshop has been completed with the RDC site staff. AWT are also heavily involved in the process modelling work which is a key input to the final design.

s 9(2)(a)

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TERAX™ Process for lignocellulosic biomass-Summary report

Lignocellulosic waste biomass from a fullscale pulp mill was subject to the TERAX™ process i.e. anaerobic fermentation followed by wet oxidation.

Method

A mixed residue of biological sludge was utilised as part of this experiment. The biological sludge consisted of waste activated sludge (WAS) and waste process solids. A single bulk stock sample of waste materials was collected and used to make up the initial substrate for the reactor experiments. Sub- samples of the material were frozen for use as fermentation feed material at a later date.

Substrates were fermented in a continuous process with a 6 day solids retention time (SRT), whereby, from a 6L reactor, 2 litres of fermented material was removed and replaced with new feed every 2 days. Samples of unfermented and fermented lignocellulosic material at approximately 3% dry solids, underwent a batch wet oxidation (WO). These materials were analysed for TS, VS, TSS, VSS, COD (soluble), COD (total), NH_3, DRP, DOC and VFA.

Short-form Results and Discussion

Following wet oxidation the %TS destruction was 83% and %VS destruction 91%.

On average, the concentration of total VFA in the unfermented material was 170 mg/l, in the fermented material this rose to 700 mg/l. WO of the unfermented material gave a VFA concentration of 7300 mg/l; whilst WO of fermented material resulted in formation of 3980 mg/l VFA. In the WO fermented sample, over 90% of the VFA-carbon was in the form of acetic acid.

Soluble COD and dissolved organic carbon (DOC) both increased following fermentation and to greater extent after wet oxidation (Figure A). The highest concentrations of CODs and DOC were seen in the wet oxidised fermented sample. The wet oxidised fermented sample had an average concentration of 9900 mg/l CODs and 3600 mg/l DOC.

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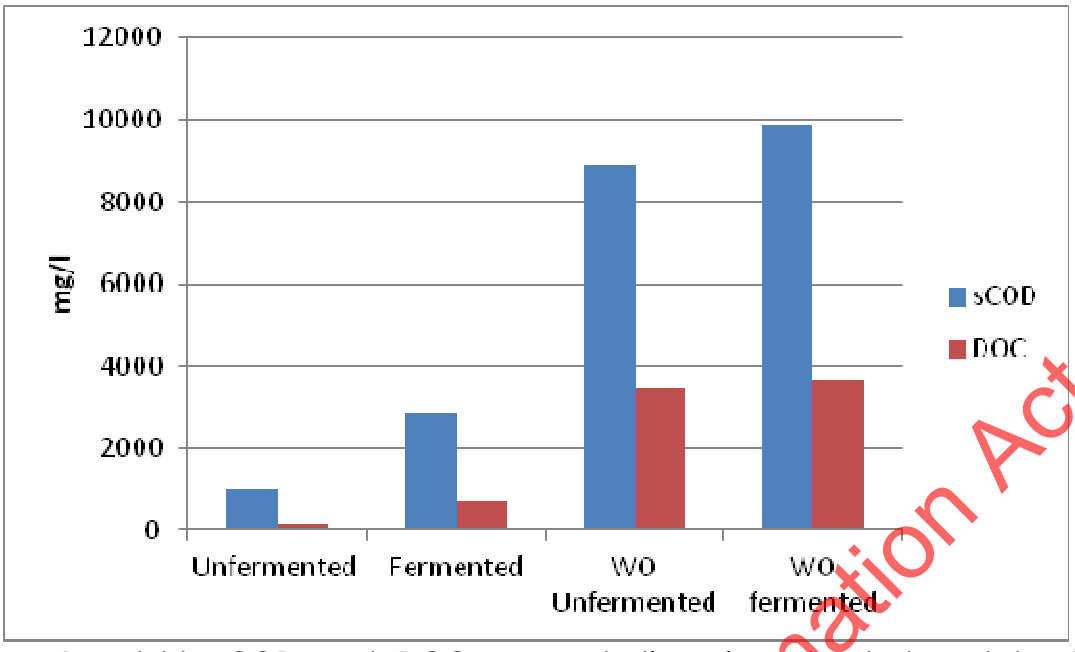


Figure A: soluble COD and DOC concentrations in untreated and treated materials

There was a significant increase in the ammonia concentration following wet oxidation, up to a concentration of 280mg/l in the processed liquor. Through the TERAX™ process there was an increase in DRP concentration from 6 mg/l to 33 mg/l.

These results indicate that the lignocellulosic biomass is amenable to degradation within the TERAX™ Process.

It is possible that components of the lignocellulosic biomass have inhibitory activity towards anaerobic fermentation. Certainly, optimisation of the fermentation step is identified as an important aspect of any ongoing work.

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Communications Report

March 2012

This Communications Report draws on data from a range of communication sources. Scion has an obligation to the Ministry for the Environement (MfE), to provide key communicaiton information on a quarterly basis.

Open Communications

Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
2	7-Mar-11	Marianna Tyler - met with s 9(2)(a) at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	24-Mar-11	Presentation	Future	Pending
5	TBC	Display in Scion booth at PF Olsen Forest Industries 2011 Expo, 5-7 Sept.	Scion	5-7 Sep 2011	Display	Future	to commence

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6	1-May-11	s 9(2)(a) be presenting Waste 2 Gold project to Auckland City Council in May as part of an Environlink workshop by CRIs	Scion	1-May-11	Presentation	Future	to commence
11	21-Jun-11	s 9(2) received e-mail enquiry regarding the W2G project from the project manager of the Australia/New Zealand Biosolids Partnership (ANZBP) requesting further information about the project for their members. The latest project updates were forwarded and the ANZBP will be contacted with updates as appropriate.	Scion	20-Jun-11	Email	Reactive/ Responsive	Ongoing
12	13-Jun-11	s 9(2)(a) received e-mail enquiry regarding the W2G project from s 9(2)(a), owner of BioRich Ltd in Hawkes Bay. Phone conversation around STOP technology, and what it could offer followed this. s interested in a follow-up visit to the pilot plant in Aug/Sept. Exploring potential investments.	Scion	13-Jun-11	Email	Reactive/ Responsive	Ongoing
13	11-Jul-11	s 9(2)(a) received enquiry from RDC to present STOP technology to Ingenium Northern Branch meeting in August, and to host a tour to the pilot plant.	RDC	11-Jul-11	Email	Reactive/ Responsive	
18	19-Jul-11	s 9(2)(a) received a call from writer for NZ Local Government Magazine scoping a story possibility for a bioenergy feature (from downstream processing)	NZ Local Government Magazine			Reactive/ Responsive	Pending
35	20-Feb-12	s 9(2)(a) received a call from the researcher for Global Radar, makers of the popular TV show Te Radar. Information on the W2G / TERAX™ pilot plant was provided. If the topic meets the show's criteria the technology may be featured in the 2013 series of Te Radar.	Global Radar	20-Feb-12	TV show	Future	Pending

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Comms Ref #	Date com prepared	Communication Description	Communicating Company	Communication release date	Type of Comms	Future, Reactive/ Responsive	Comm Status
1	14-Oct-10	Questions from Biodiesel & Biorefining Magazine, BBI International	Scion	Answers supplied			Complete
3	18-Nov-10	Request for photos for use in Secondary School textbook on sustainability published by Nelson Cengage Learning NZ	Scion	Photos & captions supplied			Complete
4	12-Mar-11	Science in the Park - Scion held its third biennial Science in the Park held at Scion‟s Rotorua campus. The main aim of Science in the Park is to create a greater awareness within the local community of what Scion does. Waste 2 Gold was a significant component of the day. 2800 visitors participated in the day - this has also let to two future display requests for the Water Conference in Rotorua (RDC) and a biowastes day in Tauranga in April.	Scion and RDC	W2G Display Pavillion			Complete
7	31-May-11	Official pilot plant opening at Wastewater Treatment Plant Rotorua. Speakers were Minister Smith, Mayor Winters, s 9(2)(a) [redacted] Invited guests included local MPs, councillors, and key people involved with the project.	Scion and RDC	Invitations sent by RDC, event management by Scion			Complete
8	4-Jul-11	Meeting with MPs Steve Chadwick and Charles Chauvel to discuss W2G technologies	Scion	Scion arranged meeting following request from Steve Chadwick's office			Complete
9	During May 2011	Media material for official opening of pilot plant & updated info on Scion (& RDC) websites. New/updated info sheet.	Scion & RDC	31-May-11	Media	Future	complete
10	1-May-11	Media advisory (media invitation to		24-May-11	Media	Future	complete

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		opening)					
14	1-Jun-11	Waste 2 Gold will be part of a Green Chemistry expo in Tauranga that will highlight our activities to BOP schools and community	Scion	27-30 June 2011	Manned Display	Future	Complete
15	1-May-11	SCION/RDC – waste2Gold team to present at the EDANZ (Economic Development) Conference?	Scion/RDC	29th - 30th June 2011	Presentation	Future	complete
16	5/04/2011	Briefed Waikato/BOP Regional Biosolids summit on Waste 2 Gold project, technology, objectives, and status. This forum was setup to try and facilitate regional approaches to biosolids management where smaller individual producers struggle to resource sustainable solutions for disposal.	Scion & RDC	5-Apr-11	Presentation	Reactive/ Responsive	complete
17	16-Jun-11	Presented to joint APPITA/IChemE technical meeting on the waste 2 Gold project, it's development and progress to date.	Scion	16-Jun-11	Presentation	Reactive/ Responsive	complete
19	8-Jul-11	s 9(2)(a) discussed STOP technology with s 9(2)(a) of Hawkes Bay. Interest around solid waste disposal	Scion	8-Jul-11	Other	Reactive/ Responsive	Complete
20	6-Jul-11	STOP technology overview sent to s 9(2)(a) of AWT Ltd, to provide to WaterCare Services Ltd of Auckland.	Scion	6-Jul-11	Collateral provided	Reactive/ Responsive	complete
21	12-Jul-11	Amendments on draft article for DEMM Magazine provided to journalist based on interviews with s 9 Photos supplied	Scion	12-Jul-11	Article	Reactive/ Responsive	complete

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22	TBC	Alison Balance, Environment & Science Producer for 'Our Changing World', Radio New Zealand is looking for stories to do in April. She's identified W2G, and would look to conversational style interviews with 1-3 people. Can you please pass this request onto the group.	Radio New Zealand	Dependent on RNZ's "Our changing world" programme schedule, likely to be October/November 2011	Radio	Future	Completed
23	28-Jun-11	s 9(2)(a) received call from DEMM (Engineering & Manufacturing Magazine) writer wanting to do a story on the pilot plant. This was facilitated, resulting in 3-page cover feature article in August 2011 issue. Story is also available online at www.demm.co.nz	DEMM Magazine	1-Aug-11	Print magazine and web article	Reactive/ Responsive	Completed
24	1-Sep-11	Pilot plant launch featured promiently in Scion's Annual Report and Highlights 2011	Scion	30-Sep-11	Print	Reactive/ Responsive	Completed
25	Oct	Display of W2G reactor and info sheet in Scion booth at WasteMINZ Conference 4-7 Oct.	Scion	4-7 Oct 2011	Display		Completed
21		Display of W2G reactor and info sheet at Green Chemistry Expo, Tauranga, 28-30 June.	Scion	28-30 June 2011	Display		Completed
22		Display of W2G reactor and info sheet at Clean Energy Expo, Taupo, 14 October.	Scion	14-Oct	Display		Completed
23		Display of W2G (TERAX) reactor and info sheet at FOMA (Federation of Maori Authorities), Tauranga, 10-13 November.	Scion	10-13 Nov 2011	Display		Complete
29	18-Jul-11	s 9(2)(a) received invitation from the Economic Development Association NZ to provide an article (for their annual connecting the regions publication) on the pilot plant development with an angle on the partnership between Scion & RDC	EDA		Print & web	Reactive/ Responsive	Complete
30	1-Nov-11	New page created for TERAX pilot plant on Scion website. Contains links to info published by 3rd parties	Scion	Nov-11	Web	Responsive	Complete

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31	1-Nov-11	Two short videos produced: TERAX at pilot scale presented by s 9(2)(a) Nutrient recovery from Terax presented by s 9(2)(a)	Scion	Dec-11	Web	Responsive	Complete
32	1-Nov-11	TERAX is feature story in "Scion Connections" newsletter	Scion	Dec-11	Print & web	Responsive	Complete
33	16-Nov-11	s 9(2)(a)	SKM	Nov-11	Visit	Responsive	Complete
34	15-Nov-11	s 9(2)(a)	GM Ngati Whakaue	Nov-11	Visit	Responsive	Complete
35	21-Nov-11	s 9(2)(a) .		Nov-11	Visit	Responsive	Complete

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Potential End User - Opportunity Tracker

Topic	Company	Date of call/opportunity
s 9(2)(a) met with Hamilton City Council Biosolids Options meeting group: making decisions on process options which would be of relevance for Hamilton City Council Present: Envt Waikato, Tainui, SKM Consultants representatives, Ham CC representatives plus two other technology providers s 9(2)(a), STERM Ltd) s 9(2) presented the developments with the RDC work, going to pilot scale, and has requested the opportunity to be added to the list of process options being considered by HCC. This was met with favourable response	Hamilton City Council	4/03/2011
s 9(2)(a) of RDC had an enqiiry from Queenstown Lakes District Council following the Wasteminz conference regarding the potential for W2G. They have no sustainable long term option for biosolids disposal	Queenstown Lakes District Council	25/02/2011
Marianna Tyler - met with s 9(2)(a) at a biosolids meeting run by HCC/SKM last week in Hamilton and Marianna Tyler briefly mentioned the opportunity for someone from Scion to present the Waste to Gold project at the next waste liaison group meeting. She thought it would be great to highlight some of the waste projects happening in RDC while they are over Scion's way and it seemed like the obvious one.	Environment Waikato	7/03/2011
Successfully through ROI stage of Melbourne Water opportunity and requested to submit a formal proposal. This was undertaken together with our engineering partner AWT Water. Proposal was submitted on 1st of June and a response is expected by the end of July.	Melbourne Water	1/06/2011
s 9(2)(a) a company specialising in organic waste management in the Hawkes Bay made contact to enquire about the project and potential application for his business. Requested updates as available.	BioRich	14/06/2011
s 9(2)(a) is also a Director/Owner (part?) of a start-up company working in the agricultural effluent/dairy farm area .. he has indicated he'd like to talk to us.	Windsor Engineering	13/10/2011
MWH Report - A preliminary list of of potential/alternative Territorial Local Authorities for the application of the TERAX™ has been identified.	Watercare Services LTD Tauranga City Council Thames Coromandel District Council Hamilton City Council Porirua City Council Palmerston North City Council Wellington City Council Selwyn City Council New Plymouth District Council	22/09/2011
s 9(2)(of Buller District Council met with Scion and visited the pilot plants. s has expressed an interest in the technology and wishes to be kept up-to-date on its progress.	Buller District Council	7/11/2011
Portugal company interested in TERAX™ and want to discuss	s 9(2)(a)	18/04/2012
Porirua Disctrict Council interested in understanding more on TERAX™	s 9(2)(a)	12/04/2012

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SCION

External Invoices

Task	Reference	Date	MFE Category	Debtor/Employee	Narrative	Amount
A09400	818	25 Jan 2012	Promotion & Dissemination of information	No Customer Recorded	Domain name renewal - waste2gold.com PU065332 Hodgeman Web & Design 58 A Aquarius Driv	$ 50.00
A09400	213768	22 Dec 2011	Licence Fees	Rotorua Dist Coun - Other	Licese fee Waste 2 Golf thermal oxidatio Rotorua Dist Coun - Other Private Bag 30	$ 100,000.00
A09401	000144457	12 Dec 2011	Consultants & Contractors	Unknown Supplier	D/CREDIT SUNDRY CREDIT (SU999) PU064933 Extra gaskets and work on O2 lines	$ 1,124.88
A09401	00014359	12 Dec 2011	Consultants & Contractors	Unknown Supplier	D/CREDIT SUNDRY CREDIT (SU999) 1 ONLY O2 line cleaning for terax	$ 3,973.98
A09401	1123	25 Jan 2012	Consultants & Contractors	Unknown Supplier	D/CREDIT SUNDRY CREDIT (SU999) PU065409 Blanking flanges and bolts P4 W2G	$ 323.52
A09401	1256	01 Mar 2012	Consultants & Contractors	Unknown Supplier	Advance Steel Engineering Ltd Purchase and install piped connection Purchase and install piped connection	$ 5,327.48
A09401	1295	01 Mar 2012	Consultants & Contractors	Unknown Supplier	Advance Steel Engineering Ltd Rebuild Shear mixer rotor and stator Rebuild Shear mixer rotor and stator	$ 795.00
A09401	00006165	21 Dec 2011	Consultants & Contractors	TN Electrical	Supply 3 phase motor for Pump 3, TN Electrical	$ 1,172.00
A09401	00006271	12 Jan 2012	Consultants & Contractors	TN Electrical	Disconnect and reconect Pump 3 Wetox TN Electrical	$ 160.00
A09401	00006685	08 Mar 2012	Consultants & Contractors	TN Electrical	Installation and cert for 240 volt TN Electrical	$ 663.20
A09401	00006698	13 Mar 2012	Consultants & Contractors	TN Electrical	Disconnection and reconnection of pumps TN Electrical	$ 270.00
A09401	020112	07 Feb 2012	Travel & Accommodation	No Customer Recorded	Mileage to check Pilot Plant McDonald B (Ben)	$ 132.30
A09401	217204	31 Jan 2012	Venue & Equipment	No Customer Recorded	Laboratory Charges for Samples PU065513 Rotorua Dist Coun - Other Private Bag 30	$ 487.00
A09401	220043	29 Feb 2012	Venue & Equipment	No Customer Recorded	Laboratory charges for samples Rotorua Dist Coun - Other Private Bag 30	$ 940.00
A09401	24022012	24 Feb 2012	Venue & Equipment	Scion Petty Cash	Petty Cash to 24.2.2012 s 9(2) Pipe Fittings Scion Petty Cash	$ 8.70
A09401	5901938	04 Jan 2012	Venue & Equipment	No Customer Recorded	20 kg sodium acetate anhydrous food Orica Chemnet	$ 250.00
A09401	5901938	04 Jan 2012	Venue & Equipment	No Customer Recorded	20 kg sodium acetate anhydrous food Orica Chemnet	$ 11.76
A09401	4944643	20 Mar 2012	Venue & Equipment	No Customer Recorded	20 kg bag sodium acetate food grade Orica Chemnet	$ 200.00
A09401	4944643	20 Mar 2012	Venue & Equipment	No Customer Recorded	20 kg bag sodium acetate food grade Orica Chemnet	$ 30.91
A09401	080212	20 Feb 2012	Venue & Equipment	No Customer Recorded	Cable ties/gloves etc Estcourt G (George)	$ 58.79
A09401	100112	18 Jan 2012	Venue & Equipment	No Customer Recorded	Mini vac/screws etc Estcourt G (George)	$ 90.97
A09401	314399751	23 Dec 2011	Venue & Equipment	No Customer Recorded	G size zero grade Nitrogen bottle BOC Gases NZ Ltd P.O.Box 587	$ 124.12
A09401	089018883	23 Jan 2012	Venue & Equipment	No Customer Recorded	Pry bar and battery Repco Limited P.O.Box 1144	$ 35.49
A09401	089018902	24 Jan 2012	Venue & Equipment	No Customer Recorded	Pipe wrench Repco Limited P.O.Box 1144	$ 80.00
A09401	314461486	24 Jan 2012	Venue & Equipment	No Customer Recorded	4 x G size bottles of zero grade air. pu065104 BOC Gases NZ Ltd P.O.Box 587	$ 167.71
A09401	314456041	19 Jan 2012	Venue & Equipment	No Customer Recorded	4 x G size bottles of zero grade air. pu065104 BOC Gases NZ Ltd P.O.Box 587	$ 1,173.97
A09401	1070735	02 Feb 2012	Venue & Equipment	No Customer Recorded	4 x G sizes xero grade air PU065292 BOC Gases NZ Ltd P.O.Box 587	$ 838.55
A09401	314511103	07 Feb 2012	Venue & Equipment	No Customer Recorded	GS15 man pack of oxygen PU065293 BOC Gases NZ Ltd P.O.Box 587	$ 1,970.50
A09401	314516834	09 Feb 2012	Venue & Equipment	No Customer Recorded	Air Zero Grade part PU065292 closed in error BOC Gases NZ Ltd P.O.Box 587	$ 503.13
A09401	314529692	17 Feb 2012	Venue & Equipment	No Customer Recorded	Dilution gas mixture MB 84997 D size BOC Gases NZ Ltd P.O.Box 587	$ 314.21
A09401	314529692	17 Feb 2012	Venue & Equipment	No Customer Recorded	Calibration gas mixture MA 84995 D BOC Gases NZ Ltd P.O.Box 587	$ 691.83
A09401	314529692	17 Feb 2012	Venue & Equipment	No Customer Recorded	Calibration gas mixture MA 84995 D BOC Gases NZ Ltd P.O.Box 587	$ 12.04
A09401	314382498	13 Dec 2011	Venue & Equipment	No Customer Recorded	G size zero grade Nitrogen BOC Gases NZ Ltd P.O.Box 587	$ 257.69
A09401	557122444	29 Feb 2012	Venue & Equipment	No Customer Recorded	5m USB extension DSE (NZ) Ltd Private Bag 102 903	$ 31.97
A09401	557122444	29 Feb 2012	Venue & Equipment	No Customer Recorded	Serial to USB converter DSE (NZ) Ltd Private Bag 102 903	$ 20.00
A09401	370380/01	05 Mar 2012	Venue & Equipment	No Customer Recorded	10ml Pipette tips Medica Limited P.O.Box 303 205	$ 69.35
A09401	370380/01	05 Mar 2012	Venue & Equipment	No Customer Recorded	10ml Pipette tips Medica Limited P.O.Box 303 205	$ 7.50
A09401	31458775(	07 Mar 2012	Venue & Equipment	No Customer Recorded	G size Zero Grade air bottles BOC Gases NZ Ltd P.O.Box 587	$ 172.33
A09401	31458775(	07 Mar 2012	Venue & Equipment	No Customer Recorded	G size Zero Grade air bottles BOC Gases NZ Ltd P.O.Box 587	$ 6.02
A09401	314586054	06 Mar 2012	Venue & Equipment	No Customer Recorded	G size Zero Grade air bottles BOC Gases NZ Ltd P.O.Box 587	$ 1,206.31
A09401	314586054	06 Mar 2012	Venue & Equipment	No Customer Recorded	G size Zero Grade air bottles BOC Gases NZ Ltd P.O.Box 587	$ 42.14
A09401	29022012	29 Feb 2012	Venue & Equipment	No Customer Recorded	LPG fills for WETOX plant Elgas New Zealand Limited	$ 492.83
A09401	9494391	13 Jan 2012	Venue & Equipment	No Customer Recorded	Signage 187135s, 188611s, 186821s, NZ Safety Ltd Private Bag 92100	$ 31.28
A09401	9494207	13 Jan 2012	Venue & Equipment	No Customer Recorded	Work boots s 9(2)(a) NZ Safety Ltd Private Bag 92100	$ 135.47
A09401	9494207	13 Jan 2012	Venue & Equipment	No Customer Recorded	Work boots s 9(2)(a) NZ Safety Ltd Private Bag 92100	$ 0.27
A09401	9527466	25 Jan 2012	Venue & Equipment	No Customer Recorded	Size 10 Fireshield overalls pu065187 NZ Safety Ltd Private Bag 92100	$ 200.55
A09401	9527466	25 Jan 2012	Venue & Equipment	No Customer Recorded	Work boots size 10 pu065187 NZ Safety Ltd Private Bag 92100	$ 145.82
A09401	9683441	15 Mar 2012	Venue & Equipment	No Customer Recorded	Firesheild Overalls for Gavin Durbin NZ Safety Ltd Private Bag 92100	$ 122.80
A09401	9730491	29 Mar 2012	Venue & Equipment	No Customer Recorded	Pair of safety gumboots NZ Safety Ltd Private Bag 92100	$ 148.52
A09401	7703	31 Dec 2011	Consultants & Contractors	No Customer Recorded	Minor Mechanical Work for December 2011 Geyserland Heating Ltd PO Box 10111	$ 466.20
A09401	233327	24 Jan 2012	Consultants & Contractors	No Customer Recorded	Small Plastic jobs for period29/11/11 Jurgen Fiedler Plastics P O Box 6071	$ 263.00
A09401	2642	16 Dec 2011	Consultants & Contractors	Allan Estcourt Ltd	Eng Services at W2G Pilot Plant pu065355 Allan Estcourt Ltd P.O.Box 1988	$ 975.00
A09401	2641	16 Dec 2011	Consultants & Contractors	Allan Estcourt Ltd	W2G Pump 3 Design pu065355 Allan Estcourt Ltd P.O.Box 1988	$ 1,500.00

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Task	Reference	Date	MFE Category	Debtor/Employee	Narrative	Amount
A09401	214989	31 Dec 2011	Consultants & Contractors	Rotorua Dist Coun - Othe	laboratory analyses as directed Rotorua Dist Coun - Other Private Bag 30	$ 372.00
A09401	2658	24 Feb 2012	Consultants & Contractors	Allan Estcourt Ltd	Engineering Services for Pilot Plant Allan Estcourt Ltd P.O.Box 1988	$ 240.00
A09401	206148040	16 Dec 2011	Other miscellaneous costs	No Customer Recorded	High Pressure Equip freight Mainfreight Ltd PO Box 14-038	$ 106.49
A09401	148127825	27 Jan 2012	Other miscellaneous costs	No Customer Recorded	Freight of Pump & Valve Mainfreight Ltd PO Box 14-038	$ 40.74
A09401	201207	17 Feb 2012	Other miscellaneous costs	No Customer Recorded	Freight !48128260 Mainfreight Ltd PO Box 14-038	$ 41.23
A09401	7728	29 Feb 2012	Consultants & Contractors	No Customer Recorded	Minor mechanical work for February 2012 Geyserland Heating Ltd PO Box 10111	$ 54.00
A09401	47614	24 Feb 2012	Consultants & Contractors	Unknown Supplier	Repair MP04 Maag pump WETOX plant Pump & Valve Specialties Ltd	$ 1,756.80
A09401	637896	08 Feb 2012	Venue & Equipment	Fluid System Technologie	S/S Swagelok Fitting, 1/4 NPT male/ PU065434 Fluid System Technologies Nz Ltd (Former	$ 15.70
A09401	637896	08 Feb 2012	Other miscellaneous costs	Fluid System Technologie	courier PU065434 Fluid System Technologies Nz Ltd (Former	$ 4.00
A09402	28267:1	14 Dec 2011	Venue & Equipment	No Customer Recorded	Calibration of 60 Gilson pipettes John Morris Scientific Ltd PO Box 6348	$ 286.29
A09402	I1000880	23 Jan 2012	Venue & Equipment	No Customer Recorded	15ml centrifuge tubes, graduated, Thermo Fisher Scientific NZ Ltd	$ 101.68
A09402	SIN025090	08 Feb 2012	Venue & Equipment	No Customer Recorded	Supor 450 filters PU065006 Alphatech Systems PO Box 62 613	$ 68.31
A09402	215985	23 Jan 2012	Consultants & Contractors	Rotorua Dist Coun - Othe	Lab Services PU065349 Rotorua Dist Coun - Other Private Bag 30	$ 212.00
A09402	214990	11 Jan 2012	Consultants & Contractors	Rotorua Dist Coun - Othe	Lab Services PU065349 Rotorua Dist Coun - Other Private Bag 30	$ 256.00
A09402	214991	11 Jan 2012	Consultants & Contractors	Rotorua Dist Coun - Othe	Lab Services PU065349 Rotorua Dist Coun - Other Private Bag 30	$ 256.00
A09402	215988	23 Jan 2012	Consultants & Contractors	Rotorua Dist Coun - Othe	Lab Services PU065349 Rotorua Dist Coun - Other Private Bag 30	$ 276.00
A09402	215987	23 Jan 2012	Consultants & Contractors	Rotorua Dist Coun - Othe	Lab Services PU065349 Rotorua Dist Coun - Other Private Bag 30	$ 160.00
A09402	215986	23 Jan 2012	Consultants & Contractors	Rotorua Dist Coun - Othe	Lab Services PU065349 Rotorua Dist Coun - Other Private Bag 30	$ 160.00
A09402	952510	18 Nov 2011	Consultants & Contractors	R J Hill Laboratories Ltd	Effluent analysis - Volatile Fatty PU065526 R J Hill Laboratories Ltd Private Bag 32	$ 266.00
A09403	503931	22 Dec 2011	Consultants & Contractors	AWT NZ Ltd	W2G process Model -December Invoice pu065354 AWT NZ Ltd	$ 5,051.13
A09403	504169	29 Feb 2012	Consultants & Contractors	AWT NZ Ltd	Costs for Waste-2-Gold AWT NZ Ltd	$ 5,152.00
					Total External Invoices	**$ 143,153.46**

Internal Invoices

Task	Reference	Date	MFE Category	Debtor/Employee	Narrative	Amount
A09400	1AYK1CKE	20 Dec 2011	Other miscellaneous costs	No Customer Recorded	Catering to 20/12 Compass Group NZ Ltd P.O.Box 12080	$ 272.17
A09400	1AY322RD	26 Feb 2012	Other miscellaneous costs	No Customer Recorded	Catering22/2 - 24/2 Compass Group NZ Ltd P.O.Box 12080	$ 11.74
A09400	038869	01 Feb 2012	Travel & Accommodation	No Customer Recorded	s 9(2)(a)	
A09400	039080	02 Mar 2012	Travel & Accommodation	No Customer Recorded		
A09400	039365	04 Apr 2012	Administration	No Customer Recorded	Copy Center Charges A09400	$ 1.50
A09401	IN318114	07 Feb 2012	Other miscellaneous costs	No Customer Recorded	s 9(2)(a)	
A09401	IN320775	13 Mar 2012	Other miscellaneous costs	No Customer Recorded		
A09401	038869	01 Feb 2012	Travel & Accommodation	No Customer Recorded		
A09401	038869	01 Feb 2012	Travel & Accommodation	No Customer Recorded		
A09401	039080	02 Mar 2012	Travel & Accommodation	No Customer Recorded		
A09401	039080	02 Mar 2012	Travel & Accommodation	No Customer Recorded		
A09401	039282	02 Apr 2012	Travel & Accommodation	No Customer Recorded		
A09401	039006	07 Feb 2012	Administration	No Customer Recorded	Copy Center Charges A09401	$ 27.12
A09401	039207	05 Mar 2012	Administration	No Customer Recorded	Copy Center Charges A09401	$ 140.25
					Total Internal Invoices	**$ 919.74**
					Total Internal and External Invoices Combined	**$ 144,073.20**

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MFE Claim form - People Hours breakdown

Hours by Person

s 9(2)(a)

	MS 1 Hours	MS 2 Hours	MS 3 Hours	YTD Hours
	427	472	390	
		2	1	
	0	0	38	
	122	115	213	
	37	55	52	
	356	211	334	
	4	5	0	
		12	29	
	4	1	7	
	341	230	348	
	309	247	188	
	2	69	6	
	270	198	131	
	331	208	31	
	10	1	1	
	0	0	4	
	57	52	48	
	24	14	4	
	1	1	1	
	211	176	3	
	7	0	0	
	136	0	0	
	261	31	319	
	25	25	2	
		6	0	
	31	0	2	
	2	0	5	
	46	4	1	
Total Hours	**3,014**	**2,135**	**2,158**	**0**

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Te Papa Tipu Innovation Park
49 Sala Street, Private Bag 3020, Rotorua, New Zealand
Telephone: + 64 7 343 5899 | Facsimile: + 64 7 348 0952
Email enquiries@scionresearch.com | www.scionresearch.com

TAX INVOICE

Ministry For The Environment
P O Box 10-362
WELLINGTON

Customer Number:	00586	***GST Reg No (NZ):***	59-493-760
Customer Reference:		***ABN No (Australia):***	512-1094-8677
Invoice Number:	**048893**	***Invoice Date:***	20/04/2012
Page :	1 of 1	***Due Date:***	20/05/2012

Particulars	Milestone 3 - Year 2 Deliverables as per WMF Waste 2 Gold Deco	***Amount $***
Milestone 3 - Year 2 Deliverables as per WMF Waste 2 Gold Deconstruction Technologies for Organic Waste Utlisation		111,057.38
Attention: Elena Wrelton	***Sub Total:***	111,057.38
	GST:	16,658.61
	Invoice Total:	127,715.99

For any queries relating to this invoice, please contact Michael Falconer
For any payment queries, please contact accounts.receivable@scionresearch.com

s 9(2)(b)(ii)

Min For Environment - Wellington **Amount:** 127,715.99

Card Number: __ __ __ __ - __ __ __ __ - __ __ __ __ - __ __ __ __ **Card Type:** Visa__ Mastercard__

Security Number: __ __ __ (Three digit number located on the back of your card

Cardholders Name: _____ **Expiry Date:** ___/___

Signature: _____ **Amount to Pay:** $_____

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MFE Claim form calculation Spreadsheet - Year 2 - Quarter 2

Sum of Amount	
MFE Category	Total
Administration	168.87
Consultants & Contractors	31,226.19
Licence Fees	100,000.00
Other miscellaneous costs	623.33
Promotion & Dissemination of information	50.00
Travel & Accommodation	452.30
Venue & Equipment	11,552.51
Grand Total	**144,073.20**

Pasted Pivot for calculations

Sum of Amount				
MFE Category	**Total**	**Margin**	**Calc**	**Exp+Marg**
Administration	169	40%	0.6	281
Consultants and Contractors	31,226	10%	0.9	34,696
Licence Fees	100,000	0%	1	100,000
Other miscellaneous costs	623	40%	0.6	1,039
Promotion and Dissemination of Information	50	40%	0.6	83
Travel & Accommodation	452	40%	0.6	754
Financial, legal and information technology expenses	0	40%	0.6	0
Venue & Equipment	11,553	40%	0.6	19,254
Capex	25,841			25,841
Grand Total	**169,914**			**181,949**

MFE Table	**Year 2**
Sum of Amount	**Q1**
MFE Category	**Exp+Marg**
Personnel	221,897
Administration	281
Consultants and Contractors	34,696
Venue and Equipment (includes licence fees	119,254
Other miscellaneous costs	1,039
Promotion and dissemination of information	83
Travel & Accommodation	754
Financial, legal and information technology e	0
Capex	25,841
Grand Total	**403,845.23**

Calculations for Scion Investment	**Q1**
MFE %	27.50%
Total = 27.5% of exps total	111057.44
RDC Payment	275,000
Total MFE contribution + RDC	386,057
Total Scion Investment	**17,787.79**

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Ministry for the Environment
Manatū Mō Te Taiao

REDUCE • REUSE • RECYCLE • RECOVER

WMF Milestone Report

This is your opportunity to tell us how the delivery phase of your project is progressing.

Milestone reports should be made on those dates agreed in your funding deed (unless otherwise discussed with your Fund Analyst). If there are any problems or issues, or you wish to make major changes to your project, please discuss with your Fund Analyst **before** completing and submitting this report.

Please read the *Waste Minimisation Fund – Grantee Guide* before you complete this report.

Project and report details

Organisation name	Scion
Project title	Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation
Contract number	WMF-00000137
Project duration *if a multi-year project select the project duration*	Two years
Current year *if a multi-year project select the current project year*	Year Two
Total number of milestones *select the total number of project milestones for the current year*	Four
Current milestone *select the current milestone for this report*	Four
Due date *agreed report due date as per your funding deed*	30/06/12
Date submitted *actual date the report was submitted*	July 2012
Report type *select whether this is an interim report or the final milestone report for the project*	Final

Please also complete the WMF Final Report

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Milestone Four details

Enter the name of the milestone, and then list all of the tasks and deliverables (as agreed in your funding deed) for this milestone in the tables below.

Indicate whether each task and deliverable is complete, and provide a summary of progress in the Comment column. If any task or deliverable is not complete, provide an explanation, and list the actions you plan to take in response.

You will also need to attach evidence of your deliverables to this report.

Press TAB on your keyboard to add a new row, if required.

Milestone name	Commercial System Design

Tasks *tasks as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Extended duration process optimisation pilot trials	Yes	The fermentation stage has run continuously since November 2011 and the hydrothermal stage based on continuous feed campaigns (up to 8hrs currently)
Process model completion and RDC scenario evaluation	Yes	The process engineering model has been further refined and has satisfactorily undergone 3rd party peer review.
Partner workshop to evaluate technology feasibility, and development criteria.	Yes	A workshop was held in Rotorua to establish the concept design criteria which were to be used and the limits of the design
Full-scale concept design and construction cost estimate	Yes	Full-scale concept design & costing completed.

Deliverables *deliverables as agreed in your funding deed*	**Complete?** *yes or no*	**Comment** *summary of progress/explanation and actions*
Quarterly technical progress statement describing pilot trial operations, results to date, and associated workplan progress.	Yes	Quarterly Technical Progress Statement submitted
Techno-economic scenario as an output from process engineering model (v3.0)	Yes	Complete and implemented
Full-scale concept design plan and cost estimate for construction	Yes	Please see attached Quarterly Technical Progress Statement
Final Project Report summarising the 2 year pilot program outcomes and recommendations/plans for moving forward	Yes	Final project report submitted
Milestone Claim Form	Yes	Milestone claim form submitted
Milestone Report	Yes	
Tax invoice for claimed amount	Yes	Tax invoice submitted

Key performance indicators (KPIs)

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For each waste type(s) and target annual tonnage you identified in your project plan, please provide the actual values your project reduced, reused, or recycled/recovered during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual tonnages fall short of targets, then please provide a short statement to explain why in the space beneath (eg, the equipment utilised for this project is not yet operating at its maximum capacity).

Press the TAB key on your keyboard to add more rows to the table, if required.

	Quantity of waste (tonnes)					
Waste type	**Reduce**		**Reuse**		**Recover/Recycle**	
	Target	***Actual***	***Target***	***Actual***	***Target***	***Actual***
Rotorua District Council biosolids Initial 8,400					Up to 1 tonne per day (pilot-scale process)	Negligible –pilot trials undertaken
Pulp and paper primary and secondary solids Initial 181,000					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible – pulp and paper organic wastes only processed at laboratory scale
Rotorua District Council Atiamuri Landfill municipal organic wastes Initial 150,000					Up to 1 tonne per day (laboratory- and pilot-scale process)	Negligible – limited testing of municipal organics at laboratory scale

This project is focused on technology development and scale-up of a proprietary waste deconstruction process that will enable significant diversion of municipal and industrial organic wastes in the future. During the course of pilot-scale plant operations the actual diverted volumes are expected to be minimal – but sufficient to demonstrate the scalability and suitability of the Process for the targeted outcomes.

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Objectives, activities and measures

As part of your project plan, you specified SMART objectives for the project, provided detail about the types of activity(ies) required, and set annual target measurements. Please provide the actual measure your project achieved during the reporting period (ie, the actual totals for this milestone).

If your project is not at a stage to measure and report on this information, or actual measures fall short of targets, then please provide a short statement to explain why in the space beneath.

Press the TAB key on your keyboard to add more rows to the table, if required.

Objective	Activity	Measure	
		Target	*Actual*
To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process. Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP. Design, construct, install and commission Pre-fermentation Module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids as per the project schedule.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and have been successfully commissioned on biosolids
To demonstrate viable scale up of the complete waste deconstruction process by 31 December 2011.	Carry out pilot trial runs under a range of process conditions and configurations. Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated. Pilot-scale demonstration of product value as a carbon source for WWTP	The complete pilot scale waste deconstruction process, TERAX™ is now in place and fully operational. Further trials are currently underway.
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to at least three alternative organic waste streams.	Preliminary work on a number of alternative organic waste streams has been completed. In particular, the TERAX™ process has been tested on pulp mill solid waste.
To produce a viable commercial scale design basis for application at the Rotorua wastewater treatment plant by 30 June 2012.	Development of a process engineering and economic model for the full-scale application of the technology.	Process model in place capable of capital and	The process engineering model has been further

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	Produce design specifications and costing for a commercial plant.	operating cost estimates for full-scale plant. A viable commercial scale design is produced.	refined and has satisfactorily undergone 3rd party peer review. Full-scale concept design & costing completed.

Additional project benefits

Please list any additional benefits (economic, environmental, social or cultural) from your project, not foreseen at planning stage. Provide a measurement, if applicable. For environmental benefits, include any reduction of harm to the environment.

Press the TAB key on your keyboard to add more rows to the table, if required.

Benefit	Measure
Detailed in Final Project Report	

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Risk management

List the main risks your delivery phase is facing. These may be technical, financial, organisational, economic, social, management, legal or environmental risks. Tell us what you are doing to reduce each risk.

If you identified risks during the development of your project plan, please explain how you are monitoring and/or managing these risks.

Please add as many risk tables as required.

Risk:

Potential risk *description of potential risk event*	Equipment failures in the new pilot plant modules affect our ability to undertake trials in a timely manner.
Project impact *description of impact*	Delay in integrating the 2 stages of the hybrid process at pilot scale causing programme to run behind schedule and/or limiting the breadth of trial work possible.
Likelihood *low – medium – high*	High
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	The operation of pilot plants inherently involves risks of equipment failure due to the developmental nature of the work, stop start operation, etc. The project team is working closely with contractor and supplier staff to deal with issues as they arise and ensure any downtime is minimised. Specific engineering expertise is also being sought as required.

Risk:

Potential risk *description of potential risk event*	Loss of key staff during final phases of project delivery.
Project impact *description of impact*	Restricted ability to run trials or deliver work.
Likelihood *low – medium – high*	Low
Risk level *minor – moderate – severe*	Moderate
Strategy to mitigate *description of risk mitigation*	Actively manage key resources to ensure adequate knowledge depth and cover for absences in critical programme stages.

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Partnership and other funding sources

Give details of your progress towards securing partnership funds and any contingency plans for any funding shortfalls.
Include all cash contributions and other funding listed in your project budget.
Press the TAB key on your keyboard to add more rows to the table, if required.

Partner / funding source	Amount requested	Amount approved	Amount received	Date balance expected
Rotorua District Council	$275,000	$275,000	$275,000	
Scion Investment	$109,309.27	$109,309.27	$109,309.27	

Procurement

Give details of any major goods, work or services you are currently arranging for your project, or which you have purchased since your last report.
You must also attach copies of any relevant briefs and provide a summary of the procurement process followed.
Press the TAB key on your keyboard to add more rows to the table, if required.

Description	Value	Date awarded	Supplier name

Evaluation

Are you evaluating your project according to your agreed Stage II Project Plan? ☒ Yes ☐ No

Please confirm that you are evaluating your project according to your agreed Stage II project plan: Yes or No? If No, please provide an explanation

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Declaration

- I declare that to the best of my knowledge, the information contained in all sections of this report, or supplied by us in support of our report is complete, true and correct.
- I declare that I have the authority to sign this report and to provide this information.
- I understand that the Information presented to the Minister is subject to disclosure under the Official Information Act, 1982.
- I declare that the fund payment request accompanying this report is complete, true and correct.

s 9(2)(a)

By typi
spa
electronically signing this form.

Date 20/7/12

Verification

I verify that the fund payment request accompanying this report is complete, true and correct, and:

- costs making up the amount of this request are part of the eligible costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by donation or credit notes.

s 9(2)(a)

P

By
space provided you are electronically signing this form.

Date 20/7/12

Bank account details

If this is the first time you are completing this form, or account details have changed, please provide the bank account details into which the payment should be made. Please also attach a pre-printed deposit slip.

Bank name: The National Bank of New Zealand

Branch name: Rotorua

s 9(2)(b)(ii)

Bank *Branch* *Account* *Suffix*

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Once complete, please email the *WMF Milestone Report*, *WMF Claim Form* and supporting evidence as listed below to your Fund Analyst.

The Ministry prefers that all required documents are sent electronically, however, where it is not possible to send documents via email, please send a paper copy to:

Waste Minimisation Fund
Ministry for the Environment
PO Box 10362
Wellington 6143

Report checklist

Use the following checklist to confirm you have included all the required information in your report.

- ☐ Complete all sections of this form.
- ☐ Sign the declaration.
- ☐ Complete a *WMF Milestone Claim Form* for this milestone. If this is the first *WMF Milestone Report* for your project, attach a pre-printed deposit slip.
- ☐ If this is the final *WMF Milestone Report* for your project, complete the *WMF Final Project Report*.
- ☒ Attach evidence of milestone deliverables, for example:
  - photographs of project progress
  - monitoring and/or evaluation data
  - record of activities
  - media coverage or other publicity
  - invoices
  - staff recruitment.
- ☐ Attach a tax invoice containing the words 'Tax Invoice', and showing the following details:
  - your organisation's GST number
  - invoice number
  - deed number
  - total claim amount
  - GST component.
- ☐ Attach a list of invoices for this reporting period, in the standard format that you/your company use to record this type of information. Please ensure the following details are included:
  - invoice number
  - invoice date
  - supplier
  - description
  - total (excluding GST).

Please note, you must request your fund payments at the frequency agreed during your Stage II project planning discussions.

The Ministry will not pay more than 90 per cent of the WMF approved amount until we are satisfied that your project is complete.

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SCION
forests · products · innovation

2012 Waste Minimisation Fund

Scion

Project Technical Report

Waste 2 Gold – Deconstruction Technologies for Organic Waste Utilisation

Date: July 2012

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"Changing the way New Zealand thinks about waste"

Waste 2 Gold

Final Report

Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation - July 2012

Executive Summary

Scion and its partner the Rotorua District Council (RDC) have successfully completed their two year Waste Minimisation Fund development project which was started December 2010.

The project focused on development of TERAX™, a proprietary organics deconstruction process. Consisting of a combination of fermentation and hydrothermal processing stages, TERAX™ has been demonstrated to pilot plant scale, and exposed to extensive techno-economic modelling analysis. Based on outcomes of the project, the technology is now ready to move into the next phase of demonstration-scale development, and expansion of the technology to the wider national solid organic waste burden.

All Objectives, Milestones and Deliverables of the project have been achieved.

Particular highlights of this work have been:

1. Delivery of a working pilot plant system of the TERAX™ process at the Rotorua District Council site;
2. Demonstration of the efficacy of the process:
    a. long-term operation of the fermentation plant since January 2012;
    b. solution of a significant number of mechanical engineering challenges to ensure a fully functional hydrothermal plant at pilot scale;
    c. batch, semi batch and continuous hydrothermal processing undertaken;
    d. highly encouraging performance of TERAX™ process operation at pilot plant scale, when compared with laboratory results;
3. a peer reviewed techno-economic model, which describes the annualised net benefit of the TERAX™ process; and
4. completion of a full scale concept design and construction cost estimate for a TERAX™ treatment plant at Rotorua Wastewater Treatment Plant.

Ultimately the success of this project is underlined by the progression towards full-scale application. Rotorua District Council have asked and received Registrations of Interest for a demonstration-scale design (>10,000 tonnes/year) of a plant at their WWTP site. Selection of the successful engineering party will initiate the next stage in scale-up and commercialisation of the TERAX™ process.

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Contents

Executive Summary 2
Introduction 4
Summary of Objective achievements 5
Communications and reporting 18
Partnership development 19

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Introduction

Scion and its partner the Rotorua District Council (RDC) have successfully completed the two year Waste Minimisation Fund development project - **Waste 2 Gold: Deconstruction Technologies for Organic Waste Utilisation**

The project's Purpose, as stated in the Final Project Plan was:

"…optimise at pilot scale a breakthrough, patented technology for organic waste destruction and value creation. Successful completion of the Project will lead to design specifications for a full-scale reference plant at the Rotorua District Council Wastewater Treatment Plant (WWTP) that can divert 8,400 tonnes of biosolid wastes annually. This is expected to catalyse an inter-regional expansion of the technology commercialisation, encompassing municipal biosolids, domestic organic wastes, and primary industry organic wastes, that could divert 340,000 tonnes per year of organic wastes within ten years."

This proprietary process, now branded as TERAX™, consists of a combination of fermentation and hydrothermal oxidation. As a result of the work in the project, it has been demonstrated to pilot plant scale and exposed to extensive techno-economic modelling analysis, which confirms its efficacy and benefits in relation to diverting organic waste streams from landfills. It is the belief of the Scion/RDC partnership that the technology is ready to move now into the next phase of demonstration-scale development for biosolids and expansion of the technology to the wider national solid organic waste burden.

This final report provides an overview of the achievement of the project Objectives contained within the Project Plan. For each of these Objectives, the work has been described under the relevant Activities identified within the Plan.

Two key points are noted:

1. The achievements of the first year have been described previously, in the Year One Progress Review, which has been submitted as part of the project deliverables. Where relevant, and for Objective 1 in particular, these are transcribed with edits into this final report.

2. The final Quarterly Technical Progress Statement (QTPS) for this project provides much that summarises the achievement of Project Objectives. Thus, where relevant, details from Year Two, Quarter Four QTPS are used within this report.

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Summary of Objective achievements

Objective 1: Establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011

Objective	Activity	Measure
To establish a complete modular waste deconstruction pilot plant facility at the RDC wastewater treatment plant by 30 September 2011.	Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process. Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP. Design, construct, install and commission Pre-fermentation Module to significantly improve the product yield.	Each of the pilot plant modules are in place at the RDC wastewater treatment plant and commissioned on biosolids as per the project schedule.

Tender, construct, install and commission Thermal Oxidation Module as the basis for the waste deconstruction process.

We have a functional **Hydrothermal Pilot Plant Module** installed at RDC Wastewater Treatment Plant. Designed by Allan Estcourt Ltd (Rotorua) and fabricated by Longveld Engineering Ltd (Hamilton), the plant was delivered to the site on 29 April, 2011. It was formally opened by the Minister for Environment, Dr Nick Smith, on 31 May 2011.

Finishing work (insulation, and commissioning modification requirements) progressed into the second year of the project. Commissioning tests were completed, including low and high pressure/temperature water commissioning. Site operating and safety systems and a major Hazard and Operability study (HAZOP) of the plant were also completed.



The first sludge hydrothermal oxidation

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trials were completed in Year One. This was a low temperature/pressure/solids experiment, designed to test the efficacy of the system under a sludge-containing, oxidative environment. The trial ran successfully for over four hours. Despite the low temperature environment, good solids destruction and soluble organics generation was evident. Subsequent processing runs in Year Two are described within this report.

Configure, install, and commission Biological Nutrient Removal Module to simulate the full-scale RDC WWTP

The **Biological Nutrient Removal (BNR) pilot plant** module was commissioned in Year One of the project. It has been successfully operating onsite for approximately 16 months.



The goal of the BNR module was to provide an appropriately sized biological reactor capable of receiving liquors generated by the TERAX™ process pilot plant. The response of the BNR pilot plant thus modelled the impact of these liquors as carbon supplements on the full-scale RDC WWTP process performance.

Commissioning was completed with the two reactors operating with identical process parameters, having ethanol as the sole carbon source for final stage denitrification. Despite a number of early process disruptions, the plant and process proved to be very robust in its wastewater treatment capability. Crucially, biosolids built up within the reactor towards levels (2-3g/L) consistent with the main RDC treatment plant (see figure below).

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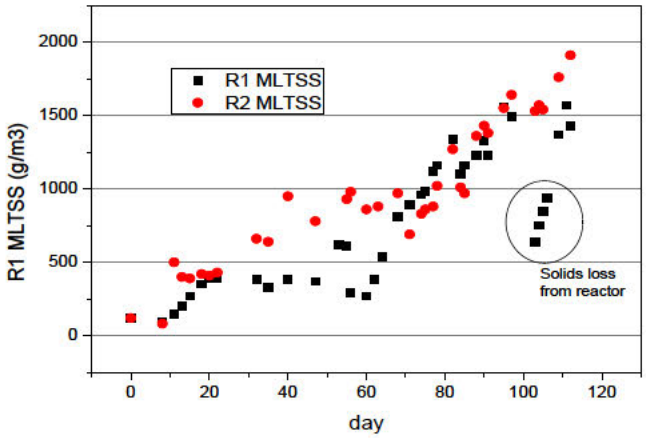


Figure 1: Mixed liquor solids build-up in BNR plant during commissioning stages

Examples of the averaged treatment performance of the two trains, operating as a model of the Rotorua WWTP, for this first commissioning stage were:

- ammonia removal of 88% and >99% for reactor 'R31' (reactor dosed with synthetic or real TERAX™ process liquor) and reactor 'R32' (reactor dosed with ethanol), respectively;
- nitrogen removal (combined ammonia and oxidised nitrogen) of 73% for both reactors;
- phosphate-P removal of 27% and 23% for reactors R1 and R2, respectively;
- good settling of the cellular biomass within the reactor system, a result critical to the effective operation of the plant.

The nitrogen removal performance was consistent with the full-scale wastewater treatment plant (WWTP) at RDC, which demonstrates greater than 80% removal. At 50-60% decrease, phosphorus removal in the full-scale system is slightly better than the pilot BNR (*unreferenced communications with RDC staff on full-scale performance data).*

Detailed studies of reactor performance followed into Year Two, detailed further in subsequent sections of this report.

Design, construct, install and commission fermentation Module

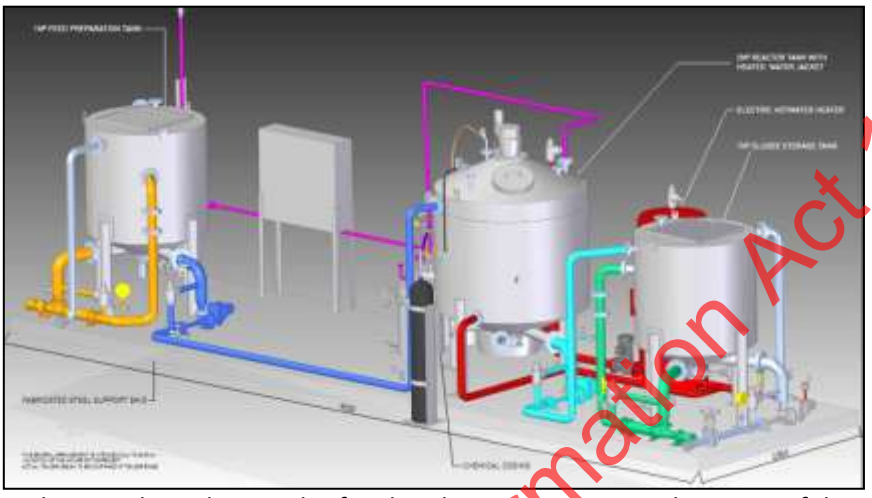
The fermentation pilot plant performs the initial pre-treatment role within the TERAX™ process. Its purpose is to improve the economic viability of solids destruction.

The **Fermentation Pilot Plant Module** was designed by a Waste 2 Gold development partner, AWT Water Ltd, as outlined in the project plan and WMF application.

This design is based on a biosolids anaerobic fermentation process specification, supported by outputs from hybrid system laboratory trials. These described the critical process parameters and capability requirements of the fermentation plant. The resulting specification was then used by AWT

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Water to carry out the detailed design and prepare a technical specification for the plant procurement.



A formal tendering process was conducted, initiated using a publicly-advertised Registrations Of Interest (ROI) process targeting appropriately qualified contractors. The respondents were evaluated against pre-determined criteria which resulted in a short list of three contractors being selected to tender for the plant construction. The successful tenderer was Longveld Engineering Ltd of Hamilton, NZ.

Under very tight time constraints, the plant was delivered to the Rotorua District Council wastewater treatment plant site during October 2011, marking the completion of a highly successful plant build.

Wet commissioning of the fermentation plant commenced immediately and was completed in the second quarter of Year Two.

Objective 2: Demonstrate viable scale-up of the complete waste deconstruction process by 31 December 2011

Objective	Activity	Measure
To demonstrate viable scale up of the complete waste deconstruction process by 31December 2011.	Carry out pilot trial runs under a range of process conditions and configurations. Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.	Laboratory scale plant results successfully replicated. Pilot-scale demonstration of product value as a carbon source for WWTP

Carry out pilot trial runs under a range of process conditions and configurations.

In order to demonstrate the efficacy of the process, and establish a solid design basis for process scale-up, the three different pilot plant units were all tested across a range of conditions.

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1. **Fermentation pilot plant**

The plant has been in continuous operation since November 2011. After an initial learning curve, its operation has been highly successful. Process variable changes have included:

- Solids input range changes
- pH changes
- Sludge retention time changes
- Temperature changes

2. **Hydrothermal pilot plant**

The hydrothermal oxidation pilot plant has been operated under the following different configurations

- Batch, semi-batch and continuous operation
- Varying biosolids concentrations
- Fermented and unfermented biosolids feedstocks
- Water only operation for heat balancing analysis
- Glucose oxidation studies for soluble substrate testing

3. **Nutrient removal (BNR) plant**

The nutrient removal plant, operated to demonstrate the impact of addition of TERAX™ liquor as a carbon supplement within a biological wastewater treatment plant, was exposed to a number of experimental phases throughout the 16 months of operation:

- Initial commissioning to compare performance of the two reactors under identical operational conditions, with ethanol as the sole carbon source for final stage denitrification
- Addition of acetic acid to the experimental reactor, as a first model for the TERAX™ liquor
- Modification of the synthetic TERAX™ liquor, with inclusion of phosphorus and ammonia to simulate a liquor without any nutrient removal (via ammonia stripping)
- Movement of the liquor dosing to the beginning of the BNR plant reactor cycle, simulating the optimal dosing site for a TERAX™ liquor not exposed to nutrient removal;
- Addition of TERAX™ liquor, generated by the pilot plant operation

A summary of the performance of the pilot plants under different process conditions and configurations is provided in the following section.

Analyse performance in terms of energy and mass balances and comparison to laboratory scale results.

The pilot scale work during this quarter was characterised by the complete integration of the TERAX™ pilot plants which involved:

1. Fermentation plant operations optimisation.
2. Extended hydrothermal oxidation plant trial operations
3. BNR operations with real TERAX™ liquor.

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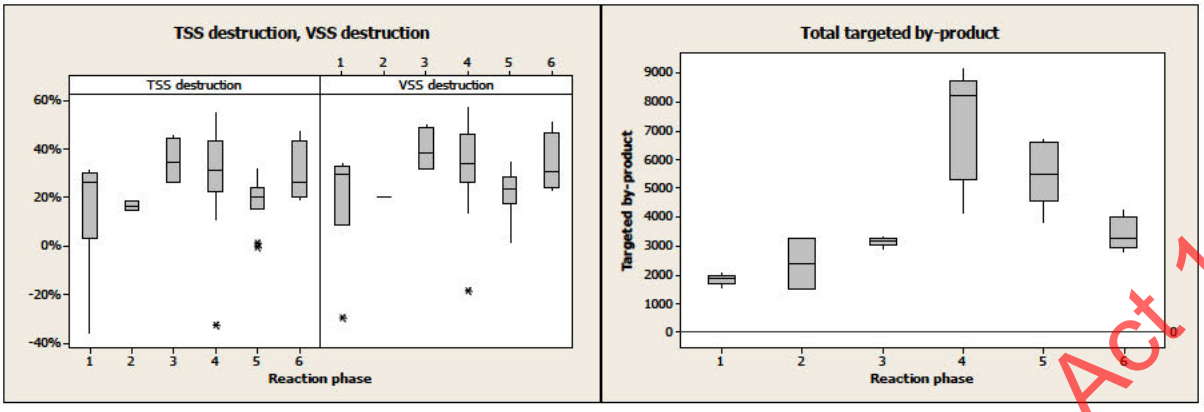
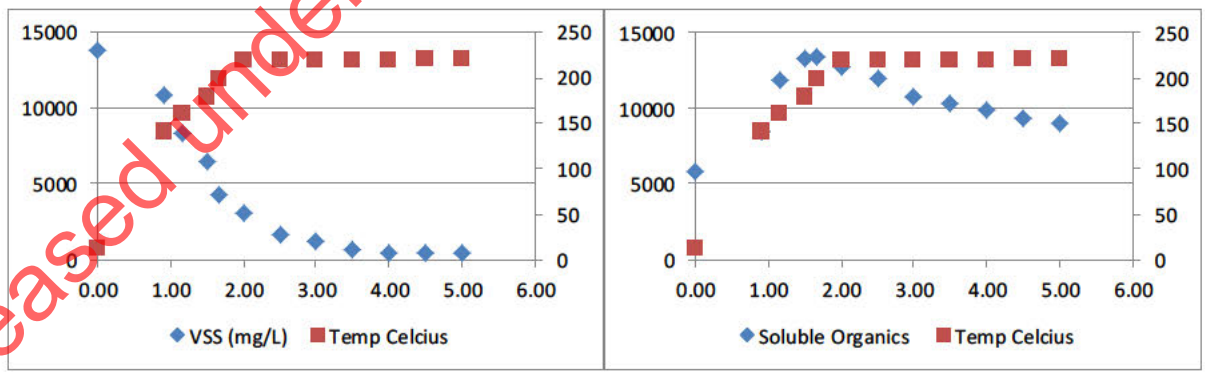


Figure 2: Impact of six reaction phases on key fermentation performance indicators

The **fermentation plant** continued to operate continuously with no downtime over the study period. Operational phase changes were implemented to optimise the overall objectives of achieving high solids destruction and improved valuable by-product yield. Six operational reaction phases were identified over the entire period of BNR operation. Each phase was characterised by a modification to process inputs. Critical performance parameters for these phases, being solids degradation and by-product production, are summarised in Figure 2.

In parallel with the fermentation trials, the **hydrothermal oxidation plant** underwent a series of experiments to establish process parameters for full scale plant design.

The parameters investigated were measured against key performance indicators including total solids destruction (TSS), and total valuable by-product generation. An example time course of a batch hydrothermal oxidation experiment is provided in Figure 3. Comparison of TERAX™ process performance parameters between pilot and laboratory scale is summarised in Figure 4. Whilst some optimisation is still required to improve by-product formation, the results are extremely encouraging.



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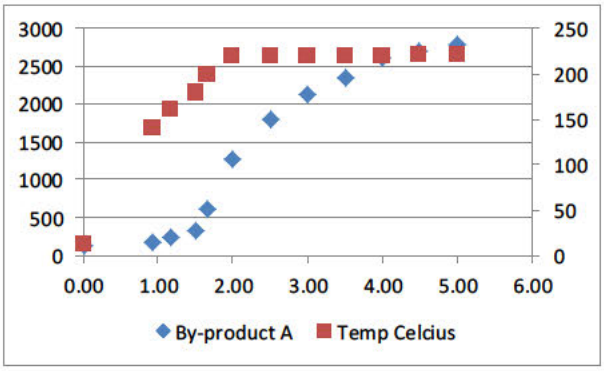


Figure 3: Demonstration of solids destruction, soluble organics production (as COD) and by-product A production during hydrothermal oxidation

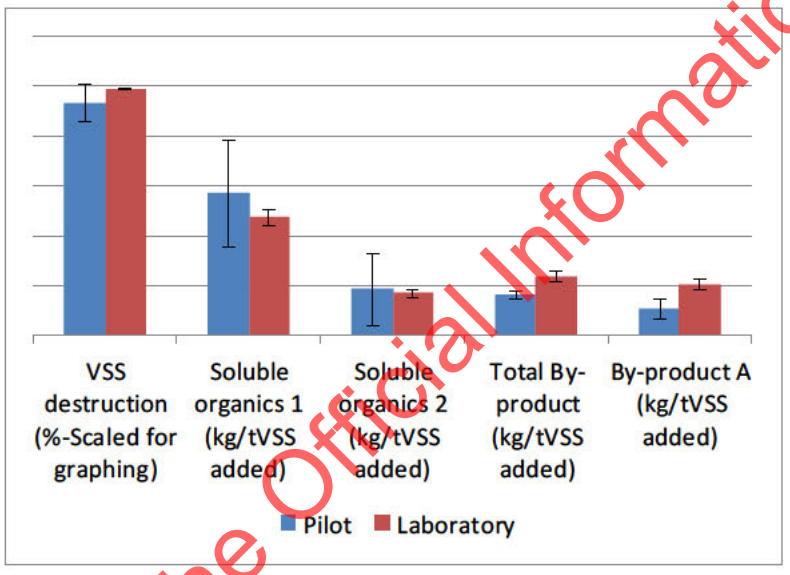


Figure 4: Performance of pilot plant batch operation (April-June runs) compared with laboratory experiments. Some parameters (particularly reaction time) vary between lab and pilot plant experiments

Continuous hydrothermal oxidation of a soluble compound (glucose) was achieved, providing valuable insight into the plant performance. However, an on-going performance problem with the continuous feed pump precluded significant use of the continuous biosolids processing mode. This problem was eventually solved, in collaboration with the pump supplier, at the conclusion of this funded project. During the preparation of this report, the first continuous trial using sludge was successfully completed and on-going work for this aspect of the technology is being conducted during July -September, 2012.

Commissioning of the hydrothermal oxidation plant to a fully operational state took more time than originally anticipated. As a result of mechanical engineering challenges which had to be overcome, fewer experiments were conducted than initially planned. Optimising the engineering solutions to these challenges is seen as a key outcome of the work, noting that the movement of a technology from laboratory into functional pilot scale is not an insignificant task for any technology. These learnings now form a vital part of the technology know-how, which will be extremely valuable for the ongoing developmental phases.

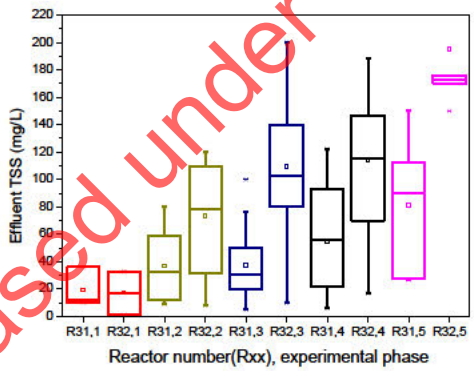
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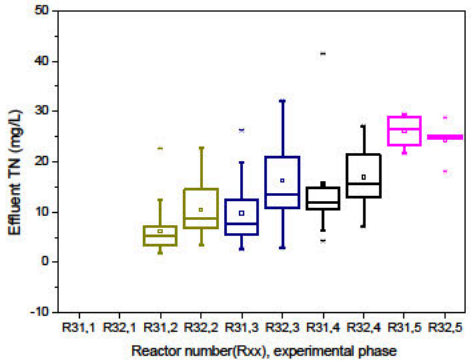
As a result of successful continued operation of the hydrothermal oxidation step, sufficient TERAX™ liquor was generated to supply doses to the **nutrient removal (BNR) plant**. This milestone was reached at the conclusion of the project, and testing is on-going into July 2012. Prior to the generation of this real liquor, a synthetic TERAX™ liquor was tested extensively. The liquor used (or modelled) was not processed for ammonia removal, and presented a worst-case scenario for nitrogen addition into the BNR system. Ethanol dosage, without excess ammonia, was continued in the control reactor.

Solids, nitrogen and phosphorous discharge have been evaluated as key performance indicators, described in the plots below (Figure 3), which summarise the experimental (R31) reactor performance, against that of the control (R32) reactor, and over five distinct reaction phases of the 16 month trial.

Encouragingly, the experimental reactor performance was generally excellent in comparison with the control, with almost no statistically significant compromise in performance. The discharged total suspended solids (TSS) were higher than would be acceptable for a full-scale BNR plant, particularly in the latter experimental phases. The nitrogen contained within this solids component directly impacted on the observed total nitrogen (TN) discharge. Despite this, the experimental reactor demonstrated equal or better performance than the control for these parameters.

Ammonia breakthrough was observed intermittently in the experimental reactor during Phase 4, where synthetic TERAX™ liquor was used as the sole carbon source for nitrogen removal. This was not unexpected, and the liquor would not be expected to be used in this fashion without removal of ammonia (via gas stripping).





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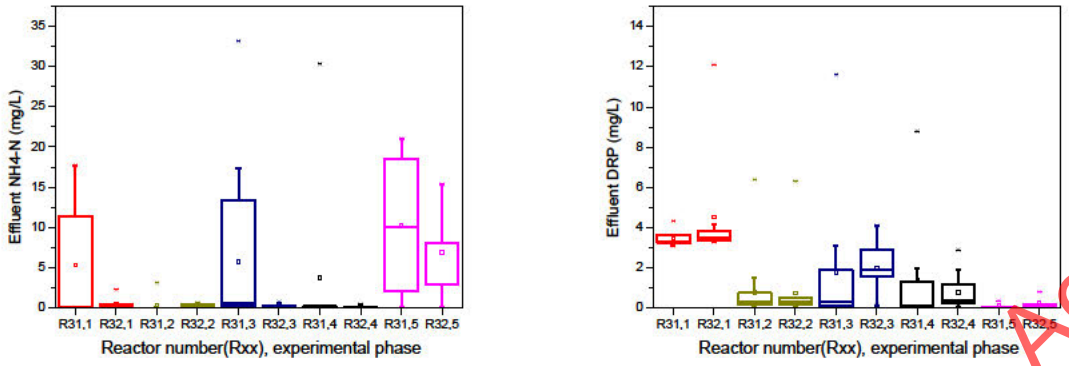


Figure 3: Comparison of key indicators of Experimental (TERAX™ carbon source, R31) and Control (ethanol carbon source, R32) reactor performance for different reaction phases (1-5)

Objective 3: Evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012

Objective	Activity	Measure
To evaluate potential application to pulp mill biosolids and other organic waste sources by 31 March 2012.	Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.	Demonstrate the potential application of the technology to at least three alternative organic waste streams.

Carry out laboratory scale trials on new organic feed stocks and alternative biosolids sources.

Trials have been completed to determine the efficacy of the TERAX™ process on a number of alternative feedstocks.

In Year One of the project, we tested three alternative organic feedstocks. The results demonstrated some significant impacts of substrate type, and consistent improvement of solids destruction combined with by-product yield (Figure 5) via the TERAX™ process, when compared to benchmark hydrothermal oxidation.

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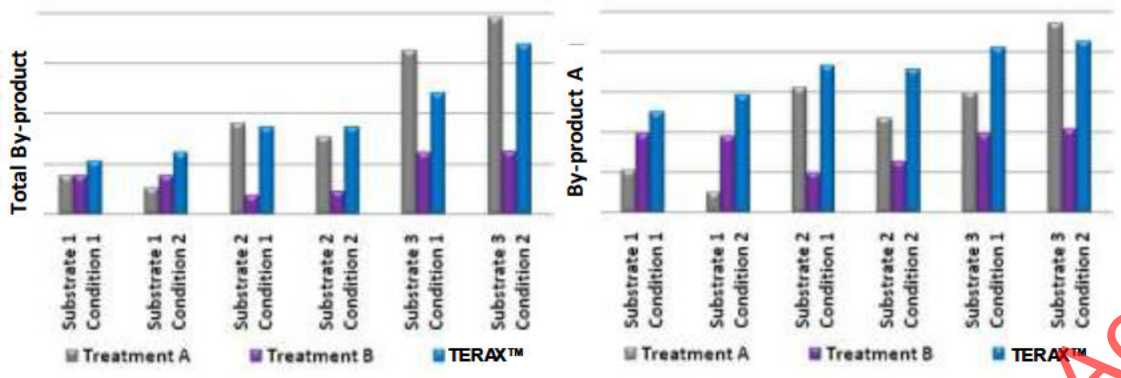


Figure 5: Year One trial results for alternative feedstock processing-demonstrating deconstruction of solids to recoverable organic by-products

The second year of the project saw further laboratory trials on alternative organic waste materials. We completed the planned trials on lignocellulosic biomass as an alternative feedstock. Semi-continuous fermentation of the material, sourced as an organic waste derived from a full-scale pulp mill, was conducted. Batch-scale hydrothermal oxidation was conducted on fermentation liquor samples.

Key results of these second trials were that:

- The two-stage TERAX™ process (fermentation followed by hydrothermal oxidation) demonstrated high volatile solids removal, at greater than 90%
- Biochemical degradation was more modest than when using domestic biosolids, implicating the presence of more recalcitrant organics, and/or inhibitory compounds in this material.
- Small-molecule organic acid (e.g. acetic acid) yields through the hydrothermal oxidation were good, similar to those produced by municipal biosolids. Due to the relatively poor fermentation performance, overall TERAX™ process yields were lower than those of municipal biosolids. On-going work to improve this response has been undertaken, and continues as part of another project within Scion.

Objective 4: Produce viable commercial scale design basis for application at the Rotorua wastewater treatment plant by 30 June 2012

Objective	Activity	Measure
To produce a viable commercial scale design basis for application at the Rotorua wastewater treatment plant by 30 June 2012.	Development of a processengineering and economic model for the full-scale application of the technology. Produce design specifications and costings for a commercial plant.	Process model in place capable of capital and operating cost estimates for full-scale plant. A viable commercial scale design is produced.

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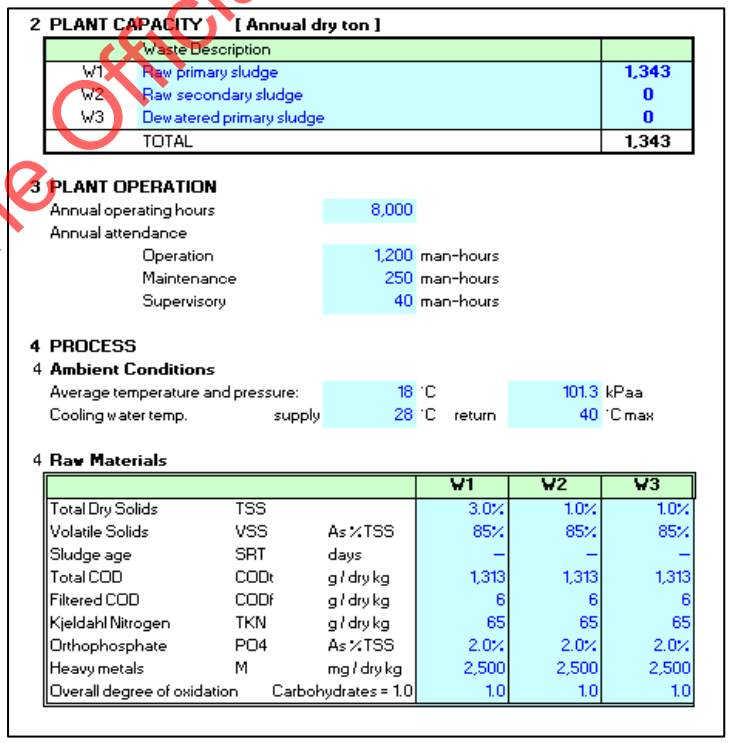
Develop a process engineering and economic model for the full-scale application of the technology.

The techno-economic model, developed for the TERAX™ process by AWT Ltd has been further refined. The spreadsheet-based model gives a steady-state analysis for the TERAX™ process at different sized wastewater treatment works. It is a generic model, so does not incorporate site-specific details (which the concept design considers). Using the techno-economic model for a wastewater treatment plant the size of Rotorua, the following results were obtained (Table 1).

Table 1: Modelled economics for TERAX™ process at scale suitable for Rotorua biosolids

Output	**Rotorua-sized plant**
Capex ($M)	5.0 - 8.7
Plant annual total dry solids (tds)	1880
Plant annual wet tonnes (t)	11750
NPV/wet tonne ($/t)	63 - 80
Landfill gate fee ($/t)	92
Landfill disposal costs ($/t)[1]	125
Benefit ($/t)	45 - 62
Annual benefit ($M / yr)	0.524 - 0.724

When compared to landfilling, the TERAX™ process shows an economic benefit for Rotorua. This analysis considers the cost savings of reduced ethanol use during wastewater treatment, arising from substituting ethanol with the outputs from the TERAX™ process. A value has also been assigned to the ammonia-rich effluent from the process.



2 PLANT CAPACITY [Annual dry ton]

	Waste Description	
W1	Raw primary sludge	1,343
W2	Raw secondary sludge	0
W3	Dewatered primary sludge	0
	TOTAL	1,343

3 PLANT OPERATION

Annual operating hours		8,000	
Annual attendance			
	Operation	1,200	man-hours
	Maintenance	250	man-hours
	Supervisory	40	man-hours

4 PROCESS

4 Ambient Conditions

Average temperature and pressure:		18	°C	101.3	kPaa
Cooling water temp.	supply	28	°C	return 40	°C max

4 Raw Materials

			W1	W2	W3
Total Dry Solids	TSS		3.0%	1.0%	1.0%
Volatile Solids	VSS	As %TSS	85%	85%	85%
Sludge age	SRT	days	–	–	–
Total COD	CODt	g / dry kg	1,313	1,313	1,313
Filtered COD	CODf	g / dry kg	6	6	6
Kjeldahl Nitrogen	TKN	g / dry kg	65	65	65
Orthophosphate	PO4	As %TSS	2.0%	2.0%	2.0%
Heavy metals	M	mg / dry kg	2,500	2,500	2,500
Overall degree of oxidation		Carbohydrates = 1.0	1.0	1.0	1.0

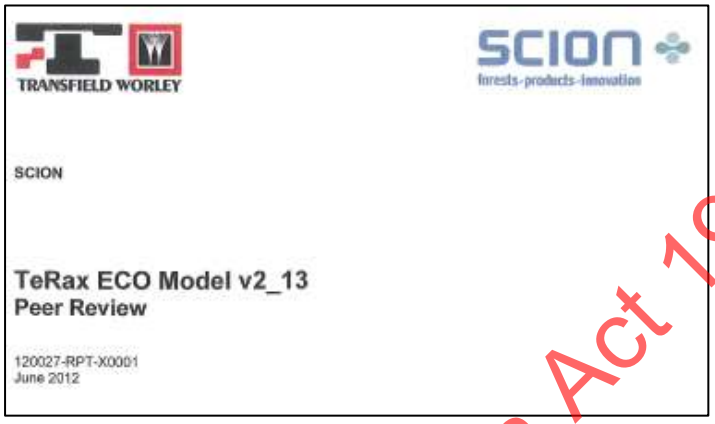
A peer review of the techno-economic model was undertaken by Transfield Worley. This was an independent review undertaken to provide the project team with confidence that the model was of a required standard. The output of this process was the generation of a report detailing conclusions and recommendations.

[1] Includes dewatering costs, transportation and landfill gate fee

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The Transfield Worley report stated that:

"overall, the techno economic model is fit for purpose as a preliminary investment appraisal tool…However, the model is of limited value for establishing the requirements for a Basic Design Package as would be required to commercially develop the Terax process."


TRANSFIELD WORLEY

SCION

forests-products-innovation

SCION

TeRax ECO Model v2_13
Peer Review

120027-RPT-X0001
June 2012

Some of the key conclusions of the peer review of the techno-economic model were that model lacked costing data for control equipment and that there were opportunities to optimise the design and minimise the cost of the reactor. Another useful output from the peer review process was identifying the application of Lang Factors as a high-level assessment tool. The Lang Factor is the ratio of the equipment costs to overall capital/ construction costs. The model outputs gave Lang Factors of approximately 2.5, whereas Transfield Worley anticipated that this type of plant should show Lang Factors of 4 – 5. This provides an indication that the techno-economic model may be currently underestimating some of the additional costs associated with constructing the plant.

Taking on board the findings of this report, the techno-economic model provides a strong basis for assessing new projects at an early stage. Going forward, it can be used to assess costs for the TERAX™ process at new wastewater treatment works or to assess the likely costs when used with waste streams from other sectors. The model remains a useful tool to run scenarios and as a basis for informing strategic decisions.

Produce design specifications and costings for a commercial plant

A full scale concept design and construction cost estimate for a TERAX™ treatment plant at Rotorua Wastewater Treatment Plant (WWTP) was commissioned and undertaken. This work was carried out by the consultant engineering firm AWT Ltd and represented a key step in the implementation of the technology.

The concept design built upon the techno-economic model and results from the pilot plant operations to construct a valid process design scenario. The associated costs of the proposed plant were evaluated and provide an improved cost estimate to stakeholders in the technology appropriate for Rotorua.

Key stages in the concept design process were:

- An initial workshop held in Rotorua to establish the concept design criteria which were to be used and the limits of the design
- The generation of a viable Process Flow Diagram (PFD)
- To assimilate data on future flows and sizing requirements for the key plant equipment
- To contact equipment suppliers and obtain quotes to supply the equipment
- An improved estimate of the capital costs and operating costs of the proposed TERAX™ plant and an assessment of the uncertainty in that estimate

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- Identification of a suitable site at Rotorua WWTP capable of locating the TERAX™ plant
- To establish a risks and opportunities register identifying items of importance in future

This work was summarised in a detailed report containing copies of supplier quotes obtained during the project.

A design horizon of 2032 was used as the basis of the costing. By this date Rotorua WWTP will be estimated to be producing 1880 tonnes of dry solids per annum due to population growth, additional sludge from chemical dosing and reticulation of additional flows. The costing exercise was a detailed bottom-up, inventory based approach starting from the developed PFD. At a high-level the following costed process included:

- Sludge thickening equipment
- Fermentation vessel
- Hydrothermal oxidation reactor
- Ammonia separation equipment
- Filtration equipment



Costs associated with ancillary equipment such as any associated pumps, valves and heat exchangers were included within the estimate.

Ultimately the success of this project is underlined by the progression towards full-scale application. RDC have remained committed to full-scale implementation of the TERAX™ process, having integrated two such plants into their 10 year development plant (one to be based at their sewage treatment plant and the other at their landfill). As a result of the successful technical and techno-economic analyses, Rotorua District Council have asked and received Registrations of Interest for a full-scale design of a plant at their WWTP site. Selection of the successful engineering party will initiate the next stage in scale-up and commercialisation of the TERAX™ process.

Communications and reporting

Project records have been kept of all the experimental and modelling work conducted in this project. Currently 25+ records related to this project have been logged on Scion's internal reporting system (SIDNEY), either as internal reports, records of external publications, or presentations.

Numerous presentations have been given and industry interest in the technology has been significant. An information day was held for selected Local Authorities and as a result of the Ingenium Conference there was a considerable attendance of a pilot plant tour.

All communications and opportunities are registered in associated databases.

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Partnership development

The partnership between Scion and RDC remains very positive and engaged. The project has been operated under an unincorporated JV with a governance board consisting of senior executives (including CEOs) from each organisation. As such, the parties have been able to proactively make decisions of mutual benefit to RDC (as an initial client for the technology) and collectively for the partnership regarding best options to roll this technology out to the broader municipal and industrial organic waste management stakeholdership.

An independent consultant's review of the technology, its market and commercialisation strategies was also undertaken by the partnership. The review concluded that investment in a fully functional demonstration scale was critical to leverage end-user engagement and de-risk the project. This would require:

- Demonstrating the hydrothermal deconstruction of municipal sewage sludge at full-scale;
- Adapting the technology to the treatment of organics in the residual Municipal Solid Waste (MSW) stream currently going to landfill, with the primary aims being to reduce volume, reduce harm, and recover value.

The demonstration TERAX^{TM} plant would be sited at the RDC waste-water treatment plant and sized to process its entire biosolids output (based on a 20 year growth projection). When fully operational within two years, such a plant would reduce the amount of sludge being sent to landfill by over 95% for the current 8,500 tonnes per annum to 275 tonnes per annum, a 30-fold decrease in the volume of solids to landfill.

RDC's recent commitment to locating a full-scale TERAX^{TM} plant at their Atiamuri Landfill (embedded in their 10 year plan) means that this strategy will be strengthened by an immediate success in both biosolids and organic solids at a commercial scale. As such, there are significant opportunities to de-risk the commercial development of the technology within the partnership.

A key component of the forward plan will be the selection of one or more commercial engineering companies to design and build the full-scale TERAX^{TM} plants and spearhead the commercial exploitation of this technology. In addition, the review encouraged the partnership to concurrently develop the next generation of this technology to target generic organic wastes, which is over 60% of the Municipal Solid Waste flow and nationally represents a market ten times larger than the biosolids stream.

In moving to the next phase of technology development – demonstration-scale on biosolids and extension to pilot-scale – the parties are now considering best options for a vehicle most suitable for commercialisation of the technology. They have also actively engaging with potential implementation partners – such as a large engineering company – to manage critical elements of market development and technology design and construction.

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WMF Application

MINISTRY FOR THE ENVIRONMENT

Reference Number: WMF-00000559

Project Name: **TERAX™ Waste Deconstruction Technology**

Engagement Primary Contact: Rotorua District Council

Submission date: 20/06/2012

Submitted by: Rotorua District Council

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WMF Application

Page 1 - Eligibility Checklist 1

Page 2 - Applicant Details 3

Page 3 - Project Details 4

Page 4 - Project Details cont. 7

Page 5 - Project Details cont. 10

Page 6 - Project Details cont. 14

Page 7 - Project Benefits 16

Page 8 - Project Benefits cont. 23

Page 9 - Milestones and Funding 26

Page 10 - Funding cont. 30

Page 11 - Funding cont. 32

Page 12 - Funding Summary 35

Page 13 - Capability 36

Page 14 - Capability cont. 40

Page 15 - Additional Information 43

Page 16 - Declaration 44

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WMF Application

Page 1 - Eligibility Checklist

Eligibility Checklist

Only waste minimisation projects are eligible for funding. Projects must promote or achieve waste minimisation.

Waste minimisation covers the reduction of waste and the reuse, recycling and recovery of waste and diverted material. The scope of the fund includes educational projects that promote waste minimisation activity.

1. Is your project a waste minimisation project?	Yes

Projects must result in new waste minimisation activity, either by implementing new initiatives or a significant expansion in the scope or coverage of existing activities.

2. Does your project result in new waste minimisation activity?	Yes

Projects should be for a discreet timeframe of a minimum of one year, and up to three years. During this time, the project objectives are achieved.

After this (where appropriate), the initiative becomes self-funding.

3. Do you require funding for three years or less?	Yes
4. Will the project objectives be achieved by the end of funding?	Yes

Funding can be used for operational or capital expenditure that is required to undertake a project.

5. Are you requesting funding for operational or capital expenditure that is essential to the project?	Yes

Applicants should apply to alternative, more suitable, government (or other) funding sources before applying to the WMF, where this is available.

Other government funding streams include the Community Environment Fund, Contaminated Site Remediation Fund or research funding from the Foundation for Research, Science and Technology.

6. Is your project more appropriately funded by another government funding source?	No

The applicant must be a legal entity. Examples of a legal entity include an individual, or an organisation

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such as a limited liability company, an incorporated society, a registered trust or body corporate.

7. Is the applicant's organisation a legal entity with capacity to enter into a contract?	Yes

The fund will not cover the entire cost of the project. Applicants will need part funding from other sources.

Note: If your project is approved for funding, we will not fund any costs incurred before the Agreement has been signed.

8. Are you able to obtain a 'cash' contribution from other sources? (Note that in-kind contributions are not eligible under the WMF.)	Yes

The minimum grant for feasibility studies will be $10,000. The minimum grant for other projects will be $50,000

9. Do you require a minimum amount of $10,000 for a feasibility study, or $50,000 for other types of project?	Yes

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WMF Application

Page 2 - Applicant Details

Applicant Information

Provide a brief description of your organisation. (maximum 100 words)	Rotorua District Council (RDC) is a Territorial Local Authority. RDC is willing to test innovative solutions that make a real difference to how waste is managed in order to achieve an enduring outcome for future generations. RDC is applying on behalf of the Waste 2 Gold Alliance, whose key parties are Scion and RDC. The Alliance has operated as an unincorporated joint venture, through a contractual structure, which the parties are in the process of formalising. All contracts for the 2012 MfE WMF proposal will be managed by RDC on behalf of the Alliance.
Legal Status. Local councils do not need to complete this question.	
Please attach a copy of your "New Zealand Companies Office Certificate" (if applicable).	

Back up Contact

We require at least one "backup" contact person for this application.

Contact Name	s 9(2)(a)
Organisation and Position	
Postal Address (if different to organisation postal address)	
Email	
Telephone (work, cell, fax)	

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WMF Application

Page 3 - Project Details

1. What are the details of your project?

Project Name	TERAX™ Waste Deconstruction Technology
Project Type: Select one project type that most closely fits your project	Infrastructure and/or Services
Waste Stream	Other
If other, please specify	Organic fraction of Municipal Solid Waste.
Project Purpose. (maximum 40 words)	This project will; Implement full-scale demonstration of the TERAX™ hydrothermal deconstruction process on Rotorua sewage sludge; and Extend application of TERAX™ into processing Municipal Solid Waste organic wastes Its primary aims are reducing volumes, eliminating hazards, and recovering value.
Project Location. Select area or region mostly affected by the project.	Bay of Plenty
Project Duration	Three years

2. Is this a large project?

Are you requesting more than $200,000?	Yes

If yes, the following additional supporting documentation is required. Please submit this with your application, using the supporting documentation section below:

* *Feasibility study*
* *Background information about the project and the organisation*
* *Reference(s) from a successfully completed publicly funded project(s) and/or customers*
* *Business plan*
* *Capability statement of the project*
* *Copy of the project manager's curriculum vitae (CV)*

Supporting Documentation	RDC Project Delivery Reference.pdf TERAX WMF 2012 - Feasibility Study.pdf TERAX WMF 2012 - Business Plan.pdf TERAX WMF 2012 - Capability Statement.pdf TERAX WMF 2012 - Project Background.pdf Project Manager CV.pdf

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3.How much waste does your project propose to reduce, reuse, recycle or recover?

Current quantity (tonnes)	8500
Reduced quantity (tonnes)	8200
Reused quantity (tonnes)	0
Recycled quantity (tonnes)	0
Recovered quantity (tonnes)	0
Additional Information (maximum 300 words). Include information, including estimates of any profit gained by reducing, reusing, recycling or recovering the waste type, or the method of converting the volume to tonnes.	The demonstration full-scale implementation of the hydrothermal deconstruction process - TERAX™- on Rotorua sewage sludge provides a key step forward in the development cycle of this technology and a critical reference site to leverage a national rollout. This plant will process 8,500 tonnes per annum of hazardous waste, de-risking and fostering implementation around the country to other TLAs landfilling sewage sludge (250,000 tonnes per annum and rising). The broader project focuses on all organic waste landfilled in New Zealand, including the largest and most difficult solid waste stream, the residual Municipal Solid Waste (MSW). This stream of approximately 50,000 tonnes per annum in Rotorua (2,531,000 tonnes nationally) has a substantial biodegradable fraction embedded in it that is not economically separable. The amount of degradable MSW suitable for this process includes Organic (28%), Paper (7%), Nappies/Sanitary (3%), Timber (11%), and Potentially Hazardous (14%), as categorised by the Solid Waste Analysis Protocol (SWAP MfE Environmental Report Card, July 2009). These fractions represent a combined total of 63% of the total landfilled volume, equivalent to approximately 1,600,000 tonnes. In addition to this, an estimated 120,000 tonnes of sewage sludge and 560,000 tonnes of industrial organic waste is disposed to private landfills. Nationally, the MSW stream is largely controlled by the private sector whose motive is maximising financial value from waste disposal. That value is

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	maximised by large scale commercial landfills and unless a real alternative that matches cost of this option is developed substantial progress on waste minimisation in NZ will be difficult to achieve. The TERAX™ hydrothermal deconstruction process has the potential to be that alternative. Implementation at a national scale offers a total opportunity in the region of 2,280,000 tonnes per annum resulting in substantial potential financial benefits.

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Page 4 - Project Details cont.

4. How does your project directly support the Ministy's waste minimisation objectives?

To reduce the generation of waste	Yes
To reuse waste	No
To recycle waste	Yes
To increase the recovery of resources from waste	Yes
Project contribution to objectives (maximum 300 words)	This project represents an opportunity to provide a step change in the way waste is managed in New Zealand through a fundamental shift away from the current practice of landfilling organic waste streams. As such, the development of the TERAX™ technology platform directly supports the Ministry's objectives: • Reduce Volume –The destruction of the organic solids fraction results in large reductions in landfill and transportation costs by reducing both the amount of solids (>90% reduction in total dry weight) and releasing the bound water content, which makes a substantial fraction of the volume (>80% in sewage sludge). • Reduce Harm –The technology rapidly accelerates the breakdown of the organic waste in a controlled environment enabling the capture, minimisation, and beneficial utilisation of resultant breakdown products. It almost completely eliminates fugitive methane greenhouse gases and nutrient-rich leachate emissions to the environment. In addition, the high temperature and pressure conditions of the process destroy all pathogenic microbial agents, effectively rendering the product sterile and free of biological hazard. • Recover Value –The controlled deconstruction of organic wastes provides the basis to significantly increase the efficiency of waste management through added-value opportunities, such as production of biogas, recovery of acetic acid for chemical production and nutrients for fertiliser applications.

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	The project builds on the success of the 2010 WMF Waste 2 Gold project, which has demonstrated scale-up from laboratory proof-of-concept to an integrated pilot scale plant. RDC is now committed to moving to the next phase of development as an end-user and reference site. Both parties have confirmed a desire to continue to invest capital and operational funding for the project to build a full-scale reference plant at Rotorua with an associated significant expansion of the underpinning R&D to extend the technology to process the larger volume Municipal Solid Waste streams.

5. What objectives have been set for your project, and how do you intend to achieve them?

Objective 1:

Objective	By 2014, reduce Rotorua sewage sludge landfill disposal by >90%
Activity	Undertake a detailed design and procurement process based on the successful outcome of the pilot- scale project. Build a full-scale demonstration plant for the treatment of 10,000 tonnes per annum of sewage sludge.
Key performance indicator	Tonnes of sewage sludge processed

Objective 2:

Objective	By 2014, extend the hydrothermal technology platform to broader MSW organic waste streams
Activity	Undertake lab and pilot scale trials on the primary components of residual MSW and combinations. Review, test and integrate pre-treatment technology options. Construct techno-economic model for full-scale opportunity.
Key performance indicator	Generation of a full-scale concept design model for MSW applications

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Objective 3:

Objective	By 2015, expand the implementation of the TERAX™ process to at least 2 new TLA or industry end-users
Activity	Engage with key government and industry stakeholders to develop the value proposition across regions and the country as a whole. Develop specific value propositions for targeted end-users. Licence the technology to commercial partner to spearhead exploitation of these opportunities
Key performance indicator	Number of new customers engaged

Objective 4:

Objective	
Activity	
Key performance indicator	

Objective 5:

Objective	
Activity	
Key performance indicator	

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Page 5 - Project Details cont.

6. Promoting waste minimisation.

Will your project promote waste minimisation to the wider public?	Yes
If yes, give details of how your project might influence, encourage or enhance the uptake of other waste minimisation activities (maximum 100 words)	The success of this technology development to date has prompted significant promotional activities, which will be continued and expanded; *RDC 10 Year Plan *Conference presentations e.g. Ingenium, Wasteminz, EDANZ, LGNZ *Increased website presence and use activities *Direct engagement with other district councils and industrial producers of organic waste *Industry journal articles *Television, radio and printed media interactions The demonstration TERAX™ plant will be a reference site for the technology. This will provide an exemplar to other potential users de-risking all future implementations and, a basis for demonstrating extension of the technology to other applications, such as MSW and industrial organics

7. Applying on behalf.

Are you applying on behalf of a territorial authority (city or district council)?	Yes
If yes, explain why this project is not funded out of your council's baseline funding and does not fall under your council's core responsibilities, and why it not funded out of waste disposal levy money received under Section 32 of the Waste Minimisation Act 2008. (maximum 100 words)	RDC has supported the scale-up development of this technology to date out of its share of funding from the waste levy. The next stage - construction of a full-scale plant treating the entire sewage sludge production, and extension to the wider organic waste stream, requires a more substantial investment. This stage still carries sufficient technical and engineering risk to be "beyond business as usual". Co-investment from Scion and the WMF will help address these risks and ensure RDC's longer term commitment to operating costs for sludge treatment and construction of a second

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	TERAX TM plant at its landfill are realised.

8. Similar waste minimisation activities.

Are you aware of any similar waste minimisation activities in your region?	No
If yes, give details of the existing activity, and explain how your project expands the scope or coverage of that activity. Funding is not available for projects that displace existing activity. (maximum 100 words)	

9. How will you evaluate your project?

How will you know your project is successful? Describe how the effectiveness of your project will be monitored, evaluated and reported, based on the key performance indicators and answers you provided in question 5. (maximum 500 words)	There are a number of technical, financial, social and investment risks associated with this project. These have been identified in our Risk Management Plan and will be monitored and evaluated accordingly. As with the previous WMF project, the overall technical and market development will be managed via the Project Governance Group and in accordance with best practice engineering approaches. Best practice Stage Gate management (using Scion systems) will ensure each milestone is reviewed to ensure the project continues to meet the requirements of its investors. . The construction of a full-scale TERAX™ plant to process Rotorua's sewage sludge is a substantial deliverable in the technology development pathway and is expected to be undertaken over a 2 year period (2012-2014). The overarching key performance indicator for evaluation will be the volume of sewage sludge processed by the plant and performance parameters on its efficacy, including : • Reductions in volume: >90% • Reliability: >90% availability • Economics – plant built within cost estimates and maintains overall cost competitiveness with landfill

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	rates • Environment – >70% reduction in GHG emissions c.f. landfilling • Downstream performance - No detrimental effect on treated effluent quality of WWTP • Chemical use – net economic benefit to the WWTP process through reduction of ethanol usage • Value Recovery – economically useable quantities of acetate, ammonia or phosphorus recovered. • Social – positive impact on Rotorua community perspective on waste managment Extension of the TERAX™ technology platform to residual MSW will build on critical knowledge gained through the research and development underteken on sewage sludge to date and evaluate the opportunity to treat the residual MSW through a phased approach. These phases will match the individual components of MSW with different scales of operation providing excellent opportunities for evaluation during the project. The organic waste programme will have same underlying performance measures as those outlined above for the full-scale application on sewage sludge.

10. Received funding before.

Has your organisation received funding from the Ministry for the Environment before?	Yes
If yes, give the details of the project(s) that your organisation undertook, and provide the name of the fund. (maximum 300 words)	RDC has received funding for projects from MfE before. Currently funding has been made available as part of the Rotorua Lakes Restoration Project via the Bay of Plenty Regional Council. RDC's scope of work in this programme included the provision of sewerage reticulation for lakeside communities. Those projects in the programme that have been completed have been to the timeframes planned and within the budgets allocated. There are still a number of communities yet to be provided with

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	sewerage reticulation and RDC has these all programmed to be completed within the scope of the overall programme. They are all expected to be successfully completed including construction of a new treatment facility in the Rotoma area. To date two of the schemes have been completed and a third is substantially complete. Some specific details around these schemes are: Scheme Okareka Okere Hamurana Budget $11.87m $14.54m $16m Actual Cost $10.23m $10.52m on track No of houses serviced 298 381 525 Construction period planned 50wks 70wks 78wks Construction period actual 50wks 55wks on track Length of mains installed 20.7km 28.1km 33.6km Substantial cost reductions on estimates have been able to be gained by installing innovative pressurised reticulation systems rather than conventional gravity systems along with contract methodologies that have secured extremely competitive rates. This recent and ongoing project provides a substantial example of Council's ability to deliver projects on time and within budgets. Significantly, as a core partner in the Waste 2 Gold alliance, RDC was directly involved in the successful 2010 WMF proposal Waste 2 Gold –Deconstruction Technologies for Organic Waste Utilisation. This project was one of the first projects to be undertaken by the WMF following the implementation of the Waste Levy in 2009 and has been successfully delivered on its major objectives to scale up the technology.

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Page 6 - Project Details cont.

11. Successful completion of other publicly funded projects.

Has your organisation successfully completed any other publicly funded project before?	Yes

If yes, give the details of the publicly funded project(s) that your organisation completed, and the name of the organisation and fund that provided funding.

Details of the project(s), organisation and fund. (maximum 300 words)	All RDC projects are publicly funded. RDC also receives funding from various government agencies e.g. New Zealand Transport Agency (NZTA). As a territorial authority, RDC has the systems in place; both procurement and management, to ensure public funds are expended in accordance with protocols expected of a public organisation. Audit NZ specifically audit RDC's accounts annually and tri-annually RDC's transport accounts and processes are specifically audited by NZTA. RDC receives approximately $5.0m p.a. from NZTA for maintenance and renewal of local roads and additional specific funding for capital works where they meet criteria in the national interest set by NZTA. An example of a current capital project is Lake Road 4-laning which is a key commuter route into the Rotorua CBD heavily overloaded. The transport component of the project has a cost of $10.6m with 56% of that cost co-funded by NZTA with another $3.0m of upgraded services. The project is currently under construction and is both within budget and on time with completion due March 2013. RDC has also recently completed many other publically funded projects in recent times. Some examples of the larger projects and their completion date are: - Energy Events Centre (2007) $28m - Sewerage Treatment plant upgrade (2012) $8.3m - Museum Upgrade (2011) $19m - Fairy Springs Road 4-laning on behalf of NZTA

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	(2011) $4.0m - Rotorua Airport (2009) $25m Many of these projects had substantial co-funding provided from a variety of other funding agencies e.g. grants from charitable trusts and other organisations.

Include the details of a contact person from one of the funding organisations. If there is more than one project, provide the details of those contact persons in a separate Word document (or on a separate piece of paper, if you are not completing this application form electronically)

Contact Person	s 9(2)(a)
Position	
Organisation's Legal Name	
Email	
Telephone (Work)	
Mobile Number	
Fax	
Contact Information	

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Page 7 - Project Benefits

12. What is the opportunity or problem that you plan to address with the project?

Describe the scope of the opportunity or the extent of the problem, and whether a demonstrated need exists. Include information on current tonnages and method of disposal, if applicable to your project. (maximum 300 words)	New Zealanders disposed of 2,531,000 tonnes of solid waste to municipal landfills in 2010 (Ref. MfE Environmental Snapshot July 2011). Up to 63% of this quantity is considered suitable for the TERAX™ technology. In addition, substantial quantities of organic wastes are directed to company landfills or mono-fills (120,000 tonnes of sewage sludge and 560,000 tonnes of industrial solid waste per year). These organic solid wastes equates to a combined total of over 2 million tonnes per annum disposed to municipal and private landfills and come with significant environmental and economic impacts: • Fugitive greenhouse gas emissions linked with air pollution and climate change • Leachates laden with nutrients contributing to eutrophication of waterways • Consolidation to large-scale landfills increasing transport distances/costs • Many landfills reaching design capacity, requiring significant new capital investment and RMA costs • Hazardous wastes containing pathogens or heavy metals resulting in H&S issues Active external reviews, needs assessments and direct engagement with the TLA sector and industrial organic waste producers has clearly shown that no existing technologies address these issues. For example, the NZ residential market for compost is easily saturated and such schemes have had only limited uptake around the country with little improvement in diversion rates over the last decade (Ref. MfE Environmental Report Card, 2009). Indeed, RDC has now stopped composting of sewage sludge all together. The partnership between RDC and Scion has

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	developed a novel, proprietary technology platform (TERAXTM; NZ Patent No. 583082) for treating very high moisture content organic solid wastes. The TERAXTM process specifically deconstructs organic waste streams to deliver substantive volume reductions (> 95%) with maximum value recovery. As such, an opportunity exists for a paradigm shift in organic waste management, in which landfilling is no longer required and significant value addition from processed waste constituents is created.

13. What is the solution you are proposing?

What specific action will your project take to seize the opportunity or address the problem? (maximum 300 words)	This project seeks to demonstrate the basis for diverting all organic waste from landfill through the TERAX™ hydrothermal treatment technology that; • Reduces volume through destruction of the organic solids; • Reduces harm through controlled capture of breakdown products and sterilising biological contaminants; • Recovers value through the targeted deconstruction and recovery of carbon and nitrogen chemicals for energy and fertiliser applications; This demonstration will be achieved through the construction of a full-scale reference plant for a proprietary hydrothermal deconstruction process –TERAX™- to treat Rotorua's sewage sludge production. It will also extend the technology platform to its application on the broader organic waste streams currently being landfilled by RDC, other TLAs and large industrial organic waste producers. The construction of a full-scale demonstration plant to process the Rotorua sewage sludge stream is based on the successful 2010 WMF pilot project

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	which has taken this technology to pilot scale. The demonstration plant will: • represent the final critical step in de-risking the technology development for this application; • provide an all-important reference site for end-user engagement; • catalyse the wider implementation of the platform across New Zealand. Value recovery from the hydrothermal treatment of waste organics will target the production of acetic acid and ammonia, which (unlike compost) are high value, low volume products. The value proposition will focus on: • Conventional conversion of acetic acid to biogas for energy applications, providing an important synergy with existing investments in landfill gas utilisation; • Recovery of ammonia for fertiliser applications as a truly recycled nitrogen source offsetting conventional sources dependant on fossil fuel (natural gas) for production. • Opportunities for recovery of further valuable compounds from the remaining ash fraction. Detailed performance analyses and techno-economic modelling will be used to create compelling value propositions for investment by multiple end-users across New Zealand.

14. How does your project result in new waste minimisation activity?

Projects must result in new waste minimisation activity, either by implementing new initiatives, or by a significant expansion in the scope or coverage of existing activities. (maximum 250 words)	The construction of a full-scale demonstration TERAX™ plant to deconstruct Rotorua sewage sludge will result in a substantial shift in the management of this hazardous waste stream and provide an essential reference in the technology development pathway. This represents a significant expansion of the successful 2010 WMF project to pilot this technology and will directly result in a new waste minimisation activities;

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	• In Rotorua –the removal of 8,500 tonnes per year of hazardous waste from the environment (Approximately 200,000 tonnes over 20 years at expected growth rates), • As a reference site that will seed wider uptake by other local authorities, a number of whom are actively following the development due to their own pressing solid waste management needs and challenges, • Provides directly transferable knowledge to the project extending the technology to the application of hydrothermal processing of residual MSW. Hydrothermal processing of residual MSW has the potential to produce a step change in waste management practices in New Zealand. The rapid deconstruction of this waste stream to recoverable compounds and a stable solid fraction represents the opportunity to realise significant economic and environmental benefits. The ultimate outcomes of this project will result in a new activity with the potential to sustainably treat all solid organic wastes in New Zealand. The fully functional TERAX™ plant will de-risk the technology and leverage end-user engagement to underpin the commercialisation activities drive a national rollout.

15. What are the specific benefits of the project?

Tick as many as apply, and provide a brief description of the benefits. (maximum 40 words each)

Economic?	Yes
Description	Reduction of landfill costs (Average net benefit $66/tonne) Income stream from recovery of high value components (Acetic Acid $500/tonne, Ammonia $350/tonne)

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	Enhancement of NZs 'clean green' reputation National rollout will expand benefit Reduces compliance under RMA
Environmental?	Yes
Description	Minimise and ultimately remove all organic matter from landfills (95% organic solids destruction) Reduction of greenhouse gases from landfills (76% reduction modelled) Reduction of landfill leachates quantity and toxicity Recovery of nutrients reducing eutrophication potential
Social?	Yes
Description	Create skilled employment opportunities (construction and operation) Enhanced community awareness and pride ('feel good factor') through leading waste minimisation practise. Eliminates the negative perception associated with other common options i.e. Landfilling, and composting. Reduce exposure of workers to hazardous material
Cultural?	Yes
Description	Strong cultural benefits linked to the destruction of organic wastes No disposal of human wastes to land.
Other?	Yes
Description	Springboard to the national rollout of a new approach to waste management. Substantially grow the existing RDC/SCION joint

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	venture to a considerable business opportunity with global potential. Rotorua will become a waste minimisation exemplar for New Zealand

16. How will you ensure the solution/benefits of the project will endure, once WMF funding has ended?

Explain how you intend to make the solution self-funding in the longer-term, or how you intend to ensure that any benefits are not lost once the project is complete. (maximum 250 words)	There are two key parts to ensuring long term benefits are maintained 1)Long term operation of the RDC Demonstration TERAX™ Plant; and 2) Uptake by others and extension to the wider organic waste stream. 1. The demonstration plant will over the 20 year life of the facility remove from landfill approximately 200,000 tonnes of sewage sludge. RDC has allowed in its financial statements funding for full maintenance and depreciation over that life, so that at end of its useful life full capital replacement has been provided for. This will ensure long term benefits of the demonstration facility are maintained. 2. The benefits will also be extended to the wider waste sector by proving success at full scale and the research work to extend the process beyond sewage sludge. The success of the pilot scale phase of this technology development now provides the direction for the last stage of scale up –a full-scale reference plant. A reference plant is critical to the final de-risking of the technology and demonstrating the actual value proposition to other prospective adopters. There is considerable interest already within both the private and public sector that have large organic waste streams to manage. These interests will be actively engaged to ensure opportunities for extension are

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	maximised. Full scale operation along with characterisation of the wider organic waste stream will demonstrate the viability of the process and the long term benefits both environmentally and economically.

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Page 8 - Project Benefits cont.

17. Which stakeholders are going to be included in this project, and how does your project support and strengthen partnerships between them?

Tick the stakeholder groups that will be included, and give a brief description about how your project will support and strengthen the partnerships between them. (maximum 40 words each)

Local or central government?	Yes
Description	In addition to the applicant, RDC, the project has already engaged directly with over 20 local authorities to communicate the outcomes and seek feedback on development plans. This includes LGNZ and EDANZ
Advisory groups?	Yes
Description	Scion Industrial Advisory Group, Scion Science Advisory Group
Industry groups?	Yes
Description	Specific industry groups engaged to date are; Ingenium, Wasteminz, and Pulp & Paper industry waste minimisation Project Committee. These relationships will continue to be developed and extended to wider NZ industry.
Community groups?	Yes
Description	RDC has included this project in its Waste Management and Minimisation Plan and it received strong community support as an option to manage organic waste.
Business groups?	Yes
Description	Kawerau Industrial Symbiosis Initiative, which is seeking opportunities for extracting value from waste streams.
Iwi	Yes
Description	Ngati Whakaue, has approached the Aliance regarding use and commercialisation of this technology for Maori and New Zealand businesses. Ngati Whakaue is an exemplar of Iwi Groups that have approached us regarding the TERAX technology.
Other	Yes
Description	As part of the commercialisation strategy, the Project is engaging with a number of potential

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	licensee partners to keep them informed of progress, provide specialist input to the technology development, and build market awareness for the technology.

18. Project potential.

Does your project have the potential to be implemented across the country?	Yes
If yes, explain how this could be achieved. (maximum 250 words)	One of the main aims of this project and the ultimate success of the TERAX™ technology development program is to catalyse implementation across NZ. There is nothing particularly unique about Rotorua's sewage sludge and MSW stream other than the fact it has lower than average costs at present. This fact provides extremely favourable circumstances and opportunities for wider uptake. It is supported by considerable interest from other TLA's around the country who have been in regular communication with the project team, and have a number of large industrial producers of organic waste. The Bay of Plenty (BoP) was initially chosen as the starting point for national rollout since it represents a microcosm of NZ waste management issues. As the fastest growing region of NZ the BoP contains national-scale examples of other biological industry sectors suitable for processing by the TERAX™ Process. The dairy sector, pulp and paper sector, horticulture, fishing and food processing, all have plants creating organic waste in the BoP within a relatively small area. The commercial partner will be expected to ramp up their sales-channels and work with the alliance to approach all suitable Municipal Authorities with a target of installing one TERAX™ plant per year for the next 10 years at the very least. The planned extension of TERAX™ to residual MSW

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	will be rapidly taken to scale on the back of previous RDC, Scion, and WMF investments in infrastructure, enabling this significant and most challenging waste stream to be evaluated for demonstration beyond this project.

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Page 9 - Milestones and Funding

19. What are the milestones for the first year of your project

Clearly outline up to a maximum of six milestones for the first year, including the tasks that make up each milestone. (maximum 100 words per milestone)

Provide the total estimated cash cost for each milestone (exclusive of GST).

Please ensure all due dates for each of the milestones are within the funding period dates available, as specified in the guidelines.

See pages 26 to 29 of the guide for information on how to complete this question.

Milestones year one

Milestone 1:

Description	Full-Scale Detailed Design This substantial milestone will take the concept design completed in the phase 2 pilot trial work for the RDC WWTP and develop it into a comprehensive technical specification for the construction of the demonstration plant. This will include; • Evaluating, selecting, and contracting a suitable engineering design firm, • Design review of concept design, • Detailed design elements and specifications for process, mechanical, electrical, and civil engineering requirements, • Detailed equipment and construction schedules, • Control system philosophy and design, • Hazard & Operability studies (HAZOP), • Construction & procurement strategy, • Detailed capital cost estimation
Due date	1/03/2013

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Total estimated cash cost $ excluding GST	500000

Milestone 2:

Description	Construction Procurement This milestone will take the detailed design specification through an established tendering process based on RDC procurement guidelines. RDC's Procurement Strategy is based on the NZTA model and has various methodologies to achieve value for money dependent on the complexity of the task. This task is likely to put as much weight on experience and technical capability as price ensuring the right contractor can deliver the final product. The completion of this milestone will result in the successful award of the construction contract for the full-scale TERAX™ demonstration plant at RDC WWTP.
Due date	1/05/2013
Total estimated cash cost $ excluding GST	100000

Milestone 3:

Description	MSW Option Establishment This milestone consists of several activities that forms the basis of translating the hydrothermal deconstruction technology platform to a residual MSW application. Key activities within this stage include; • Investigation and evaluation of existing technology for MSW handling and pre-treatment, • MSW initial component characterisation and selection for trialling, • Review and modify lab and pilot equipment to handle MSW components • Establish a process economic model design to enable the results of trials to be captured and evaluated for scenario analysis. The completion of this milestone will enable the

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	more detailed evaluation tasks to be initiated.
Due date	1/02/2013
Total estimated cash cost $ excluding GST	223000

Milestone 4:

Description	Hydrothermal Component Trials This milestone moves the MSW investigation into a more practical phase of laboratory scale trials on representative MSW component substrates. Key activities within this stage include; • Selection of MSW handling and pre-treatment technology options for trialling, • Combined MSW component and potential contaminant evaluation, • Development of representative synthetic substrates for trials, • Laboratory scale trials on MSW components, • Complete development of first generation process economic model. The completion of this milestone will provide the first significant calibration of hydrothermal deconstruction application to residual MSW components.
Due date	15/04/2013
Total estimated cash cost $ excluding GST	229000

Milestone 5:

Description	Hydrothermal mixed MSW Trials Progression of laboratory-scale trials to more complex mixed MSW, and scale up of component investigations to pilot based on the facilities developed for sewage sludge. Key activities include; • Establishment of MSW pre-treatment trial equipment to enable evaluation at a suitable scale, • Assessment of risk and toxicity potential of hydrothermally deconstructing MSW components • Laboratory scale trials on MSW blends, • Pilot scale trials on selected MSW components,

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	• Refinement and peer review of the process economic model. Completion of this milestone rapidly advances the scale of the investigation which will highlight specific engineering challenges.
Due date	1/07/2013
Total estimated cash cost $ excluding GST	270000

Milestone 6:

Description	Pre-treatment Trials Establishment Continued progression of laboratory and pilot scale trials to include trialling a number of pre-treatment technology options focussed on conditioning this highly variable feedstock. Key activities include; • Pre-treatment technology trials at laboratory and pilot scale where appropriate, • Laboratory-scale trials on mixed MSW with selected contaminants, • Pilot scale trials on selected MSW blends, • Refine process economic model to integrate trial results and initiate the development of a full-scale design. The completion of this final year 1 milestone will provide a strong basis for the technology translation from sewage sludge to mixed residual MSW.
Due date	1/10/2013
Total estimated cash cost $ excluding GST	278000

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Page 10 - Funding cont.

20. Following years.

If you require funding for more than one year, what is planned for the following year(s)?

Only complete this question if you are applying for multi-year funding (up to three years). Note that funding is not available for more than three years.

See page 29 of the guide for more information on how to complete this question.

Milestones year two

Clearly outline up to a maximum of six high-level milestones for year two.

Include the tasks that make up each milestone. (maximum 200 words)	Demonstration Plant Construction & Commissioning Complete the build of the full-scale demonstration plant at RDC WWTP to treat the entire sewage sludge production Successful commissioning of the full-scale plant and establishment of reliable continuous operation. (Budget $4.6m) MSW Pilot Trial Expansion Integrating pre-treatment and hydrothermal pilot trials to establish key design criteria for application to an entire residual MSW stream and/or separable components for targeted value recovery. Process economic model development to optimise MSW pre-treatment needs based on trial results and product values. (Budget $1.0m)

Provide the total estimated cash cost for year two (exclusive of GST).

Estimated total cost for year two $	5600000

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Milestones year three

Clearly outline up to a maximum of six high-level milestones for year three.

Include the tasks that make up each milestone. (maximum 200 words)	Full-scale MSW Treatment System Design The culmination of this substantial transition of the hydrothermal deconstruction technology to residual MSW will be a full-scale concept design. Pilot trials will address the variable nature of the residual MSW stream and operate on real MSW flows where possible. Engagement and partnership of specialist engineering expertise to expedite the design process and facilitate a rollout to full-scale (Budget $0.8m)

Provide the total estimated cash cost for year three (exclusive of GST).

Estimated total cost for year three $	800000

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WMF Application

Page 11 - Funding cont.

21. How much funding have you secured from other external sources (including partners)?

All costs should be cash only and exclusive of GST. If your application is successful we may contact the nominated person to discuss the status of the funding. In-kind contributions are not eligible.

See page 29 of the guide for information on how to complete this question.

Other external funding sources year one

External funding source 1:

Organisation name	Scion
Contact name and phone number	s 9(2)(a) [redacted]
Status of offer	Confirmed
Expected date for funding	5/07/1905
Amount $	200000

External funding source 2:

Organisation name	
Contact name and phone number	
Status of offer	None of these options
Expected date for funding	
Amount $	0

External funding source 3:

Organisation name	
Contact name and phone number	
Status of offer	None of these options
Expected date for funding	
Amount $	0

External funding source 4:

Organisation	
Contact name and phone number	

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Status of offer	None of these options
Expected date for funding	
Amount $	0

External funding source 5:

Organisation	
Contact name and phone number	
Status of offer	None of these options
Expected date for funding	
Amount $	0

Other external funding sources year two

Provide as much information as is currently known.

External funding source 1:

Organisation name	Scion
Contact name and phone number	s 9(2)(a) [redacted]
Estimated amount $	300000

External funding source 2:

Organisation name	
Contact name and phone number	
Estimated amount $	0

External funding source 3:

Organisation name	
Contact name and phone number	
Estimated amount $	0

Other external funding sources year three

Provide as much information as is currently known.

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WMF Application

External funding source 1:

Organisation name	Scion
Contact name and phone number	s 9(2)(a)
Estimated amount $	300000

External funding source 2:

Organisation name	
Contact name and phone number	
Estimated amount $	0

External funding source 3:

Organisation name	
Contact name and phone number	
Estimated amount $	0

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Page 12 - Funding Summary

22. How much are you requesting from WMF?

Your cash contribution to the project?

The amount your organisation is contributing to the project.

Year one 2011/2012 $	400000
Year two 2012/2013 (if applicable) $	1800000
Year three 2013/2014 (if applicable) $	0

Funding sought from WMF?

Year one 2011/2012 $	1000000
Year two 2012/2013 (if applicable) $	3500000
Year three 2013/2014 (if applicable) $	500000

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Page 13 - Capability

23. Which other partner organisations will be involved in the project?

What do your partner organisations bring to the project? Complete details in the spaces provided below.

If your application is successful we may contact the person to discuss the project.

See page 32 of the guide for information on how to complete this question.

Partner organisation 1:

Name of organisation	Scion
Contact person	s 9(2)(a)
[redacted]	[redacted]
[redacted]	[redacted]
Details of involvement (maximum 40 words)	Scion and RDC are joint-venture partners in this technology development. Scion has been the specialist provider of research and development services to the project. s 9(2)(a) has budgetary authority for Scion investment and decisions over the technology and the programme.

Partner organisation 2:

Name of organisation	
Contact person	
Position	
Phone number and email	
Details of involvement (maximum 40 words)	

Partner organisation 3:

Name of organisation	
Contact person	

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Position	
Phone number and email	
Details of involvement (maximum 40 words)	

Partner organisation 4:

Name of organisation	
Contact person	
Position	
Phone number and email	
Details of involvement (maximum 40 words)	

Partner Organisation 5

Name of organisation	
Contact person	
Position	
Phone number and email	
Details of involvement (maximum 40 words)	

Letters of support

Letters of support from the partner organisations as noted above	s 9(2)(a) 19 June 2012.pdf

24. Who is your project manager, and what skills and experience do they have?

Provide details of the person who will have overall responsibility for delivering this project, including their relevant technical skills and experience.

See page 32 of the guide for information on how to complete this question.

(maximum 100 words)	s 9(2)(a)

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	s 9(2)(a)

25. What project governance is planned for the project?

Describe the project governance that you plan for the project, to ensure that decisions are made consistently and robustly, money is spent responsibly, and risk is managed effectively.

See page 33 of the guide for information on how to complete this question.

(maximum 250 words)	This project will continue to be overseen by the established Project Governance Group (PGG) which consists of executive managers from both RDC and Scion. The PGG has successfully guided the delivery and strategic development of the technology over the last 2 years and provides an excellent platform for taking it forward. The strength of this partnership has been demonstrated in the achievements to date and is essential to the project's on-going success. The overall project management structure will be: • Project Governance Group –responsible for overall delivery, strategic development, commercialisation, and financial oversight; • Project Management Team –responsible for operational delivery, financial management, resourcing, programming, and technical review; • Technical Lead Team –responsible for management of the technical programme ensuring research milestones are achieved and quality

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	control. In addition, the project will be overseen by RDC process as required under the Local Government Act. Primary reporting will be to the Infrastructure Services Committee for the project and 3 monthly reporting to the Corporate and Customer Services Committee on financial management. RDC has a long established procurement strategy which has been endorsed by Government Agencies such as NZTA. The procurement methodology has been used to successfully deliver all RDC projects. Well established best practice methodologies will be used for delivery of professional services and physical works required for the implementation of this project.

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Page 14 - Capability cont.

26. What resources does your organisation have to ensure successful completion of the project?

See page 33 of the guide for information on how to complete this question.

Select as many as apply.

Resources	Office space IT equipment Internet access Staff skills and experience Other
If other, please specify	RDC has all the necessary resources to deliver significant projects such as this, including an in-house engineering business unit -Hydrus. Projects much larger than this have been successfully completed in the past. For this particular project, RDC owns and maintains the pilot plant essential for the scale up trialling of the MSW, and has in place a joint venture with Scion who have the technical expertise and laboratory resources for the initial MSW characterisation. The demonstration plant will be delivered via RDC's procurement process consistent with methodologies used on all engineering projects. RDC is in the unique position of owning both a WWTP and landfill which gives ready access to the waste streams targeted under this project. It also provides an incentive for RDC to find better solutions as we have costs for waste disposal along with ultimate responsibility for management of the whole waste stream.

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27. Support from local government.

Does your project have strong support from local government (eg, territorial authority and/or regional council)? If so, complete details in the spaces provided below.

WMF Application

See page 33 of the guide for information on how to complete this question.

Council 1:

Name	Tauranga City Council
Details of involvement (maximum 40 words)	TCC are maintaining an active interest in the project through regular communication. Their stated interest is the demonstration of TERAX™ competing with the cost of landfill.
Contact person	s 9(2)(a)
[redacted]	[redacted]

Council 2:

Name	Buller District Council
Details of involvement (maximum 40 words)	BDC have been actively exploring options with the project team due to pressing needs for a waste management solution. A diminishing market for their current compost production and significant distance to landfill are key drivers.
Contact person	s 9(2)(a)
[redacted]	[redacted]

Council 3:

Name	Nelson District Council
Details of involvement (maximum 40 words)	Keen on this as an option for waste management and looking to take to Nelson Regional Sewerage Business unit (includes Tasman District) for support.
Contact person	s 9(2)(a)
[redacted]	[redacted]

Council 4:

Name	Porirua City Council
Details of involvement	Believe this is a viable option for consideration and

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WMF Application

(maximum 40 words)	looking to take a report to Council for support.
Contact person	s 9(2)(a)
[redacted]	[redacted]

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Page 15 - Additional Information

28. Other applications.

Is your organisation submitting another application(s) to this fund, or any other Ministry for the Environment fund, this year?	No
If yes, provide further information below. See page 34 of the guide for information on how to complete this question. (maximum 100 words)	

29. Is there anything else we need to consider about your application?

This space is for you to provide any additional information that your organisation considers important, but has not been covered in previous sections of this application form. See page 34 of the guide for information on how to complete this question. (maximum 250 words)	Waste Management in NZ is largely controlled by the private sector. Auckland Council in their WMMP report that only 17% of the waste stream is controlled by the Council. This is probably typical for NZ. Unless a competitive alternative is available the private sector will continue to dispose of waste in the most cost effective manner. The default option is landfilling for large commercial operators and they will eventually operate as a monopoly. It is difficult for Councils to economically justify substantial change in the waste sector for both collection services and current disposal options. This technology can challenge that monopoly by offering a cost competitive alternative to landfill.

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Page 16 - Declaration

Electronically signing your application.

This declaration must be completed by a person with the organisation's signing authority. See page 34 of the guide for information.

Important: Please contact the Funds Management Team if you have any queries regarding the terms and conditions of the funding deed for the Waste Minimisation Fund.

As a duly authorised representative of the organisation as per Section 1 of this Waste Minimisation Fund application form:

** I declare that I have read the Waste Minimisation Fund Guide for Applicants.*

** I declare that to the best of my knowledge, the information contained in all sections of this application form, or supplied by us in support of our application is complete, true and correct.*

** I declare that I have the authority to sign this application form and to provide this information.*

** I declare that the application is not being made by an organisation that is in receivership or liquidation, or by an undischarged bankrupt.*

** I declare that all regulatory requirements regarding the project have been met, and that any required approvals and/or consents have been granted, if applicable.*

** I understand that information presented to the Minister for the Environment and Ministry for the Environment is subject to disclosure under the Official Information Act 1982.*

** I agree that the Ministry for the Environment may collect information about our organisation from other parties, and may liaise with local and national organisations in respect of this application.*

** I agree that the Ministry for the Environment can undertake a background check on the applicant(s).*

** I declare that I have read, and agree to, the standard terms and conditions of the Funding Deed for the Waste Minimisation Fund.*

Provide any comments regarding the Declaration in this space. (maximum 250 words)	Our main concern relates to work that will provide commercially sensitive or IP outputs. We would be seeking to make amendments to the Deed of Funding that would include: (i) Statements relating to IP ownership, both background and new, being retained; (ii) Limitations on MfE's rights to use, disclose and

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	sublicense; (iii) Limitations on the obligation to make all outputs available to the public; and (iv) Some obligations of confidentiality in favour of the applicant to allow us to report to MfE and to allow MfE to perform their functions, but at the same protect trade secrets, sensitive business information and potential inventions. Amendments would also relate to the Ministry's powers and liability, the granting of security interests, key personnel and the indemnity provision.
Name	s 9(2)(a)
Position	
Signature	

By typing your name in the 'Signature' space provided you are electronically signing this application form.

Date	19/06/2012

Your feedback

Did you find this application form easy to understand and complete?	Mostly
Any general comments?	

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Waste to Gold Alliance Business Plan

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June 2012

Executive Summary

Landfilling is becoming an increasingly expensive option for local bodies and is now strongly discouraged by the New Zealand Government via the Waste Minimisation Act 2008. In 2010, the total waste that New Zealand disposed to municipal landfill was 2.531 million tonnes of solid waste.

In response to this situation, Scion and the Rotorua District Council have jointly developed and provisionally patented a novel technology platform (TERAX™) for deconstructing very high moisture content organic solid waste. This technology has been developed to pilot scale, where trials have been undertaken at the Rotorua waste-water treatment plant on sewage sludge.

Key findings include:

- Up to 30-fold reduction in volume to landfill
- Significant financial benefits accrue where landfill disposal costs exceed an of average $66 per wet tonne(range $42 - $86) depending on the size and plant configuration
- Detoxification and sterilisation of the sewage sludge waste stream
- Recovery of acetic acid, ammonia and phosphorus co-products creating additional revenue streams

This Ministry for Environment Waste Minimisation Fund (WMF) proposal seeks investment to fast-track and de-risk a significant expansion of the current technology to create a full-scale TERAX™ reference plant in Rotorua – the first in New Zealand and first in the world. This will provide the opportunity to engage a large international engineering company as a licensee for the technology and to commercialise it.

The WMF proposal also seeks to support a significant expansion of the technology to process the organic fraction of the Municipal Solid Waste (MSW) stream that is 10 times larger than the sewage sludge waste stream nationally. The development team believes that it can significantly reduce over 60% of the municipal solid waste (MSW) stream to essentially remove the degradable component of currently landfilled solid waste.

The potential impact of this technology for New Zealand is highly significant. Over the entire country it has the potential to reduce the quantity of material going to landfill by over 50%, with some waste streams, e.g. sewage sludge reduced up to 30-fold. It can reduce harm, and can transform hazardous waste into sterile and valuable products.

Overall the WMF proposal represents excellent value for money considering the potential environmental, social and financial benefits for New Zealand including export potential. We recommend that MfE supports this project, to allow the technology to fully achieve its potential.

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CONTENTS

Executive Summary **2**

Introduction **4**
Purpose 4
Situation 4
Scope 5

Key Parties **5**
Structure 5
Rotorua District Council 5
Scion 6

Solution Scenarios **7**
Solution requirements 7
Technology Options 7
TERAX™ Platform 7

The Plan **9**
Progress so Far 9
Proposed Timeline 10
Waste Minimisation Fund Proposal 10
Technology Roll-out Plan 11
Key Milestone 11

Benefits **11**
NZ Market Analysis 11
Non-Financial 11
End-users 12
New Zealand community 12
Direct investors 12
Financial 12

Risk Management **13**

Investment requirements **15**

Commercialisation strategy **15**

Recommendation **15**

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Introduction

Purpose

This business plan outlines the potential waste minimisation benefits for New Zealand arising from the development and national deployment of the TERAX™ waste minimisation platform. The overall goal is to significantly reduce the quantity of New Zealand's organic waste being sent to landfills. This will be achieved through initially targeting sewage sludge (also known as municipal biosolids, at 253,000 tonnes per annum nationally) followed by the organic fraction of Municipal Solid Waste (MSW). Future applications include industrial organic waste arising from the pulp and paper, food, dairy and meat processing operations.

Situation

The New Zealand Waste Minimisation Act 2008 has a stated purpose to encourage waste minimisation and a decrease in waste disposal in order to:

(a) protect the environment from harm; and
(b) provide environmental, social, economic, and cultural benefits.

Landfilling is becoming an increasingly expensive option for local bodies and is now strongly discouraged by the New Zealand Government via the New Zealand Waste Strategy 2002 and the Waste Minimisation Act 2008. In 2010, the total waste that New Zealand disposed to municipal landfill was 2.531 million tonnes of solid waste[1]. The potentially degradable fraction of this waste represents up to 63% of the overall waste stream)[2] [3]. This estimate is based on the *Solid Waste Analysis Protocol* (SWAP) classification of waste components targeting the combined; organics, potentially hazardous, timber, paper, nappies and sanitary, categories.

Sewage sludge from the treatment of sewage are classified as *potentially hazardous* wastes and are therefore not included in the organic waste component cited by MfE. However, the TERAX™ technology easily processes such material and effectively sterilises it.

Landfilling sewage sludge creates a financial burden on Territorial Authorities associated with transport and disposal. It also creates an environmental burden on the landfill area due to leachate generation and their ready conversion to greenhouse gases (e.g. Methane).

The New Zealand Waste Strategy (2002) set targets for reduction in organic waste of:

- 60% of organic wastes from landfill and to be used beneficially by 2005 and to exceed 95% diversion by 2010; and
- divert 95% of sewage sludge disposed to landfill into compost, beneficial use or treated to reduce harm.

In its New Zealand Waste Strategy: Review of Progress (2006), the Ministry for the Environment (MfE) estimated that only 35% of organic waste and 32% of sewage sludges were diverted – both well below target. Since the 2006 Review, the Wellington scheme to divert sewage sludge to produce compost has terminated as has the Rotorua District Council (RDC) which was one of the first to introduce sewage sludge composting in the early 1990's. The proportion of composted sewage sludge has steadily reduced over the

[1] Ministry for the Environment (2011) Solid Waste Disposal, 2010: Environmental Snapshot July 2011. Ministry for the Environment, Wellington. Publication Number: INFO 610.
[2] Ministry for the Environment (2009) Solid Waste Composition: Environmental Report Card July 2009. Ministry for the Environment, Wellington. Publication Number: INFO 420.
[3] Waste Not Consulting (2009), Analysis of Solid Waste at Rotorua Landfill – October 2009.

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last decade due to lack of markets for the compost and onerous quality assurance requirements. Other regions along with some industry producers of sewage sludge have moved to alternative options such as mono-fills and land remediation, effectively avoiding waste levy and ETS obligations.

The revised 2010 New Zealand Waste Strategy enables a more flexible approach to waste management and minimisation through two high level goals: reducing the harmful effects of waste, and improving the efficiency of resource use.

Scope

The scope of this plan relates to the reduction of municipal waste from

1. Sewage sludge from waste-water treatment plants

   Scion, in partnership with the Rotorua District Council, has developed the patented TERAX^{TM} process to a pilot scale to reduce sewage sludge from waste-water treatment plants by >95% as well as producing valuable co-products.

2. Organic fraction of Municipal Solid Waste

   Scion and the Rotorua District Council plan a significant expansion of the existing TERAXTM technology to demonstrate its ability to significantly reduce over 60% of Municipal Solid Waste.

Key Parties

Structure

This Business Plan has been developed by the Waste to Gold Alliance, whose key parties are Scion and the Rotorua District Council. The Alliance has operated as an unincorporated joint venture, through a contractual structure, which the parties are in the process of formalising. All contracts for the 2012 MfE WMF proposal will be managed by RDC on behalf of the Alliance.

The Alliance is actively seeking a large nationally recognised engineering company with the capacity to commercialise this technology nationally and internationally.

Rotorua District Council

The Rotorua District Council (RDC) is an innovative territorial authority located in the heart of the Bay of Plenty. RDC have been aggressively seeking a solution to manage the increasing quantities of sewage sludge that is generated from their Waste-Water Treatment Plant (WWTP). They have recognised that a solution is urgently needed beyond business as usual and have been a key participant in developing the TERAX^{TM} Process to pilot scale. RDC are both an end-user and an investor in this development as they recognise the potential value that can be achieved from its wider application in New Zealand.

RDC have demonstrated a long term commitment to be an early adopter of innovative solutions that deliver good commercial outcomes. Examples include:

- installation of one of the world's first commercial-scale Bardenpho Waste-Water Treatment Plant to remove phosphorus from sewage wastewaters and reduce the eutrophication of the Rotorua lakes;
- development of a commercial composting system for sewage sludge management (90% of sewage sludge processed in 1998, now terminated due to technical and market limitations;

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- installation of an extensive pray irrigation infrastructure for treated wastewater that is built around tourism use of the Whakarewarewa Forest; and
- a successful resource recovery centre that diverts as much material from landfills as traditional kerbside recycling schemes.

Key RDC staff involved in the project include:

s 9(2)(a)



Scion

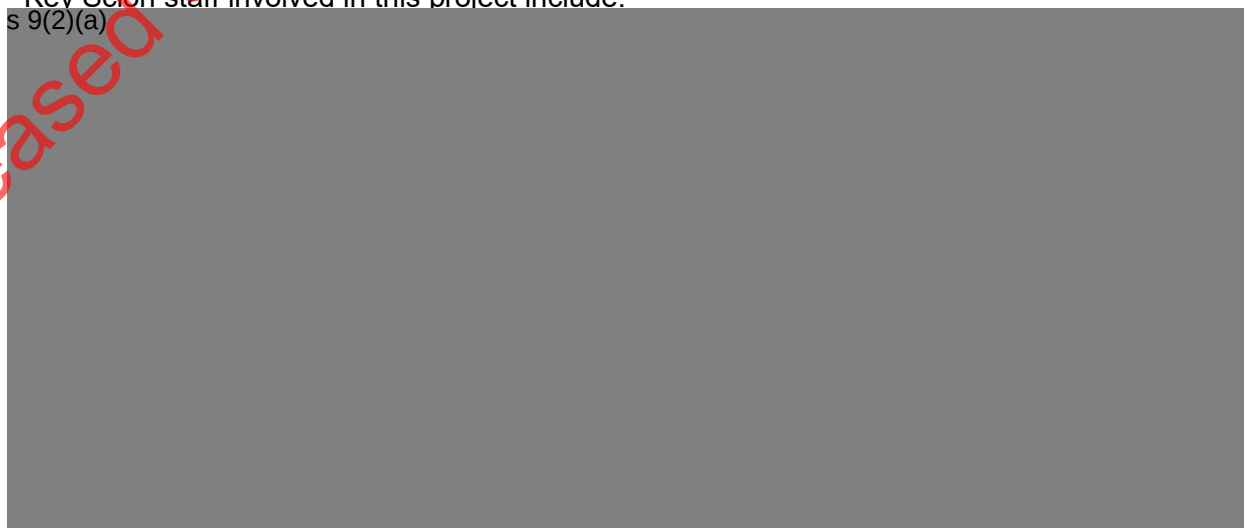
Scion is one of eight Crown Research institutes in New Zealand that delivers benefit to New Zealand through the development of technology-based solutions and partnering with commercial entities to implement these solutions. Scion is highly experienced in managing and delivering publically-funded and public-private co-funded projects and opportunities.

Scion has a strong track record of successes including:

- waste management solutions for the New Zealand pulp and paper industries that have allowed companies to cost effectively meet key discharge consent requirements;
- a nutrient capping system implemented in the Rotorua Lakes (Lake Okaro, since 2007) by Bay of Plenty Regional Council in association with Blue Pacific Minerals Ltd;
- monitoring the impact of wastewater and sewage sludge solutions to a diverse range of clients including PF Olsen Ltd (sewage sludge application to Rabbit Island) and Rotorua District Council (wastewater spray irrigation to Whakarewa ewa Forest);
- the DRYSPEC kiln drying system for Windsor Engineering Ltd, which is used to dry over 90% of all softwoods in Australasia.

Key Scion staff involved in this project include:

s 9(2)(a)



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s 9(2)(a)

Solution Scenarios

Solution requirements

Scion has completed a comprehensive review of technical and management solutions that can address waste minimisation. A sustainable and acceptable option for the long-term disposal of biosolid wastes must be one that:

- Overcomes the current negative perceptions towards beneficial re-use of bio-solids;
- Minimises or eliminates waste residues;
- Eliminates any potential toxicity or human health issues;
- Generates value; and
- Can be implemented at the source of waste generation to minimise transportation costs.

In addition, the long-term economic, environmental and social sustainability of any disposal technology will see an increasing desire to avoid solutions that have:

- high energy demand as energy cost continues to increase;
- large land area requirements;
- produce unacceptable levels of greenhouse gases, either directly or via indirect activities (e.g. transportation);
- impact on neighbouring land users through, for example, odour production;
- cultural issues associated with disposal (e.g. Restoration of mauri through land cleansing)

Technology Options

After completing a comprehensive review of 15 technical and management solutions that could address waste minimisation, Scion ranked each system to assess their acceptability based on a matrix of evaluation criteria. Hydrothermal processes were identified as a having the highest potential to meet the requirements to reduce net energy consumption (i.e. net producer of energy), have a very low land and environmental footprint.

There are a range of hydrothermal processes currently available in the market and a competitor analysis has been undertaken. The different processes largely differ by the presence and type of catalyst used and the nature of the organic waste treated. These technologies are primarily designed to completely eliminate solid wastes during processing. This requires high temperatures and pressures to ensure the organic material is fully converted to carbon dioxide. High capital and operating costs for these plants have limited their broader introduction into the market.

TERAX^{TM} Platform

Scion, in collaboration with RDC, has developed and provisionally patented (Patent No. 598479) a novel technology platform (TERAX^{TM}) for treating very high moisture content organic solid waste. The TERAX^{TM} process specifically deconstructs organic waste streams to deliver substantive volume reduction (>95%) with maximum value recovery.

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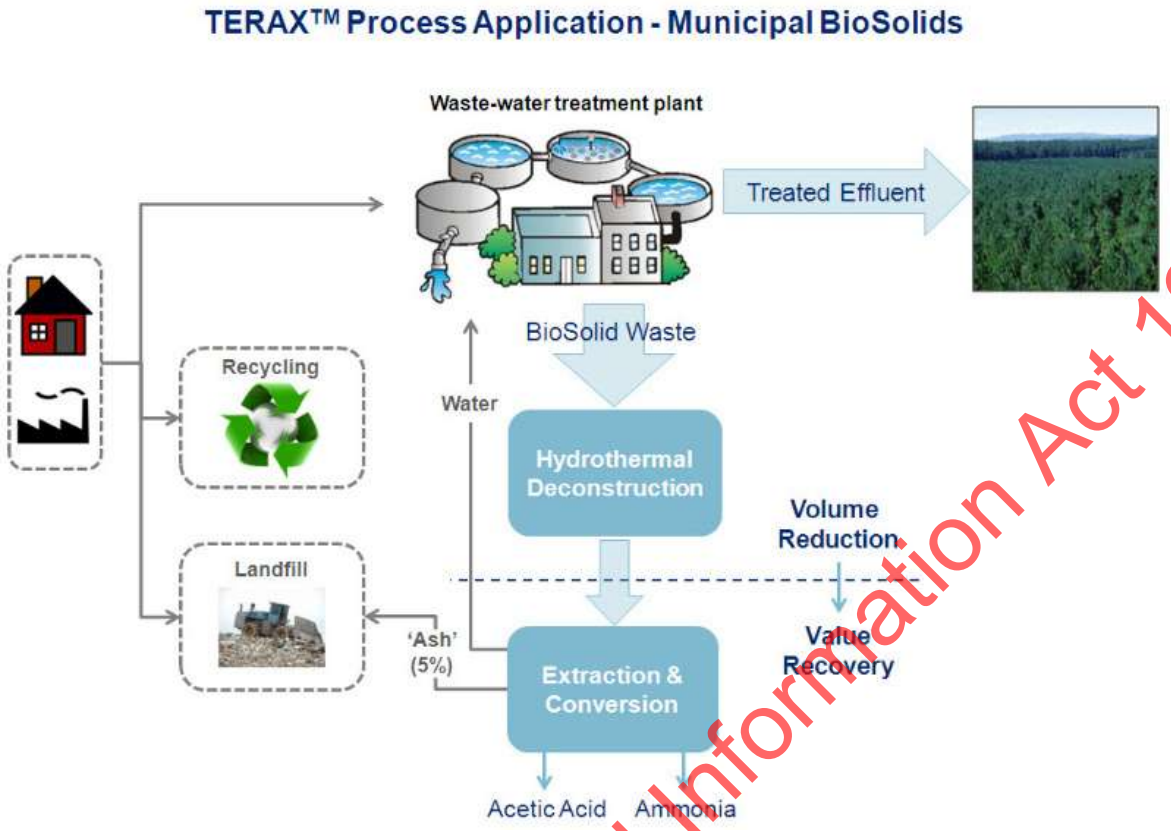


Figure 1 Schematic diagram of TERAX™ technology for sewage sludge processing.

Stage 1 The anaerobic fermentation stage uses bacterial cultures to pre-treat the organic waste, thereby i) improving pumping transferability under high pressure conditions, ii) partially converting bulk organics to thermal oxidation precursors, and iii) reducing the volume of material (and therefore capital/operating costs) that requires downstream hydrothermal oxidation.

Stage 2 The hydrothermal oxidation stage uses high pressure, temperature and oxygen within tightly controlled operating parameters to rapidly and substantially break down and convert organic waste constituents into smaller and simpler compounds, such as fermentable volatile organic acids, ammonia and phosphate, whilst achieving almost total reduction in the solids content:

Value recovery The process is auto-thermal, generating excess heat that can be recovered for external use. The major carbon-derived product from the TERAX™ process is acetic acid, which can be used for a range of value-added benefits, such as:

- Biomethane generation for electricity production, transportation or industrial/municipal heating;
- Feedstocks (current market value $1200/t) in industrial applications, such as de-icing chemicals, bioplastics production, or conversion to liquid biofuels;
- Readily degradable carbon supplement for sewage treatment processes.

Nitrogen is recovered from the aqueous phase as ammonia for use as a fertiliser or platform chemical. The remaining ash product contains approximately 38% phosphate, which is greater than that in superphosphate fertilisers.

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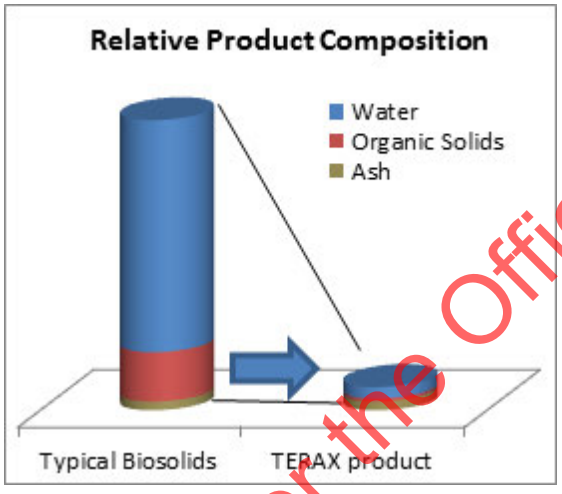
Table 1 describes the key components of a basic mass balance surrounding the TERAX™ process, with Figure 2 showing examples on input and output streams.



Figure 1 Examples of input and output streams for the TERAX™ process.

Table 1 Mass balance across TERAX™ process.

Components	Inputs	Outputs
Water	90	90
Organic Solids	8.5	0.5
Ash	1.5	1.5
Liquid & gas products		8.0
Total	**100**	**100**



Scion has designed and manufactured a pilot-scale TERAX™ deconstruction system that integrates a proprietary on-line monitoring/control system, biological fermentation, high pressure reaction vessels and downstream processing and testing infrastructure. This system has been operating at the Rotorua District Council waste water treatment plant for twelve months. Further work has also been completed on added value analysis, including laboratory scale biomethane generation and nutrient recovery processes.

The Plan

Progress so Far

Scion, in partnership with The Rotorua District Council, has developed the patented TERAX™ platform. Work to date is summarised in the accompanying Feasibility Study, but key points are:

- In 2009, Scion conducted proof of concept testing in the laboratory to gain initial understanding and data about process performance.
- The results of the proof of concept trials were extremely encouraging, which led to the development of a pilot-scale plant sited at the RDC's waste-water treatment plant. The pilot plant is capable of processing 200 kilograms of sewage sludge per hour and it validated the proof of concept results that >95% reduction in solids was achievable.
- A detailed techno-economic model has been developed to calculate operating and capital costs as multiple scale and on a range of feedstocks.
- This work has identified a number of process improvements over more conventional hydrothermal oxidation in the published literature, leading to an

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international patent filing and the creation of the TERAX™ trademark for the new process.

The final phase of this development is to build a full-scale demonstration plant that will process the entire RDC sewage sludge production. This project is the subject of a 2012 MfE Waste Minimisation Fund proposal.

Proposed Timeline

The proposed timeline for the full-scale TERAX™ plant development is:

- June 2012, submit proposal to MfE Waste Minimisation Fund,
- October 2012, MfE Waste Minimisation Fund project contracted, joint venture incorporated, commercialisation partner selection in progress, and full-scale TERAX™ plant detailed design in progress,
- March 2013, completion of detailed design
- May 2013, procurement complete and success award of the construction contract
- February 2014, construction completed
- June 2014, commissioning completed and plant handover to RDC

The proposed timeline for the R&D on Municipal Solid Waste is:

- October 2013, technologies for MSW pre-treatment identified and tested
- October 2014, pre-treatment and hydrothermal stages integrated
- October 2015, pilot-scale studies on Municipal Solid Waste complete

Waste Minimisation Fund Proposal

The proposed Waste Minimisation Fund investment is critical to leverage end-user funding and de-risk the project over the next two years to construct a full-scale demonstration TERAX™ plant at Rotorua.

This project seeks to;

1. Enact a significant expansion to the treatment of organic solids from municipal wastewater treatment plants and build a full-scale demonstration facility that will also be a reference site for market expansion.
2. Develop the proof of concept and pilot scale exemplars for a significant expansion of the TERAXTM technology to the treatment of Municipal Solid Waste, a waste stream that s 10 times larger than the organic solids from municipal wastewater treatment plants.

The full scale TERAX™ plant will be sited at the RDC waste-water treatment plant and will be sized to process its entire sewage sludge output based on a 20 year growth projection. When the WMF application is approved, the plant is expected to be fully operational within two years, and should reduce the amount of sludge being sent to landfill by over 95% (8,500 tonnes per annum to 275 tonnes per annum), a 30-fold decrease in the volume of solids to landfill.

The Rotorua District Council is a typical exemplar for engagement with New Zealand territorial authorities, and they have identified sewage sludge as their current priority waste issue. Developing this reference site is expected to immediately engage other TLA's in commercial development.

A key component of the WMF project will be the selection of one or more commercial engineering companies to design and build the full-scale TERAX™ plants. This company will be licensed by the Alliance to undertake this work and will be expected to spearhead the commercial exploitation of this technology.

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In addition, the R&D team will be concurrently developing the next generation of this technology to reduce over 60% of the Municipal Solid Waste, a waste stream that is nationally 10 times larger than the sewage sludge stream.

Technology Roll-out Plan

The Bay of Plenty (BoP) was initially chosen as the starting point since it represents a microcosm of New Zealand waste management issues. It is the fastest growing part of New Zealand, creating pressure on sewage sludge disposal. With a successful MfE WMF proposal, the Rotorua demonstration site should be fully operational by 2014 as a full-scale exemplar of the process.

The BoP also contains national-scale examples of other biological industry sectors suitable for processing by the TERAX™ Process. The dairy sector, pulp and paper sector, horticulture, fishing and food processing, all have plants creating organic waste in the BoP within a relatively small area.

The high interest in this technology across New Zealand may mean that the BOP focus is unnecessary and the platform can be readily implemented at a larger national scale if an appropriate commercialisation partner and investor is secured during the next phase of development. The commercial partner will be expected to insert this technology into their sales channels and work with the Alliance to approach all suitable Municipal Authorities with a target of installing at least one TERAX™ plant per year for the next 10 years.

Key Milestone

A critical milestone for the scale-up and commercial development of the TERAX™ Process is to construct a full-size reference site at the Rotorua District Council Waste-Water Treatment Plant. The purpose of the Waste Management Fund project is the fast-track and de-risk this investment, while bringing a commercial engineering partner on board.

Benefits

NZ Market Analysis

The primary customers of the TERAX™ Process are territorial authorities seeking to reduce the quantity of organic municipal waste material being sent to landfill. The other significant customers are major industrial operations that create biological waste streams (e.g. pulp and paper, dairy, and meat processing) and need to dispose of large volumes of primary and secondary sludges produced from these waste streams. Another potential customer segment is landfill operators. Using this technology on site could significantly increase the life of their current landfill site.

Non-Financial

To determine the potential market size for organic waste deconstruction in New Zealand, Scion surveyed territorial authorities and regional councils in 2008-2009 to obtain data characterising the composition and size of waste streams in New Zealand (full report available on request). As with previous studies, the data accuracy varied considerably between regions. Data was not scaled to take account of these gaps.

Based on the survey results, the total amount of material that has the potential to be treated using the TERAX™ technology platform was 2.5M tonnes per year. With full market penetration, the TERAX™ technology has the potential to reduce this to less than 100,000 tonnes per year. Using no other technology, this could increase the life of New Zealand's landfills by up to 30 years.

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As described above in the technology roll-out plan, a conservative growth strategy would see 6-8 TERAX^{TM} plants in operation in the Bay of Plenty and Auckland regions within 5-10 years. The current quantity of waste entering landfills from these sites is 356,000 tonnes per annum, which would be reduced to 18,000 tonnes per annum.

The 2009 survey data was updated in 2010, which showed that the national sewage sludge waste stream totals 253,000 tonnes per annum. The national Municipal Solid Waste stream is approximately 10 times larger.

It is clear that as the TERAX^{TM} technology is deployed, it has the potential to have a very significant impact on the amount of waste entering landfills nationally. Over the entire country it has the potential to reduce the quantity of material going to landfill by over 50%, with some waste streams, e.g. sewage sludge reduced up to 30-fold. It can reduce harm, and can transform hazardous waste into sterile and valuable products.

Proof-of-concept studies, embodying technical, economic and sustainability assessments, have demonstrated that the TERAX^{TM} technology should achieve:

- 96% reduction in landfill costs;
- 76% reduction in greenhouse gas emissions;
- 40% reduction in eutrophication potential; and
- 90% reduction in photochemical ozone creation potential.

In addition, the TERAX^{TM} technology detoxifies the sewage sludge waste stream, kills pathogens and produces essentially sterile output streams.

In summary, the successful national implementation of the TERAX^{TM} technology platform would reap benefits to:

End-users

- An ability to substantially reduce the costs associated with current municipal sewerage and industrial wastewater treatment and, more broadly, organic waste disposal;
- The potential to reduce their environmental footprint through reduction in waste transportation, landfill leachates and greenhouse gas emissions;
- The ability to develop new revenue streams through sales of products of the process.

New Zealand community

- Reduced environmental impacts through reduced waste to landfill, reduced greenhouse gas emissions, reduced eutrophication and reduced ozone depletion;
- Improved capacity to move towards the NZ Waste Strategy Targets;
- Ability to develop new TERAX^{TM} technology manufacturing opportunities for domestic and export development;
- Enhance New Zealand's environmental credentials and build reputation for clean technology development.

Direct investors

- An economic return from exploitation of the technology both in New Zealand and internationally.

Financial

A techno-economic model that includes a discounted cashflow analysis and accounts for capital and operating costs over the selected period has been developed for the TERAX^{TM}

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technology. The model has recently been peer reviewed by Transfield Worley, who considered it 'fit for purpose as a preliminary investment appraisal tool'.

Three different sewage sludge treatment scenarios were run through the model corresponding to small (Rotorua size), medium and large (Mangere -Auckland) plants, including the returns from acetic acid and ammonia. The time period was set at 20 years at a discount rate of 8%, with the results shown in Table 2.

Table 2 Techno-economic model for three TERAX™ plants including returns from acetic acid and ammonia.

Output	Small	Medium	Large
Plant annual wet tonnes (t)	8,500	62,500	150,000
Landfill disposal costs ($/t)[4]	$125	$125	$125
TERAX™ cost per wet tonne ($/t) NPV	$68 - $86	$47 - $58	$42 - $51
Benefit ($/t)	$39 - $57	$66 - $78	$74 - $83
Annual benefits ($M/y)	**$0.33 - $0.48**	**$4.2 - $4.9**	**$11.1 - $12.4**

At the current landfill costs for Rotorua, this technology shows excellent annual returns.

The technology roll-out plan estimates that by 2020 the TERAX™ process will be deployed at sites currently producing 356,000 tonnes of solid waste per annum. The average benefit per tonne in Table 2 is $66 per wet tonne. When this is applied to 29/30 of 356,000 tonnes of organic waste, the net financial benefit is close to $23M per annum.

Risk Management

The overall technical and operational risk will be managed via best practice engineering approaches especially as a large and experienced engineering company manages the technology commercialisation. This includes staged development of the full scale reference plant incorporating testing of the economic and engineering feasibility at each stage.

The risk management plan for this development recognises issues that could either hinder or stall the implementation of this business plan. These include:

- **Adverse change in government policy**: New Zealand will be under increasing pressure from our major markets to improve its environmental performance. Reduction of recoverable material, particularly the organic fraction, from landfills will be a prime target as has been demonstrated by the European Union;
- **The needed capital is not available**: Assuming the process is technically and economically robust, then pressure to adopt processes of this type (as Best Available Technologies) will continue to drive investment in this direction;
- **The district plan does not allow for construction of such plants**: If the territorial authority considers that the building of a plant is a priority, a specific consent or designation in the district plan can be implemented under the Resource Management Act (1991). As a precedent, the TERAX™ plant has already been designated into the RDC district plan;
- **The benefits do not outweigh the costs**: The territorial authority or private business will need to consider whether they are prepared to risk the additional cost of alternative disposal when considering the long term implications (e.g. possible increases in Waste Levy charges, uncertainty of ETS costs);

[4] Includes dewatering costs, transportation and landfill gate fee

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- **A suitable engineering company to commercialise the technology cannot be found**: Several national and international engineering companies with appropriate experience have already expressed interest which to date has not been actively sought;
- **The engineering capability to build the plants may be outstripped by the demand for new plants**: Engineering expertise could be sourced internationally (e.g. through licensing to major environmental engineering companies, such as Veolia) and introduction could be staged to accommodate availability of facilities and people;
- **Ratepayers do not accept the need for the plants**: The ten year market growth plan only considers participation in the BOP region and one plant in Auckland. Other territorial authorities and businesses will be approached;
- **The existing investment in infrastructure precludes consideration of alternative treatment processes**: The most likely alternative infrastructure for wastewater treatment is anaerobic digestion. This can be readily integrated with a new deconstruction plant to provide the combined benefits demonstrated during our feasibility study. For landfills, the methane generated by the landfill can be recovered using a number of currently available technologies. Often these are in the form of micro-turbines generating electricity. A TERAX^{TM} plant could be deployed on-site to generate the precursors to methane. With some additional processing more methane could be generated and fed into the existing turbines.

Taking these factors into account, the Project's risk management strategy is shown in Table 3.

Table 3 Risk management strategy

Risk source	Management approach
Capital risk and return on investment	Managed in accordance with best practice engineering development with on-going review of economic criteria. Within Scion it is managed using a Stage Gate process whereby each progression to a new stage is reviewed and agreed to.
Technical risk	The key sources are: *Unfavourable energy balance*: current evaluations indicate that the energy balance is neutral but the aim is to provide net energy outputs. This may integrate use of low grade heat or geothermal energy. *Managing inorganic build up (scaling):* Scion has an alliance with University of Manitoba, who specialise in this area. They will be used as technical experts to assist in assessing and alleviating this issue. *Scale-up risks*: Managed through involvement of very experienced external engineers and engineering companies
Social and public risk.	The re-use of products from sewage sludge may create concerns with public and in particular with Maori. This is being worked through with local Iwi and is a key role for the Project's Maori liaison team. The plant uses high pressures and temperatures. The process will be subjected to full HAZOP analyses at each stage. Public acceptance is not expected to be a problem as such processes are now quite common in public works activities. However it will be part of the public consultation process.
Market risk	The RDC are very interested in a full-scale plant with final sign-off due in July 2012, they have included two such plants in their 10 year plan budget. Interest has been formally expressed by at least 6 TLA's one waste management company (Watercare) and 3 industry end-users (Wallace Corporation, Norske Skog and Carter Holt Harvey. These interests are now being formally developed. A full-scale demonstration plant will significantly improve market acceptance of this technology.

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INVESTMENT REQUIREMENTS

Key areas for future investment in the TERAX™ technology are:

1. Developing a full-scale demonstration site to showcase the technology in its application to the treatment of biosolids from municipal wastewater treatment plants;
2. Developing the next generation of the technology for application to Municipal Solid Waste;
3. Developing future generations of the technology for application to waste streams from different primary industries, such as pulp and paper, meat, dairy, etc.; and
4. Developing scaled-down variants of the technology (e.g. transportable modules for application to smaller waste streams at a local level.

The techno-economic model of the TERAX™ technology has been designed to quantify the capital and operating costs for a particular plant, once its operating parameters have been entered into the model.

The techno-economic model was set up for a full-scale TERAX™ plant sited at the RDC waste-water treatment plant sized to process its entire sewage sludge output with a 20-year growth projection, varying the choice of oxidant (air or oxygen). The model estimated the following costs for this plant:

- Capital cost: $4.99-5.33M
- Annual operating costs: $1.09-1.59M

The capital cost above has taken into account all activities required to create a fully functioning plant. Although contingency has been allowed as part of the NPV cost analysis, there remains considerable risk associated with the cost analysis to full-scale:

- this is an application of a hydrothermal (wet oxidation) technology, never attempted in New Zealand
- This is an application of a novel technology-hybrid biological hydrothermal technology (TERAX™).

Thus, it is recommended that steps be taken to ensure that sufficient capital is available to cover the likely unidentified costs development hurdles, and commissioning challenges which new applications bring. Seeking external sources of funding for mitigation of this development risk is recommended. Given the national-good benefit which will arise from successful adoption of the technology, application to NZ government funding – particularly the MFE Waste Minimisation Fund - would be appropriate.

COMMERCIALISATION STRATEGY

The key parties in the Waste 2 Gold joint venture Alliance are Scion and Rotorua District Council. As full commercial implementation is non-core business for both Scion and RDC, a commercial partner must be sought.

A common thread with most technology commercialisations is the need to secure manufacturing and sales channels for the new technology. License (or outright sale) agreements are often enacted with the sales organisation.

On 31 May 2012, the Rotorua District Council issued a Request for Registration of Interest for the Design, Project Documentation and MSQA Services to successful commissioning of the proposed demonstration-scale TERAX™ plant for treatment of sewage sludge at the RDC wastewater treatment plant. The request seeks Registrations of Interest from

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companies by 26 June 2012. Several engineering companies have already expressed interest in undertaking this role.

The process of selecting a suitable commercialisation partner is expected to be completed by the time MfE has approved a 2012 investment proposal from the Rotorua District Council in collaboration with Scion.

The nature of the TERAX^{TM} technology platform and its wide potential application across a number of different industries makes the management of its commercialisation and continued development an important strategic priority for the Joint Venture. In fact, at this stage of the development and with an eye to the future, it will become increasingly important to incorporate the current unincorporated Joint venture.

The Incorporated Joint Venture will then be in a position to license the TERAX^{TM} technology to the selected commercialisation partner for applications to municipal waste. This agreement may also allow for the commercialisation partner to also have licenses for the technology in other industries.

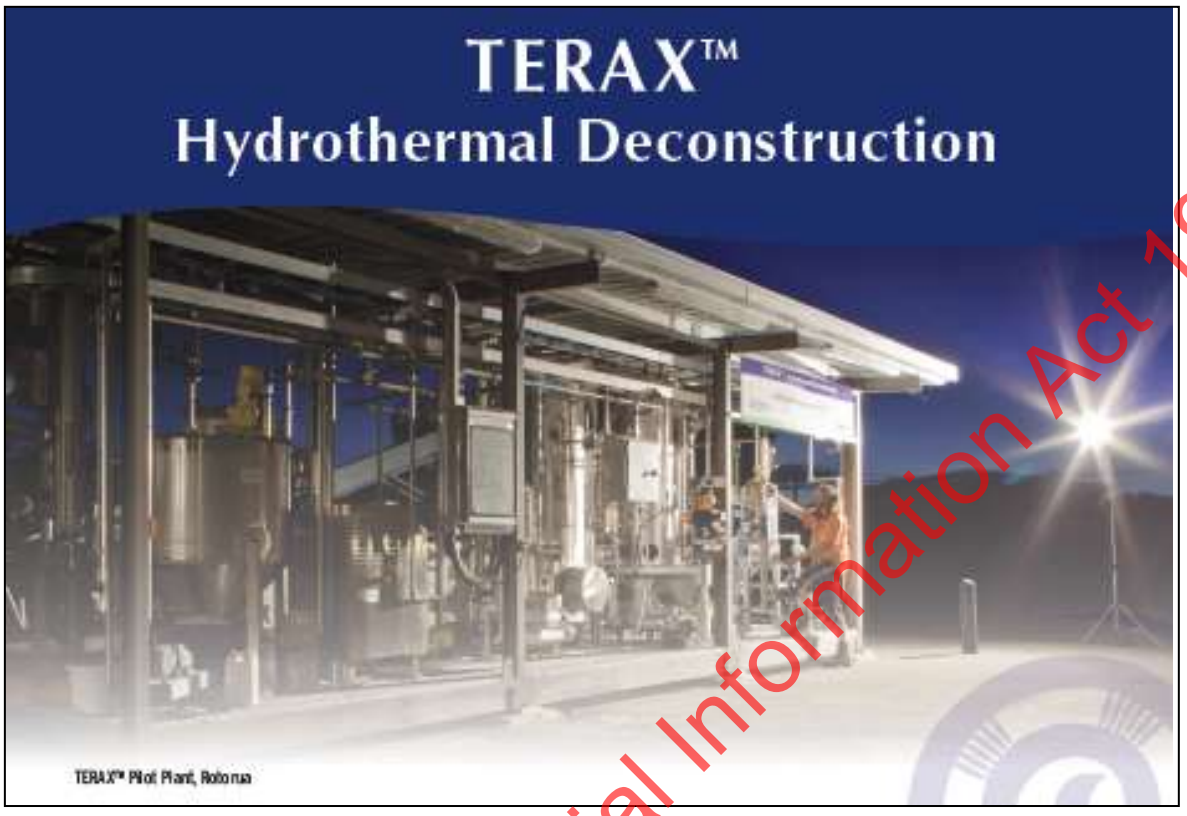
RECOMMENDATION

Scion and the Rotorua District Council have jointly developed the TERAX^{TM} process for deconstructing sewage sludge from waste water treatment plants. Pilot plant operation at the RDC waste water treatment site, including technical, economic and sustainability assessments; has successfully demonstrated that the TERAX^{TM} technology can achieve:

- 95% reduction in sewage sludge going to landfill;
- 76% reduction in greenhouse gas emissions;
- 40% reduction in eutrophication potential; and
- 90% reduction in photochemical ozone creation potential
- detoxification of the sewage sludge waste stream
- pathogens and produces essentially sterile output streams
- acetic acid production for value creation
- nitrogen recovery as ammonia for additional value creation
- residual solids have ~38% phosphate content, greater than superphosphate
- significantly positive financial benefits for municipal authorities with landfill costs greater than $66 per tonne of wet solids.

RDC is now committed to moving to the next phase of development as an end-user and reference site. Both parties have confirmed a desire to continue invest capital and operational funding. We also recommend that continued co-investment from MfE be sought for the project to build a full-scale reference plant at Rotorua with an associated significant expansion of the underpinning R&D to extend the technology to process the larger Municipal Solid Waste stream.

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Feasibility Study

June 2012

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Background

In 2010, New Zealand disposed of 2.53 million tonnes of waste to municipal landfills. Volumes to industrial or private landfills are difficult to ascertain, but are estimated to be of a substantial magnitude. Landfilling is becoming an increasingly expensive and environmentally unsustainable option for local bodies and is now strongly discouraged by the New Zealand Government via the Waste Minimisation Act 2008.

The New Zealand Waste Strategy (2002) targeted significant reductions in organic wastes (95% diversion by 2010). However, in its 2006 review the Ministry for the Environment (MfE) estimated that only 35% of organic wastes and 32% of sewage sludge were being diverted. The underlying causes for this failure lie in the economics, performance and market constraints of existing technology options, such as composting, incineration and anaerobic digestion.

For the past six years, Scion has been actively pursuing a Waste 2 Gold research programme, which seeks to develop technology platforms that address the current limitations to organic waste diversion by:

- Achieving substantial volume reductions -
    - effectively eliminating the need for landfilling or downstream marketing of partially converted waste products;
- Maximising embodied energy and chemical recovery -
    - providing compelling, positive economic returns from waste use;
- Ensuring recalcitrant/harmful contaminants are destroyed or segregated –
    - mitigating key environmental risks from organic waste disposal.

In 2008, Scion partnered with the Rotorua District Council to form the Waste 2 Gold Alliance – an unincorporated joint venture dedicated to i) solving local constraints to sewage sludge and organic waste landfilling in Rotorua and ii) creating a critical mass of stakeholder and end-user engagement to commercialise resulting successful technologies to the broader NZ waste management community.

This partnership has developed a novel, proprietary technology platform (TERAX™; NZ Patent No.NZ598479) for treating very high moisture content organic solid wastes. The TERAX™ process specifically deconstructs organic waste streams to deliver substantive volume reductions (> 95%) with maximum value recovery.

The success of TERAX™ in achieving the desired outcomes has been demonstrated at pilot plant scale, which was completed in parallel with a rigorous, externally reviewed techno-economic feasibility study and market assessment.

Process Description

TERAX™ is a hybrid process that combines the strengths of biological and thermo-chemical approaches to waste treatment to improve the overall efficiency, effectiveness and economics of organic solids destruction and value recovery:

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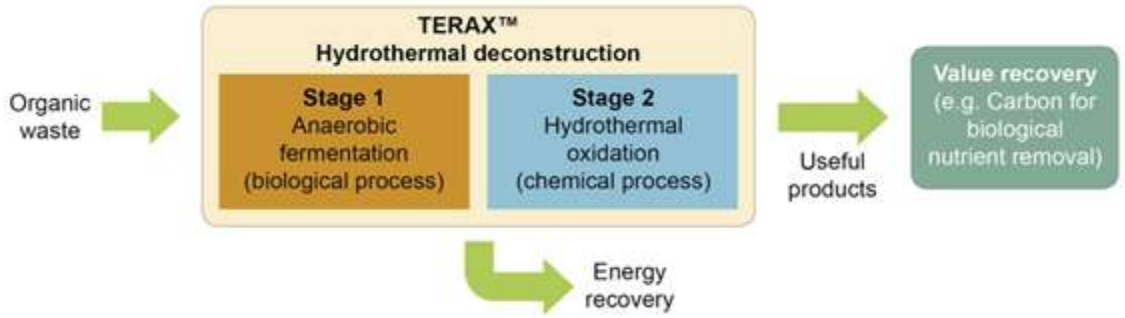


Figure 1: TERAX™ process schematic

Stage 1 The anaerobic fermentation stage uses bacterial cultures to pre-treat the organic waste, thereby i) improving pumping transferability under high pressure conditions, ii) partially converting bulk organics to thermal oxidation precursors, and iii) reducing the volume of material (and therefore capital/operating costs) that requires downstream hydrothermal oxidation.

Stage 2 The hydrothermal oxidation stage uses high pressure, temperature and oxygen within tightly controlled operating parameters to rapidly and substantially break down and convert organic waste constituents into smaller and simpler compounds, such as fermentable volatile organic acids, ammonia and phosphate, whilst achieving almost total reduction in the solids content.

Value recovery The process is auto-thermal, generating excess heat that can be recovered for external use. The major carbon-derived product from the TERAX™ process is acetic acid, which can be used for a range of value-added benefits, such as:

- Biomethane generation for electricity production, transportation or industrial/municipal heating;
- Feedstocks (current market value $1200/t) in industrial applications, such as de-icing chemicals, bioplastics production, or conversion to liquid biofuels;
- Readily degradable carbon supplement for sewage treatment processes.

Nitrogen is recovered from the aqueous phase as ammonia for use as a fertiliser or platform chemical. The remaining ash product contains approximately 38% phosphate, which is greater than that in superphosphate fertilisers.

Technical development

Concept design The TERAX™ concept has its genesis in a Foundation for Research, Science and Technology funded project undertaken by Scion, which investigated approaches to improving waste management for the pulp and paper industries – New Zealand's largest industrial organic waste producer. An extensive literature review and assessment methodology ranked all significant domestic and international organic waste processing technologies (including landfills) against pre-determined performance criteria. The study highlighted hydrothermal oxidation processes, which ranked first as a long term sustainable treatment solution.

In parallel to this research programme, the local municipality responsible for solid waste disposal, the Rotorua District Council, undertook an extensive procurement exercise with the objective of securing a sustainable disposal technology for its sewage sludge, which were no longer able to be composted or landfilled. Despite evaluating numerous options , none were found to be satisfactory.

As a result of these activities, the two parties recognised their convergent interests in this area and created a formal collaboration to explore options utilising hydrothermal oxidation as a platform for sewage sludge management at Rotorua.

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Proof of Concept trials In 2009, Scion conducted an extensive laboratory evaluation of hydrothermal oxidation using RDC sewage sludge to establish proof of concept for the technology. Results from this work (depicted in Figure 2):reinforced the desktop outcomes and identified excellent potential for the technology to meet RDCs long term disposal needs

- >95% volatile solids destruction (90% total solids) ;
- high conversion rates (200 kg/t dry sludge) to an acetate-rich carbon supplement for the RDC wastewater treatment plant (WWTP);
- over ~75% conversion of sludge nitrogen to ammonia;
- Retention and concentration of solid phase phosphorus (38% as phosphate)



Components	Inputs	Outputs
Water	90	90
Organic Solids	8.5	0.5
Ash	1.5	1.5
Liquid & gas p oducts		8.0
Total	**100**	**100**

Figure 2: Depiction of sludge conversion

More importantly, this work identified a number of process improvements over more conventional hydrothermal oxidation in the published literature, leading to an international patent filing and the creation of the TERAX^{TM} trademark for the new process. The TERAX^{TM} process continues to be trialled at laboratory scale on a range of other organic waste streams, such as food wastes, pulp and paper residues, lakeweed, meat and dairy processes wastes, and spent yeast products, with significant success to date.

Pilot plant and experimental program In 2010, RDC and Scion committed funding to construction of a pilot plant facility, which would allow:

i) optimisation of process conditions and multi-stage integration;
ii) testing of process outputs for suitability in the RDC biological nutrient removal wastewater treatment system;
iii) evaluation and calibration of a techno-economic model of the TERAX^{TM} technology; and
iv) provision of performance and design metrics for a full-scale demonstration plant.

The Ministry for Environment (MfE) Waste Minimisation Fund (WMF) to supported the pilot-scale development through to June 2012, as a result of a successful Scion bid.

The pilot plant was built by Longveld Engineering, Hamilton, using a technical specification prepared by Rotorua-based consulting engineers Allan Estcourt Ltd. It was officially opened on 31 May 2011. The facilities include three individual pilot plant modules for evaluating both process and product performance.

- Anaerobic fermentation unit (Figure 3b) – 2000 L capacity; onsite August 2011

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- Hydrothermal oxidation unit (Figure 3a) – 2 x 200 L capacity; onsite May 2011
- Biological nutrient removal unit[1] – 2 x 1000 L capacity; onsite Jan 2011



Figure 3: a) Hydrothermal oxidation module & b) Anaerobic fermentation module

This pilot phase of the project had a budget of approximately $3.5 million, made up of funding from RDC ($1.7M), Scion ($800K), and the MfE Waste Minimisation Fund ($1.0M). It has involved the establishment of substantial pilot plant facilities and associated operational trials over a two year period.

Key outcomes of the pilot-scale phase of the programme have been:

1. Substantive confirmation of laboratory-scale results:

a. The fermentation module has demonstrated effective high rate fermentation. The target feed solids concentration (6%) has been met and the module has operated continuously for six months, generating 20-30% solids destruction from fermentation alone and good yields of short chain fatty acids.
b. Demonstrated efficiencies in hydrothermal oxidation. High organic solids destruction (greater than 90%), nutrients conversion and dissolved organics production have been achieved within our cost envelope when used in combination with the fermentation stage – a key element embodied by the hybrid TERAX™ process.
c. Excellent performance as a carbon supplement to the BNR system. The WWTP testing has identified ammonia removal as key to use of the TERAX™ liquors as a final stage denitrification carbon source and lead to opportunities for further IP protection in this space.

2. Identification of key engineering challenges:

a. Pump identification, specification and maintenance have proven critical requirements, as often there is a multiple criterion on the pump duty (pressure, temperature and presence of abrasive materials). Critical equipment redundancy will be important to stable operation.
b. Oxygen control is vital for ensuring the correct conversion reactions occur without excess costs of supply. Scion's proprietary on-line gas and liquid monitoring system (TOGA) has proven invaluable to optimisation and control strategies;
c. The system has significant levels of hazard, coupled with some complexity. Excellent systems, procedures and high automation levels for plant safety and operation have been developed for the next phase of scale-up.

[1] pre-existing unit provided in-kind by Scion

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Once the final optimisation studies on sewage sludge are completed, the pilot-scale facility will be an ideal platform for extending the application focus to other waste streams, such as mixed organic municipal wastes.

Overall, the pilot phase testing of the TERAX™ has been very successful and addressed all key technical performance barriers and risk elements for further enhancement and scale-up. The results have been sufficient for RDC to commit to further capital investment in the next stage of development – demonstration full-scale (8,500 t/yr current capacity). In addition, availability of the plant for visits by potential end users of the technology has been a critical element in the very positive engagement we have achieved with municipal and industrial organic waste managers. We anticipate that TERAX™ will become a real solution to their future disposal requirements.

Techno-economic analysis

A detailed techno-economic model has been developed for the TERAX™ technology that includes process sensitivity analyses, a discounted cashflow analysis and accounts for capital and operating costs over the selected period. An environmental consultancy company, AWT Water Ltd, who have broad experience in a number of industries and technologies (including pulp and paper effluent treatment and municipal water and wastewater treatment),was contracted to supply the expertise for the process engineering elements of the techno-economic analysis.

The overall techno-economic model was recently successfully peer reviewed by Transfield Worley, a large engineering company with extensive experience in the types of high pressure, advanced engineering components embodied by the TERAX™ process.

To test the economic feasibility of the TERAX™ process, three different sludge treatment scenarios arising from the model were evaluated (Table 1). These correspond to small (current Rotorua WWTP scale), medium and large (Mangere WWTP scale) plants and include value-add returns from organic acid and ammonia[2]. The time period for these analyses was set at 20 years with a discount rate of 8%:

Table 1: Modelled economic outputs for sewage sludge processing

Output	Small	Medium	Large
Plant annual wet tonnes (t)	8500	62,500	150,000
TERAX™ cost ($/wet tonne) NPV [3]	68 - 86[4]	47 - 58	42 – 51
Landfill disposal costs ($/t)[5]	125	125	125
Benefit ($/t)	39 - 57	66 -78	74 – 83
Annual benefit ($M / yr)	0.33 - 0.48	4.2 – 4.9	11.1 – 12.4

At the current landfill costs for Rotorua, this technology shows excellent economics within a capital costs and payback window that, coupled with its environmental/social criteria, meets RDC's investment criteria . It is worth noting that an external review of landfill costs in NZ by MWH Ltd concluded that Rotorua is very much at the lower end of the cost spectrum, suggesting that the economic benefits of TERAX™ will be significantly higher for most other users.

[2] $500/tonne for acetic acid, $350/tonne for ammonia
[3] Net present value (NPV) based analysis, includes cost of capital, annual costs and revenues
[4] Ranged values in table generated from base cost, versus elevated capital cost modelled from application of Lang factor analysis
[5] Includes dewatering costs, transportation and landfill gate fee

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Overall, the techno-economic model has proven invaluable as a tool for analysing the opportunity for processing of organic sludges using this technology. The model outputs, in conjunction with the pilot plant programme, has been used to provide confidence that the Waste 2 Gold Alliance should proceed to the next stages of the development programme – demonstration full-scale processing of all the RDC sludge. In addition, a significant expansion of the hybrid hydrothermal oxidation platform into the more challenging organic fractions of municipal and industrial landfills is proposed.

Competitor and market analysis

Technical options

A broad range of technical options exist for addressing value recovery from organic solid waste. Important categories and comments around these are addressed in Table 2.

Table 2: Technical options for value recovery from solid waste

Technology	Capital costs	Volume reduction	Value recovery	Hazard removal	Compliance costs
Incineration and gasification	High	High	Moderate (moisture content limits energy recovery)	High	High (air)
Thermal drying	Moderate	Low (water removal only)	Low	Moderate (metals & nutrients remain diluted in product)	Med/Low
Wet oxidation-full destruction	High	High	Low	High	Med/Low
Composting (incl. vermicomposting)	Low	Low (negative if bulking agents used)	Low (limited product markets	Low (pathogen removal only)	Med/High
Anaerobic digestion	Moderate	Moderate (further treatment needed)	Moderate (biogas)	Low (hazards transferred to liquid and residue phases	Low
TERAX™: combined biological-hydrothermal	High	High	High	High	Med/Low

Compelling technical aspects of the TERAX™ technology include

- no drying requirement- making a significant impact on energy costs and recovery compared with other thermal technologies;
- minimisation of dewatering costs at treatment plants;
- essentially complete (>90%) solids destruction;
- value recovery potential for three components (carbon, nitrogen phosphorus);
- increased organic carbon value recovery due to combined hybrid process
- significantly lower gas cleanup costs c.f. incineration;
- guaranteed product sterility.

Competitor Analysis

Scion and RDC have been actively assessing the most suitable options for sewage sludge and organic waste disposal. A detailed technology ranking by Scion favoured hydrothermal oxidation over 15 other disposal technologies and practices. A thorough analysis of options by RDC, as an end-user, failed to find an existing acceptable option

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that would meet its economic and environmental criteria. Scion has also participated in international visits and conferences to identify emergent platforms – and has found nothing comparable to this technology.

A technical visit to Europe by one project staff member s 9(2)(a) allowed visits to a number of companies involved in wet oxidation (small-scale - Granit Technologies, Switzerland; large-scale - Veolia Water, France). This visit confirmed wet oxidation is a re-emerging technology, competitive and different to incineration (the dominant destructive route for sewage sludge). Indeed, there is a New Zealand-based company (Wetox Ltd) attempting commercialisation of a wet oxidation technology. The point of difference for TERAX™ remains the pursuit of a hybrid biological-hydrothermal processing to minimise capital and operating costs, whilst maximising recovery of all three of organic acids, ammonia and phosphorus products.

Workshops and one-on-one meetings held with a broad range of territorial authorities and manufacturing industry stakeholders over the past two years have been used to highlight the performance benefits of the TERAX™ system. This has met with a resoundingly positive response, and many potential users have highlighted their own difficulties in finding sustainable disposal options.

NZ Market Analysis

The primary customers of the TERAX™ process are territorial authorities seeking to reduce the quantity of sewage sludge and organic municipal waste material being sent to landfill. The secondary customers are major industrial operations that create biological waste streams (e.g. pulp and paper, dairy, and meat processing) or need to dispose of large volumes of primary and secondary sewage sludges produced from wastewater treatment.

Initial proof-of-concept studies, embodying technical, economic and sustainability assessments, demonstrated that the TERAX™ technology could achieve:

- 96% reduction in landfilling;
- 76% reduction in greenhouse gas emissions;
- 40% reduction in eutrophication potential; and
- 90% reduction in photochemical ozone creation potential.

In addition, the TERAX™ technology detoxifies the sludge waste stream, kills pathogens and produces essentially sterile output streams. In summary, the successful national implementation of the TERAX™ technology platform would reap benefits to:

End-users

- An ability to substantially reduce the costs associated with current municipal sewerage and industrial wastewater treatment and, more broadly, organic waste disposal;
- The potential to reduce their environmental footprint through reduction in waste transportation, landfill leachates and greenhouse gas emissions;
- The ability to develop new revenue streams through sales of products of the process.

New Zealand community

- Reduced environmental impacts through reduced waste to landfill, reduced greenhouse gas emissions, reduced eutrophication and reduced ozone depletion;
- Improved capacity to move towards the NZ Waste Strategy Targets;

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- Ability to develop new TERAX™ technology manufacturing opportunities for domestic and export development;
- Enhanced environmental reputation for New Zealand.

Direct investors

- An economic return from exploitation of the technology both in New Zealand and internationally.

To determine the potential market size for organic waste deconstruction in New Zealand, Scion surveyed territorial authorities and regional councils in 2008-2009. As with previous studies, the data accuracy varied considerably between regions so the summary data shown below represents a conservative analysis of the potential organic waste market:

Table 3: New Zealand landfilled waste by region

Region	Putrescible	Greenwaste	Biosolid	Other	Total	t/capita
Northland	13,828	6,800	5000	13,420	39,048	0.25
Auckland	138,000	52,000	131,581	3000	324,581[1]	0.23
Waikato	110,000	83,000	10,260	890,000	1,093,260	2.72
BOP	73,100	114,190	19,540	nd	206,830	0.77
Gisborne	3,623	19,056	nd[3]	66,020	88,699	1.93
Taranaki	26,000	8720	1260	Nd	35,980	0.33
Hawke's Bay	62,300	8,360	nd	130,477	201,137	1.32
Horizons	11,623	44,867	5951	321	62,762	0.27
Wellington	98,510	23,535	21,836	Nd	143,881	0.30
Nelson/Marl	8,220	7,580	15,243	25,000	56,043	0.41
Southland	24,000	11,735	nd	13,000	48,735	0.52
West Coast	4900	nd	854	4100	9,854	0.31
Otago	5650	23,621	13,079	2130	44,480	0.22
Canterbury	43,803	88,947	28,766	44	161,560	0.29
Total	**623,557**	**492,411**	**253,370**	**1,147,512**	**2,516,294**	

1 *Limited Auckland data made available – as the largest municipality in NZ, this figure is likely to be significantly lower than actuals.*

The above table estimates the total amount of material that has the potential to be treated using the TERAX™ technology platform is 2.5M tonnes per year, 61% of NZ's total landfilled waste stream. With full market penetration, the TERAX™ technology has the potential to reduce this to approximately 125,000 tonnes per year - significantly increasing the life of New Zealand's current rapidly filling landfills.

To gain greater insight into specific market opportunities, MWH Ltd was commissioned by the Waste 2 Gold Alliance to actively engage their contacts at selected Territorial Local Authorities (TLAs) throughout New Zealand. The engagement brief was to both investigate the interest in the TERAX™ process, and to collect relevant information that would assist the Alliance in identifying the value proposition to TLAs in adopting the technology given future disposal plan security and the potential for more stringent resource consent requirements.

Detailed analyses by MWH for 14 key TLAs showed that average total disposal costs were around $800 per dry tonne of sludge but with a very broad range: $60 - $2,200 per dry tonne. In nearly all cases, the TLA was looking at alternative organic waste disposal options to existing practices.

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Extension into landfill organics

There is a clear opportunity for the TERAX™ technology to move beyond the sewage sludge market, targeting the huge annual volume of organics delivered to landfills. However, this poses a considerable step-up in complexity. Unlike sewage sludge, municipal solid waste contains a highly complex mixture of end-of-life products. The targets for TERAX™ include putrescibles, paper and wood/timber, nappies and sanitary fractions – representing 61% of the landfilled total (see NZ Market Analysis section). Non-organic waste such as plastics and metals should be considered separable and recoverable.

To enable conceptualisation, a basic process schematic of a potential TERAX™ process for landfill organics is provided in Figure 4.

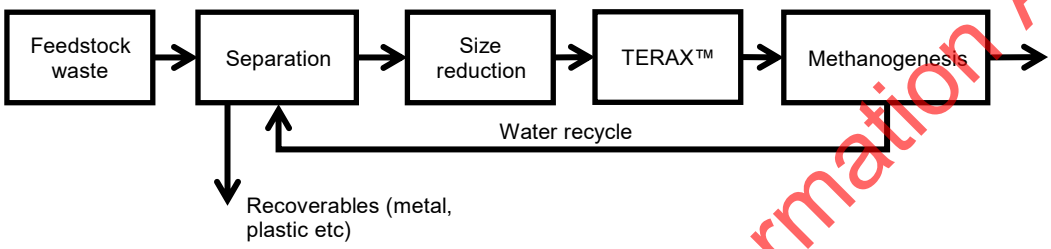


Figure 4: Schematic of potential landfill TERAX™

Critical to success will be the separation and size reduction steps, whereby non-process elements of the incoming waste are removed from the feedstock. This could include metal and plastic materials, although the latter could potentially be incorporated into the process feedstock, depending on the conditions of the hydrothermal process. We envisage a targeted adoption and adaption of commercially-available technologies to achieve the required separation and size reduction steps.

Methanogenesis (biological production of methane) is a logical end-point for the soluble organics produced by TERAX™. Organic acids are readily converted into methane, and the produced gas can integrate into existing infrastructure for methane capture present at many landfill sites. This does not, however, preclude other applications of the TERAX™ liquor organic acids, dependent on market drivers.

Given the development infrastructure established by the project Alliance, the TERAX™/ methanogenesis platform can be readily trialled from laboratory through to pilot scale. A staged approach would be taken, working through a progressively more complex mix of feedstock inputs through to a rationally optimal mixture of real municipal waste.

The TERAX™ platform assessment is not rigidly fixed to the two-stage fermentation plus wet oxidation approach described in Figure 1. Assessment should include non-oxidative hydrothermal processing or single stage wet oxidation as alternative configurations.

The construction of a techno-economic model target organic landfill wastes will be at least as important as the technical work proposed. The process complexity, and processing options, will be significantly greater than the original sewage biosolids case. Nevertheless, building on the maturity of knowledge gained in the original TERAX™ work, the project should make a step-change in process modelling quality, moving to a commercial process engineering software base, such as Aspen PLUS (Aspen Technology Inc. USA).

To support this transition, the project team have excellent in-house capability. There is also a strong link to leading New Zealand control and modelling expertise, in staff at the Industrial Information and Control Centre, AUT (I^2C^2, www.i2c2.aut.ac.nz). Indeed, we are

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currently embarking on detailed modelling simulation of our hydrothermal process plant via a postgraduate student supervised by I²C² directors s 9(2)(a) .

Taking a combined technical and techno-economic modelling approach, we should be able to produce a confident recommendation as to the efficacy of taking this hydrothermal deconstruction technology to the next, full-scale demonstration application for municipal landfill organics.

Targeting CCA treated timber

A unique aspect of in the technology may lie in its use for waste treated wood. We see the opportunity for hydrothermal processing to deal with copper, chrome and arsenic (CCA) treated timber as potentially solving one of New Zealand's most challenging waste problems.

Whilst thermal processes (incineration, gasification) can be used to recover the energy from the timber, preventing the escape of the toxic elements (and particularly the volatilisation of arsenic) is of primary concern, and results in high costs. Hydrothermal processing of treated timber has been assessed at laboratory scale (Catallo & Shupe, 2008[6]; Catallo et al., 2004[7]), and offers an alternative approach to the dry processing step.

Given magnitude of treated timber production and associated challenges of disposal in New Zealand[8], this should be a target of any ongoing TERAX™ development.

Commercialisation strategy

Investment in a fully functional demonstration scale is critical to leverage end-user engagement and de-risk the project. This would require:

- Demonstrating the hydrothermal deconstruction of municipal sewage sludge at full-scale;
- Extending the technology to the treatment of organics in the residual Municipal Solid Waste (MSW) stream currently going to landfill, with the primary aims being to reduce volume, reduce harm, and recover value.

The demonstration TERAX™ plant would be sited at the RDC wastewater treatment plant and sized to process its entire sludge output (based on a 20 year growth projection averaging 10,000 tonnes per annum). When fully operational within two years, such a plant would produce a 30-fold reduction in the amount of sludge being sent to landfill. Thus, for the current 8,500 tonnes per annum, this would reduce to 275 tonnes per annum, greater than 95% volume reduction.

RDC is also committed (10-Year Plan: 2012-2022) to locating a full-scale TERAX™ plant at their Atiamuri Landfill, to treat the wider organic waste stream. This strategy will be strengthened through the immediate success of treating sewage sludge at a commercial scale.

A key target for technology uptake is to secure one or more engineering companies as a partner to support its roll-out and implementation. In addition, the R&D team will be

[6] Catallo, W.J., Shupe, T.F. 2008. Hydrothermal treatment of mixed preservative-treated wood waste. Holzforschung, 62(1), 119-122.
[7] Catallo, W.J., Shupe, T.F., Gambrell, R.P. 2004. Hydrothermal treatment of CCA- and penta-treated wood. Wood and Fiber Science, 36(2), 152-160.
[8] Love, S. (2007). Extended Producer Responsibility of Treated Timber Waste. Scion. SB07 Sustainable Building Conference, New Zealand (Building Research)

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concurrently developing the next generation of this technology to target generic organic wastes – which nationally represents a market ten times larger than the sewage sludge stream.

In the 2010 WMF application, the Bay of Plenty was chosen as the starting point since it represented a microcosm of New Zealand waste management issues. It is the fastest growing part of New Zealand, creating pressure on sewage sludge disposal. The Rotorua demonstration site should be fully operational by 2014 and will be a full-scale exemplar of the process.

The BOP also contains national-scale examples of other biological industry sectors suitable for processing by the TERAX™ Process. The dairy sector, pulp and paper sector, horticulture, fishing and food processing, all have plants creating organic waste within a relatively small area.

Table 4: Potential targets for TERAX™ 2010 application implementation.

Year	Waste	Quantity diverted (t/yr)	Residue landfilled* (t/yr)	Rationale
2015	Rotorua District Council sewage sludge	8,500	336	Priority waste for Rotorua District Council - formal partner in Alliance who has committed to co-investment to de-risk opportunity at pilot-scale
2016	Tauranga sewage sludge	16,500	660	Solution for NZ's fastest growing municipality (sludge currently transported out of region) and leverages off RDC influence in BOP
2017	Auckland sewage sludge	106,000	4,240	Largest point source of sewage sludge in NZ. Scion is already developing a dialogue with Watercare regarding this project.
2018	BOP Organics	150,000	6,000	Expansion to a broader BOP solution leveraging off the solutions already in place – creates option of "Waste Management Islands" for integrated waste processing at existing landfills
2019	Pulp and paper biosolid sludge	75,000	2,700	Both major NZ pulp and paper sites located within 50 km of Rotorua. Represents largest point source of industrial organic waste in NZ – success will leverage into other industrial organic waste producers

** based on 96% destruction efficiency by the Process and no further extraction of useful materials in the remaining solid residues*

The high interest in this technology across New Zealand may mean that the BOP focus is unnecessary and the platform can be readily implemented at a larger national scale if an appropriate commercialisation partner and investor is secured during the next phase of development.

Next steps

The next steps for the project are:

Technical

Having successfully completed proof of concept and pilot scale exemplars of the TERAX™ technology, the next steps are to:

1. Enact a significant expansion to the treatment of organic solids from municipal wastewater treatment plants and build a full-scale demonstration facility that will also be a reference site for market expansion.

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2. Develop the proof of concept and pilot scale exemplars to expand the TERAX™ technology to the treatment of Municipal Solid Waste, a waste stream that is 10 times larger than the organic solids from municipal wastewater treatment plants.

Scion has engaged AWT Water Ltd to produce a full-scale concept design with costings for a TERAX™ plant capable of processing all of the RDC wastewater treatment sewage sludge with a 20 year design horizon (8,500–12,000 t/yr). This cost estimate builds upon and expands on the generic techno-economic model, including specific process flow diagrams, cost estimations for all significant plant items, and a specific plant layout for the RDC site. These will be completed as a deliverable for the Waste Minimisation Funded project approved in 2010.

The next phase of development for the full-scale implementation is to take the concept design for the RDC WWTP and develop it into a comprehensive technical specification for the construction of the demonstration plant:

- Evaluating, selecting, and contracting a suitable engineering design firm,
- Design review of concept design,
- Detailed design elements and specifications for process, mechanical, electrical, and civil engineering requirements,
- Detailed equipment and construction schedules,
- Control system philosophy and design,
- Hazard & Operability studies (HAZOP),
- Construction & procurement strategy,
- Detailed capital cost estimation.

The initial studies on the application of the TERAX™ plant to the treatment of Municipal Solid Waste will be undertaken at Scion's purpose built laboratories, using material from the RDC and other sources. The pilot plant for the application of the TERAX™ plant to the treatment of Municipal Solid Waste is expected to remain at the RDC WWTP with trial wastes to be imported as required.

Commercial

The key parties in the Waste 2 Gold joint venture Alliance are Scion and Rotorua District Council. As full commercial implementation is non-core business for both Scion and RDC, a commercial partner must be sought.

A common thread with most technology commercialisations is the need to secure manufacturing and sales channels for the new technology. License (or outright sale) agreements are often enacted with the sales organisation.

On 31 May 2012, the Rotorua District Council issued a Request for Registration of Interest for the Design, Project Documentation and MSQA Services to successful commissioning of the proposed demonstration-scale TERAX™ plant for treatment of sewage sludge at the RDC wastewater treatment plant. The request seeks Registrations of Interest from companies by 26 June 2012. Several engineering companies have already expressed interest in undertaking this role.

The process of selecting a suitable commercialisation partner is expected to be completed by the time MfE has approved a 2012 investment proposal from the Rotorua District Council in collaboration with Scion.

The nature of the TERAX™ technology platform and its wide potential application across a number of different industries makes the management of its commercialisation and continued development an important strategic priority for the Joint Venture. In fact, at this stage of the development and with an eye to the future, it will become increasingly important to incorporate the current unincorporated Joint venture.

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The Incorporated Joint Venture will then be in a position to license the TERAX™ technology to the selected commercialisation partner for applications to municipal waste. This agreement may also allow for the commercialisation partner to also have licenses for the technology in other industries.

Investment requirements

Key areas for future investment in the TERAX™ technology are:

1. Developing a full-scale demonstration site to showcase the technology in its application to the treatment of biosolids from municipal wastewater treatment plants;
2. Developing the next generation of the technology for application to Municipal Solid Waste;
3. Developing future generations of the technology for application to waste streams from different primary industries, such as pulp and paper, meat, dairy, etc.; and
4. Developing scaled-down variants of the technology (e.g. transportable modules for application to smaller waste streams at a local level.

The techno-economic model of the TERAX™ technology has been designed to quantify the capital and operating costs for a particular plant, once its operating parameters have been entered into the model.

The techno-economic model was set up for a full-scale TERAX™ plant sited at the RDC waste-water treatment plant sized to process its entire sewage sludge output with a 20-year growth projection, varying the choice of oxidant (air or oxygen). The model estimated the following costs for this plant:

- Capital cost: $4.99-5.33M
- Annual operating costs: $1.09-1.59M

The capital cost above has taken into account all activities required to create a fully functioning plant. Although contingency has been allowed as part of the NPV cost analysis, there remains considerable risk associated with the cost analysis to full-scale:

- this is an application of a hydrothermal (wet oxidation) technology, never attempted in New Zealand
- This is an application of a novel technology-hybrid biological hydrothermal technology (TERAX™).

Thus, it is recommended that steps be taken to ensure that sufficient capital is available to cover the likely unidentified costs, development hurdles, and commissioning challenges which new applications bring. Seeking external sources of funding for mitigation of this development risk is recommended. Given the national-good benefit which will arise from successful adoption of the technology, application to NZ government funding – particularly the MFE Waste Minimisation Fund - would be appropriate.

Recommendations

It is recommended that an application is made to the Waste Minimisation Fund of the Ministry for the Environment, to assist in the de-risking and timely creation of a full-scale demonstration plant.

In addition, the WMF proposal should include a significant expansion of the technology in its application to the treatment of Municipal Solid Waste.

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Project Background

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June 2012

Partners

Rotorua District Council

Rotorua District Council is the local government organisation for Rotorua District and is a corporation constituted under the provisions of the Local Government Act 2002. Elected members (mayor, 12 councillors, and 4 community board members) and approximately 450 staff work towards achieving social, environmental, economic and cultural wellbeing for the community.

Some of Council's functions include:

- providing infrastructure for the likes of roading, refuse disposal, sewerage and water systems;
- planning for the way land in the district is used;
- regulating the health of the environment;
- providing and managing facilities for recreation;
- promoting the district for tourism, events and other economic development;
- services specifically required under government legislation and much, much more.

Council's mission is about "shaping a great future together". We work hard to build on our reputation for visionary leadership and open active democracy. We strive to achieve multicultural partnerships with special emphasis on our relationship with tangata whenua, sustainable community services, and ongoing community and economic development. We are constantly undertaking activities and projects that enhance the quality of life for our residents and that provide a rich world class experience for every visitor to our district.

RDC's Ten Year Plan (TYP) specfically identifies treatment of biosolids and other organic waste as a priority. The TYP has the stated aim of beneficially re-using waste from the wastewater treatment plant, reducing disposal costs and providing a low cost carbon source for use in the treatment process. The TYP under waste management has the stated aim to extract value from 65% of the current waste stream. The TERAX process is included in the TYP as a method to achieve both these goals.

Organic waste is the largest portion of the waste stream and causes most environmental effects. Council's strategy is to have a long term sustainable solution to treat such wastes. The TERAX process will treat all types of organic material. Complimentary to the organic waste treatment process is the need to manage nutrients. Nutrients are currently recycled to the treatment plant adding treatment cost and using capacity. This project will break the cycle and add capacity to the wastewater treatment plant.

RDC collects refuse from around 25,000 properties in the Rotorua District, equating to nearly 2 million bags per year, and sends approximately 4,000 tonnes to the recycling centre annually. Expansion of the Te Ngae Road recycling centre was completed in December 2011. This included doubling capacity, two additional recycling bays and enhanced traffic management. The upgraded facility now includes a larger facility for the sale of second-hand goods and a purpose build e-waste facility. The upgrade took 4 months to complete and cost $930,000.

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Organisational Chart

senior management structure



Scion

The New Zealand Forest Research Institute Limited, trading as Scion, is a Crown Research Institute (CRI) dedicated to improving the international competitiveness of the New Zealand forest industry and building a stronger bio-based economy for New Zealand. Scion is constituted under the Companies Act 1993 and the Crown Research Institutes Act 1992.

The corporate intent for Scion is to deliver benefit to New Zealand. It achieves this through development of technology-based solutions and partnering with appropriate commercial entities to implement these solutions. As a CRI, Scion is highly experienced in managing and delivering publicly-funded or public-private co-funded projects and opportunities.

Scion carries out research and development into novel technologies, processes and systems to overcome current and future environmental challenges such as resource depletion, greenhouse gas emissions and waste disposal. Our environmental technology development capability includes process and chemical engineering, bioreaction engineering, environmental biotechnology/molecular biology, organic and analytical chemistry, developing green catalysts, and wastewater technologies focused on the wood processing industry.

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The Problem

In a world of increasing demand for sustainable waste management, the drivers for reducing waste volumes to landfills have become critical. Identification of significant waste streams by the Ministry for the Environment (2009) prioritised the following types:

- Organics;
- Construction and demolition waste;
- Wastewater;
- Nappies;
- Packaging;
- Agrichemicals;
- Hazardous waste;
- Household lighting;
- Tyres;
- Used oil; and
- Waste electrical and electronic equipment (e-waste).

Organic solid wastes (representing organics, timber from construction & demolition waste, wastewater, nappies and packaging from the above list, plus paper) create some of the greatest concerns regarding landfill operation:

- They represent a high proportion of wastes entering landfills in New Zealand;
- Their high moisture content elevates transport costs;
- Under landfill conditions organic wastes generate large volumes of poorly recoverable methane, a potent greenhouse gas;
- Leachates from these wastes contain high levels of nutrients which contribute to eutrophication in recipient waterways; and
- Some organic wastes, such as wastewater treatment plant sludges, contain hazardous pathogens or heavy metals, creating health and safety issues.

Significant diversion from landfills remains a considerable challenge, despite legislative and economic pressures and voluntary efforts. Currently available technologies for organic waste are only partially successful, attributable to a range of factors including:

- Inability to achieve required volume reductions (e.g. anaerobic digestion);
- Significant land areas required (e.g. vermi-composting);

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- Odour generation (e.g. windrow composting) or high gas treatement costs (incineration);
- Inadequate energy balances (e.g. incineration or drying);
- Lack of sufficient quality control and markets for diverted products (e.g. compost); and
- Contain contaminants that preclude substantial re-direction (e.g. heavy metal limits for land application of sewages sludges).

Project Objectives

The TERAX programme seeks to develop technology platforms that address the need for diversion of organic wastes by:

- Achieving substantial volume reductions;
- Maximising energy recovery from these low-value carbon substrates;
- Generating added value co-products where appropriate; and
- Ensuring that recalcitrant or hazardous contaminants are destroyed or segregated.

Project History

The TERAX Project is a product of approximately six years of development. It has grown from an original proposition, through the development of research opportunities, increasing capability (both in up-skilling staff and development of laboratory infrastructure) through to engagement with industry and local government, and ultimately to the successful scale up of a pilot plant project.

Initial desk top evaluation - This work originated as part of a Scion-led research programme funded by the New Zealand government's Foundation for Research, Science and Technology (now Ministry of Business, Innovation and Employment). The programme investigated approaches to improving liquid and solid waste management for the pulp and paper industries, who represent some of the largest point source producers of these waste streams. A key output of the desktop based research was an extensive literature review on the 'Treatment Technologies for primary and secondary wastewater solids'.

This review ranked numerous technologies at various stages of commercialisation against pre-determined criteria. The results highlighted hydrothermal oxidation based processes as having a high potential as a long term sustainable treatment option.

In parallel to this research programme, the local municipality responsible for solid waste disposal, the Rotorua District Council (RDC), undertook an extensive procurement exercise with the objective of securing a sustainable disposal technology for its sewage sludge. Despite numerous options being evaluated, none were found to be satisfactory.

In 2008, Scion partnered with the Rotorua District Council to form the Waste 2 Gold Alliance – an unincorporated joint venture dedicated to i) solving local constraints to sewage sludge and organic waste landfilling in Rotorua and ii) creating a critical mass of stakeholder and end-user engagement to commercialise resulting successful technologies to the broader NZ waste management community.

Bench top and laboratory trials **-** In 2009, an extensive technical evaluation of hydrothermal deconstruction processes was carried out at Scion's facilities in Rotorua, New Zealand. This study focussed on RDC sewage sludge and compared numerous process conditions from published literature as well as investigated options for further process development.

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This work identified a number of process improvements over more conventional hydrothermal oxidation in the published literature, leading to an international patent filing and the creation of the TERAX^{TM} trademark for the new process.

The results of the laboratory trials were presented to RDC in December 2009 together with a design for a proposed pilot plant. These results reinforced the desk top outcomes and identified excellent potential for the TERAX^{TM} technology to meet RDC's long term disposal needs:

- >95% volatile solids destruction
- 150-200 kg/tonne carbon retained
- ~75% Nitrogen conversion to ammonia
- Retention and concentration of solid phase phosphorus (38% as phosphate)

As a result of these trials, RDC committed to funding the construction of a pilot plant facility which would allow the techno-economic feasibility of the technology to be fully evaluated and a full-scale design to be completed. Scion successfully bid into the Ministry for Environment (MfE) Waste Minimisation Fund (WMF) to support the pilot scale development through until June 2012.

Pilot plant and experimental program **-** The pilot program involved the establishment of substantial pilot plant facilities and associated operational trials over a two year period (June 2010-2012). The facilities included three pilot plant modules for evaluating both the process and its products:

- Anaerobic Fermentation Pilot – condition and pre-treat the biosolids trials; onsite August 2011
- Hydrothermal Oxidation Pilot – a core element of the treatment process; onsite May 2011
- Biological Nutrient Removal (BNR) Pilot – to evaluate deconstruction products as a carbon source for the RDC wastewater treatment plant (onsite Jan 2011)

This pilot phase of the project had a budget of approximately $3.5 million, made up of funding from RDC ($1.7M), Scion ($800K), and the MfE Waste Minimisation Fund ($1.0M).

Engineering Economic Model **-** One of the primary outputs which captures and interprets the results of this technical work is a process engineering and economic model for the technology. The scope of this model has on providing an evaluation tool for a Rotorua scenario for sewage sludge processing. The model has been adapted to other scenarios in order to evaluate their feasibility. The first generation of the model has been completed and the ongoing pilot trial results have been used to further refine the model.

Importantly, this work has identified innovative approaches to improving hydrothermal treatment performance and resulted in a significant accumulation of intellectual know-how and the filing of an associated patent application. This knowledge holds considerable potential for intellectual property gains for the country, as New Zealand's organic waste problems are mirrored throughout the world.

Overall, the work has demonstrated a significant development from initial conceptualisation, proof of concept research, through to applied research, up to a level where it is investment-ready for demonstration-scale construction.

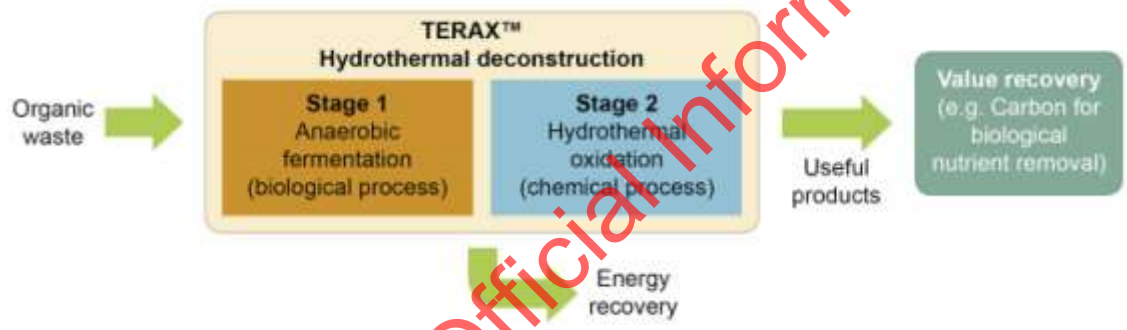
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The Process

The technical approach is to break down complex organic wastes into simple, short-chained organic molecules. These products can then be converted to a range of end products, including bioenergy.

The knowledge base and innovations developed during the course of the Waste 2 Gold programme have resulted in a novel technology position being adopted and named as the TERAX™ process. This hybrid process combines the strengths of biological and chemical approaches to waste treatment to improve the overall efficiency and effectiveness of the objectives of solids destruction and value recovery.

Central to the technology is a hydrothermal deconstruction process developed by Scion that combines high pressures and temperature with oxygen to break down the physical structure of the waste material. The process leads to a substantive solids reduction (greater than 90%) but is controlled in a manner that retains a carbon fraction as a readily degradable liquid organic feedstock:



Stage 1 The anaerobic fermentation pilot plant uses mixed bacterial cultures to pre-treat the organic waste and reduce the volume of material that enters hydrothermal oxidation.

Stage 2 The hydrothermal oxidation pilot plant uses high pressure and temperature with oxygen to break down waste material into smaller, and simpler organic compounds and decrease the solids content.

Value recovery The chemicals produced can be used as building blocks for industrial biotechnology applications, such as bioplastics, biofuels, bioenergy, fertilisers, or for electricity production. At the biological nutrient removal pilot plant, the output produced from TERAX™ can be used to replace commercial ethanol (value $600,000 /yr) as a carbon supplement.

Moving Forward

The TERAX™ process has been proven to pilot scale on municipal sewage sludge, a significant fraction of New Zealand's landfilled solid organic waste. The next step on the development cycle is a full-scale demonstration plant to de-risk the process to a commercial level. This will confirm the technical validity and overall value proposition for a national roll-out of TERAX™.

Excellent potential exists to address the wider organic waste-streams associated with landfilled organics. As a significantly greater challenge, a carefully staged laboratory and pilot scale proof-of concept is required, which can be developed in conjunction with increasingly sophisticated techno-economic model development.

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Project Capability Statement

June 2012

Structure

The TERAX™ programme is overseen by the Waste to Gold Alliance, whose key partners are Scion and the Rotorua District Council. The Alliance is operated as an unincorporated joint venture through a contractual structure which the parties are in the process of formalising. All contracts will be managed by RDC on behalf of the Alliance (it has successfully developed the TERAX plant.

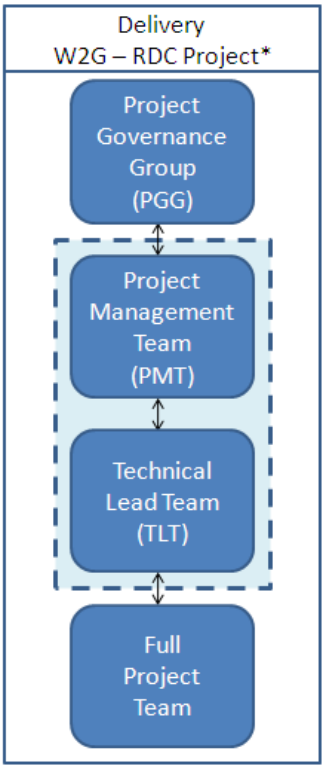
The following defines the current structure, roles and key responsibilities; it also includes key reporting responsibilities, communications and meeting frequency.

Project Governance Group (PGG)

This group acts as the conduit between the commercialisation activities, such as strategy and partnership development, meets the requirements of the MFE Deed and the operational delivery of the project.

Group Members

s 9(2)(a)



Contributors

s 9(2)(a)

Key Tasks

- Overall responsibility for W2G-RDC project and strategic decisions
- Partnership Management and decision making
- Commercialisation and financial oversight
- Communication within partner organisations and external stakeholders
- Meeting frequency – monthly/quarterly once established
- Reports to – Council and Company Boards

Project Management Team (PMT)

This group is tasked primarily with the operational delivery of the project.

Team Members

s 9(2)(a)

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Key Tasks

- [redacted] Manage budget/resource
- [redacted] Project management
- [redacted] Review of technical outputs/programme deliverables
- [redacted] Review and approval of technical programme deliverables and outputs
- [redacted] Output delivery and active risk management
- [redacted] Engage with stakeholders
- [redacted] Contract management
- [redacted] Meeting frequency – Monthly
- [redacted] Reports to PGG/MFE Liaison
    - Reports to the PGG
    - Standard agenda update at PGG meeting, minutes, and actions
    - Quarterly report to MFE Liaison

Technical Lead Team (TLT)

This team will be responsible for managing the science, ensuring the research for the pilot plant is carried out, overseeing the laboratories, managing capital and ensuring delivery of the technical programme.

Team Members

s 9(2)(a) [redacted]

Key Tasks

- [redacted] Develop and deliver workplans
- [redacted] Manage technical delivery/programme
- [redacted] Production of technical outputs/programme deliverables
- [redacted] Produce QTPS (Quarterly technical progress statements)
    - PMT and MFE Liaison
- [redacted] Project data management and maintenance
- [redacted] Meeting frequency - fortnightly
- [redacted] Communications
    - PMT, Wider project team and BSG
- [redacted] Reports to PMT
    - Standard agenda update at PMT meeting
    - Minutes, actions

Full Project Team

This team will undertake and carry out key science work to ensure the successful delivery of key tasks for the W2G - RDC project.

Team Members

- [redacted] Key science staff

Key Tasks

- [redacted] Implementation of workplans
- [redacted] Methodology development
- [redacted] Maintaining key science/pilot plant capability

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- Reports to TLT Meeting

Key Project Staff

The alliance has brought together a senior project management team from across the partnership. It will be responsible for operational delivery of the Project, including budget and programme management, review and approval of programme deliverables and outputs, contract management, and PGG/MFE liaison.

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Technological Management

Intellectual Property
Scion has an Intellectual Property Policy that sets in place the framework within which it will manage Intellectual Property in both a strategic and an operational sense and to best practice standards. Research conducted within Scion is subject to this framework in order to best enable a pathway to commercialisation and maximise the benefit to New Zealand.
Scion has a process to keep information concerning intellectual property confidential and report any key inventions or developments to the Intellectual Property Manager.

An internal committee within Scion is responsible for determining the appropriate form of Intellectual Property protection (e.g. trade secret, copyright, patent, etc.) and strategy (including such matters as what to patent, when to patent, where to patent) based upon the recommendations of the Intellectual Property Manager who is a patent lawyer.

Risk Management

The risk management plan for this development recognises issues that could either hinder or stall the implementation of this business plan. These include:

- **Adverse change in government policy**: New Zealand will be under increasing pressure from our major markets to improve its environmental performance. Reduction of recoverable material, particularly the organic fraction, from landfills will be a prime target as has been demonstrated by the European Union;
- **The needed capital is not available**: Assuming the process is technically and economically robust, then pressure to adopt processes of this type (as Best Available Technologies) will continue to drive investment in this direction;
- **The district plan does not allow for construction of such plants**: If the territorial authority considers that the building of a plant is a priority, the district plan can be changed through a consultation process under the Local Government Act (2002). As a precedent, the TERAX^{TM} process has already been integrated into the RDC 10-year district plan;
- **The benefits do not outweigh the costs**: The territorial authority or private business will need to consider whether they are prepared to bear the additional cost when considering the long term implications (e.g. possible increases in Waste Levy charges);
- **A suitable engineering company to commercialise the technology cannot be found**: Several international engineering companies with appropriate experience have already expressed interest and we have not been actively seeking them;

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- **The engineering capability to build the plants may be outstripped by the demand for new plants**: Engineering expertise could be sourced internationally (e.g. through licensing to major environmental engineering companies, such as Veolia) and introduction could be staged to accommodate availability of facilities and people;
- **Ratepayers do not accept the need for the plants**: The ten year market growth plan only considers participation in the BOP region and one plant in Auckland. Other territorial authorities and businesses will be approached;
- **The existing investment in infrastructure precludes consideration of alternative treatment processes**: The most likely alternative infrastructure is anaerobic digestion. This can be readily integrated with a new deconstruction plant to provide the combined benefits demonstrated during our feasibility study.

Taking these factors into account, the Project's risk management strategy is as follows:

Risk source	Management approach
Capital risk and return on investment	Managed in accordance with best practice engineering development with on-going review of economic criteria. Within Scion it is managed by a Stage Gate process whereby each progression to a new stage is reviewed and agreed to.
Technical risk	The key sources are: *Unfavourable energy balance*: current evaluations indicate that the energy balance is neutral but the aim is to provide net energy outputs. This may integrate use of low grade heat or geothermal energy *Managing inorganic build up (scaling):* Scion has an alliance with University of Manitoba, who specialise in this area. They will be used as technical experts to assist in assessing and alleviating this issue. *Scale-up risks*: Managed through involvement of very experienced external engineers and engineering companies
Social and public risk.	The re-use of products from biosolids may create concerns with public and in particular with Maori. This is being worked through with local Iwi and is a key role for the Project's Maori liaison team. The plant uses high pressures and temperatures. The process will be subjected to full HAZOP analyses at each stage. Public acceptance is not expected to be a problem as such processes are now quite common in public works activities. However it will be part of the public consultation process.
Market risk	The RDC are very interested in a full-scale plant with final sign-off due in July 2012 Interest has already been formally expressed by Watercare, Norske Skog and Carter Holt Harvey. These interests are now being formally developed. A full-scale demonstration plant will significantly improve market acceptance of this technology.

The overall technical and operational risk will be managed via best practice engineering approaches especially as a large and experienced engineering company manages the technology commercialisation. This includes staged development of the full scale reference plant incorporating testing of the economic and engineering feasibility at each stage.

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SCION
forests · products · innovation

19 June 2012

Peter Guerin
Chief Executive Officer
Rotorua District Council
Rotorua
NEW ZEALAND

Dear Peter,

RE: WMF proposal to Ministry for the Environment

On behalf of Scion, I write to offer Scion's very strong support for the TERAX™ WMF proposal, which Rotorua District Council will be submitting on behalf of the Waste 2 Gold Alliance in June, 2012.

The programme's integrated activities in:

1. Developing a full-scale demonstration site to showcase this technology in its application to the treatment of biosolids from municipal wastewater treatment plants; and,

2. Extending the technology for application to Municipal Solid Wastes and beyond,

target the critical next steps for development of the TERAX™ Platform, which we believe will be an important contributor to improved environmental performance within New Zealand's future landfill and waste management landscape.

The Waste 2 Gold Alliance has been a highly successful partnership between a territorial local authority and a CRI. The strength of this relationship speaks to our common values and determination to create economic benefits and significant environmental performance gains from waste management.

Scaling-up and commercialising this proprietary technology will offer exciting opportunities in resolving waste disposal challenges in the Rotorua District. Further, based on the on-going and very positive engagement Scion has had with a broad range of potential NZ and international end-users, we are confident of this being extended across a range of NZ regions and municipal/industrial sectors.

However, we recognise that these next stages carry with them elements of technical and commercial risk. This makes it very appropriate that we maintain our investment relationship with the Ministry for the Environment via the Waste Minimisation Fund. In this regard, we can point to a highly successful partnership between the three parties through the WMF project

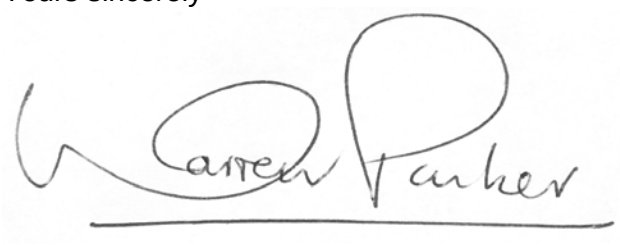
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operated in 2010-12, which has now taken the technology to pilot scale – a significant achievement for waste management here in NZ.

Overall, this WMF proposal is a critical element towards diverting organic waste streams from New Zealand's landfills. Scion strongly endorses its technical focus, business strategy and anticipated outcomes.

We look forward to continuing our strong and dynamic partnership with your Council.

Yours sincerely



Warren Parker
Chief Executive Officer

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Ministry for the Environment
Manatū Mō Te Taiao

Community Environment Fund
&
Waste Minimisation Fund

Milestone Report

Organisation: Rotorua District Council

Project name: TERAX™ waste deconstruction technology

Deed number: 20351

Year: 1

Milestone: 1

Milestone due date: 1 March 2013

New Zealand Government

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Official Information

Important: Information presented to the Minister for the Environment or the Ministry for the Environment is subject to disclosure under the Official Information Act 1982 (OIA). Certain information may be withheld in accordance with the grounds for withholding information under the OIA. Further information on the OIA is available at www.ombudsmen.parliament.nz.

Information held by the Minister and Ministry may have to be released under the OIA in response to a request from a member of the public (or any other body) for that information. If you wish to provide sensitive information to the Minister or Ministry which you do not want released, it is recommended you consult with the Ministry as to whether the information is necessary for the application, and whether there may be grounds in the OIA for withholding the information. For instance, if release of the information would disclose a trade secret, or be likely to unreasonably prejudice the commercial position of the person who supplied or who is the subject of the information, then there may be grounds to withhold the information. The Ministry will endeavour to contact you to discuss an OIA request relating to your application if one is received, and what the implications of releasing your information are.

The grounds for withholding must always be balanced against consideration of public interest that may justify release. Although the Ministry does not give any guarantees as to whether information can be withheld under the OIA, it may be helpful to discuss OIA issues with the Ministry in advance, if information provided with an application is sensitive.

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Introduction

This milestone report provides the Ministry for the Environment with information about how the delivery phase of your project is going. It must be completed and submitted for each milestone by the dates agreed in your funding deed, unless otherwise discussed with your Fund Analyst.

> Ensure you have read the 'Milestone reporting and payments' section of the *Guide for grantees* before you complete this report.
>
> It is preferable to complete this report electronically, and submit it by email.
>
> You must discuss any problems, issues, or major changes to your project with your Fund Analyst before completing and submitting this report.

When your report is complete

Milestone reports should be submitted by the dates agreed in your funding deed, unless otherwise discussed with your Fund Analyst.

Email the following documents to your Fund Analyst:

- completed milestone report
- completed claim form
- completed invoice breakdown spreadsheet
- supplier invoices for any item over $50,000, and any capital costs of $10,000 value or more.

Alternatively, you can post these to: Community Environment Fund or Waste Minimisation Fund, Ministry for the Environment PO Box 10362, Wellington 6143.

What happens next?

Your Fund Analyst will assess the report to ensure that you have met the requirements for funding as specified in your funding deed. During your Fund Analyst's review of the report and supporting documentation, further information (including evidence confirming actual expenditure) may be requested. Allow at least seven working days for the assessment to take place. A report for a final milestone may take longer to assess, and may also be dependent on the results of an independent audit.

Once the Ministry for the Environment is satisfied that your milestone claim meets the funding requirements, your Fund Analyst will arrange payment with the Ministry's finance department.

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Section 1: Evaluation of this milestone

Complete the tables below to show how your project is tracking against this milestone in your project plan. Submit the following with this milestone report:

- *completed milestone claim form*
- *completed summary of expenses form*
- *final project report template (if this is the final milestone)*
- *evidence of the deliverables.*

Press the Tab key on your keyboard to add more rows to the tables, if required.

(1A) Activity *List the activities for this milestone as specified in your project plan*	Summary of progress *Provide a summary of the progress made for each activity associated with this milestone*
• Investigation and evaluation of existing technology for MSW handling and pre-treatment	• Focus of the initial work has been on waste material size reduction, as a priority requirement for process development. • Results from the pilot scale operation of the wet oxidation process suggest that particle sizes of 1-3mm may be manageable, but above 3mm could cause significant problems with pumping to the high pressures required of a hydrothermal process such as used in TERAX™. Thus size reduction to less than 3mm, and possibly less than 1mm is desirable. • Any pre-treatment (e.g. size reduction) equipment must be able to handle significant levels of contamination. For example, food processing waste materials may be contaminated with metals, which may slip past primary sorting/decontamination. • Process design of the TERAX™ unit operations is likely to be critical to success in this project. Thus, it is recommended that attention be given to potential modification from the initial biosolids-base design to allow for larger sized materials processing and presence of contaminants. • Size reduction may significantly impact on fermentation and hydrothermal reaction rates, providing a benefit to the size reduction beyond simple plant protection. • A number of technologies were identified which provide interesting capability in particle size reduction. It is anticipated that this database of technologies will grow with time through the project. These technologies will be evaluated for selection, in the coming quarter.
• MSW initial component characterisation and selection for trialling	• Rotorua disposes of 40,000 tonnes solid waste per annum excluding sewage sludge and cleanfill, equating to 574 kg waste per capita per year. Of this inventory, 12,000 tonnes (30%) was classified as

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	putrescible waste (kitchen/food, greenwaste, and other [e.g. meat processing dead animals, wool scour]). Kerbside collection gathers approximately 50% of the putrescible waste. • Values for Rotorua are close to nationwide median values for municipal solid waste MSW disposal. Thus, the Rotorua site is quite representative of the nationwide landfilling activity. • Based upon the MSW component description and a simplifying assumption that all material within a waste category will be able to be processed, a total of 19,000 tonnes per year (48% of 40,000 tonnes) has a good likelihood of being effectively processed using wet oxidation, whilst a further 7,500 tonnes (19%) has some likelihood of effective processing. • As the major fraction of organic wastes entering the landfill, and having high likelihood of being effective transformation within TERAX™, Putrescibles are clearly identified as a strong target for initial study in the project.
• Review and modify lab and pilot equipment to handle MSW components	• Detailed workplans have been produced, outlining hydrothermal and anaerobic fermentation trial plans for the year. These will undergo review in early April, for actioning work beginning in Quarter 2. • Within the laboratory, two key elements have been identified which require attention for hydrothermal processing trials: a. Safety assessment of hydrothermal laboratory. With this new project, the key equipment used for the hydrothermal processing is being evaluated afresh. Equipment modifications, which have occurred over a period of two years, will be studied. A hazop-style analysis will be undertaken to minimise risk of working with this high temperature/pressure reactor system. This is due for completion in April, 2013. b. Funding a larger hydrothermal reactor. This is described further below, but is identified here as a an interconnected laboratory/pilot plant activity. • Laboratory fermentation trials require reactor systems capable of functioning at high solids concentrations (10-30% feed concentrations). This will be a challenge and requires some testing of our current facility and likely purchase of at least one system which is representative of high solids processing. • Maintain the fermentation pilot plant. This plant has had heavy use over the past year and requires some maintenance. Further, communications, the control system and feed handling capability of the plant has been poor and requires addressing. The costs of plant maintenance and modification have

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	been identified. Required expenditure will be agreed-to and actioned in Quarter 2, ready for utilisation in Quarter 3. • Source a mid-sized hydrothermal reactor. The small 600mL Parr reactor (Parr Instrument Company) is too small for some of the desired work, particularly when completing multiple sampling procedures and attempting continuous processing at smaller scale. The larger pilot plant (200L) is too large for some highly detailed work. For example, this plant is sometimes compromised by having very long heating times, confounding the results of batch processing by variable temperature profiles. Further, the resource and personnel requirements of any work at this scale are very high, having significant impact on experimental costs. To solve this, a funding application is being prepared to purchase a mid-sized (5-10L) hydrothermal reactor, which will be completed for submission to Scion in Quarter 2. This would be a significant investment by Scion into the project (well over $100,000, potentially over $200,000). Initial pricing has been sought from a number of vendors, with full quotes pending. None of the equipment modifications will prevent initiation of the laboratory trial activities of Quarter 2.
• Establish a process economic model design to enable the results of trials to be captured and evaluated for scenario analysis.	The process economic (or techno-economic) modelling task has established the framework for transforming the current model from TERAX™-biosolids model to TERAX™-municipal solid wastes. Key outcomes of the task have been the following recommendations: • To use multiple modelling tools as appropriate to the situation, from the mix of Biowin (EnviroSim Associates Ltd, Canada) in wastewater treatment, MicroSoft Excel (MicroSoft Corp, USA) generally, and Aspen (Aspen Technology Inc, USA); • In the first instance, the current Excel-based model should be used with modification to accommodate aspects of the new project requirements. It is anticipated that over the course of the project Aspen software (or other engineering simulation software) will become the base technology for describing the process engineering aspects of TERAX™. • To focus effort on comparing TERAX™ against landfilling alternative; • The scope of the effort should be put into costing activities after the waste has arrived at the gate, not costs for collection, delivery or materials recycling activities; • Business case modelling will be separated from technical modelling, which is the focus of the current project.

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(1B) Deliverable *List the deliverables for this milestone as specified in your project plan*	Status *Complete or incomplete?*	Reason *If not complete please let us know why*
• Quarterly PGG update report in dashboard format.	Yes	
• Quarterly Project management progress report	Yes	
• Quarterly technical progress statement describing trials undertaken, results to date and associated workplan progress	Yes	
• Recommended changes to lab and pilot plant systems	Yes	Provided an Executive Summary – the full internal reports can be viewed during your visit.
• Process economic model framework for MSW application	Yes	Provided an Executive Summary – the full internal reports can be viewed during your visit.
• Quarterly communication report	Yes	
• Milestone report • Milestone claim form • Documentation to support actual expenditure (i.e. receipts/invoice) • Tax invoice for claimed amount	Yes	

Section 2: Evaluation of Project Objectives

Delivery of each milestone will help you progress towards achieving your project's overall objectives. Complete the table below to show how your project is tracking against its objectives.

Your Project Objectives *List the project objectives from your project plan.*	Key performance indicators (KPIs) *List the KPIs from your project plan.*	Actual Measure *Describe the current situation. This will show if you are on target to meet the project's objectives.* *If your project is not at the stage of measuring and reporting on this information, please provide a short statement to explain why.*

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Construct full scale TERAX™ plant at Rotorua Wastewater Treatment Plant	Plant constructed in 2014	Detailed design for full scale TERAX™ biosolids plant is currently underway and on schedule.
By 2014, reduce Rotorua sewage sludge offsite disposal (land or landfill) by >90%	8,500 Tonnes/year of sewage sludge processed	This will be achieved through the construction of the full scale TERAX™ biosolids plant which is on schedule for delivery.
By 2014, extend the hydrothermal technology platform to broader MSW organic waste streams	Production of a report on design parameters for the processing of municipal solid waste at full-scale. Will include concept design and cost details to proceed to full-scale plant for Rotorua district wider organic waste stream.	This first milestone has established the project framework for delivering the research project to extend the technology platform to MSW waste streams. Activities towards this objective are currently on track and gathering momentum as we enter this 3 year research phase.
By 2015, expand the implementation of the TERAX™ process to at least 2 new TLA or industry end-users	Number of new customers engaged	The engagement of a number of potential end-users has been maintained largely reactively to-date as the TERAX™ commercialisation structures have been formalised over the last quarter. These are now largely complete, enabling proactive end-user engagement going forwards.

Section 3: Additional information

Please provide any additional information that the Ministry should be aware of, please consider:

- *Successes you have had this milestone or particular progress you have made towards your project objectives*
- *Risks that have appeared or challenges faced this milestone and ways you plan to mitigate them*

Refer to Detailed Project Management report for risk management.

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Section 4: Procurement

Did you buy any major items or award contracts during this milestone (over $10,000)? If so please list the item or contract and briefly explain the procurement process you went through.

Attach a copy of all contracts, requests for proposals (RFPs), etc with this milestone report as supporting documentation.

*Press the **Tab** key on your keyboard to add more rows to the tables, if required.*

Supplier name	Description of good/work or service, and the procurement process you followed	Value	Date awarded
Scion	Professional Services contract – Terax Demonstration Plant and Further Research – Contract No, 13/018	$3,000,000	27/02/2013
Transfield Worley	Professional Services contract – TERAX™ Plant: D&PD and MSQA	$981 000	17/01/2013

Section 5: Other sources of funding

Provide information about other external funding for this project (other than that from the WMF/CEF). Include all cash contributions and other funding listed in your project plan.

The amount paid towards this milestone (the amounts in the far-right column) must also be provided in your milestone claim form.

If you have more than three partners or external funding sources press the Tab key on your keyboard to add more rows to the tables.

Funder name	Total amount requested	Total amount approved	Amount received to-date	Amount paid towards this milestone
Scion	$50,000.00	$50,000.00	$50,000.00	$50,000.00
	$0.00	$0.00	$0.00	$0.00
	$0.00	$0.00	$0.00	$0.00

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Section 6A: In-kind contributions (only CEF projects to complete this section)

Provide information about the in-kind contributions that your project has received during this milestone, including what this is worth in dollars, excluding GST. Note that in-kind contributions are separate from the cash costs of the project.

	Description	**Total estimated in-kind contribution** *excluding GST*
Professional services and goods *calculate professional services using the actual hourly rate*		$0.00
Use/donation of equipment, etc		$0.00
Facilities provided		$0.00
Community volunteers/staff time *calculate at a rate of $30 per hour*		$0.00
	Total in-kind contribution	$0.00

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Section 6B: Waste minimised
(only WMF projects to complete this section)

Complete the table below. Provide the actual (net) values your project has reduced, reused, recycled and/or recovered during this milestone.

Tonnage data should be recorded once in the most appropriate category for the material being processed (i.e. material should not be reported in more than one of the reduce/reuse/recycle/recovered categories.

All figures should be reported in tonnes. Conversion factors are available in the Grantee Guide, if required.

		Definition
Reduced quantity	0 tonnes	To lessen the generation of waste, including by using products more efficiently, or by redesigning products. In relation to a product, this includes lessening the generation of waste.
Reused quantity	0 tonnes	To use waste or diverted material (in its existing form) further, for the original purpose of the materials or products that constitute the waste or diverted material, or for a similar purpose.
Recycled quantity	0 tonnes	To reprocess waste or diverted material to produce new materials.
Recovered quantity	0 tonnes	To extract materials or energy from waste or diverted material, for further use or processing.
Total quantity (this milestone)	0 tonnes	*This should be the total tonnage of material recycled/recovered/reused to date for this milestone only.*
Total quantity (project to date)	0 tonnes	*This should be the total tonnage of material recycled/recovered/reused to date for all milestones.*

If your project is not at a stage to report on this information (or if the actual tonnages fall short of the targets), explain why:

At quarter 1, milestone 1 of a 3 year project, this project is still very much in its infancy. Data of this nature will not be able to be reported on until construction and commissioning of the Demonstration Plant is complete.

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Declaration

As a duly authorised representative of the organisation:

- I declare that to the best of my knowledge, the information contained in all sections of this milestone report, or supplied by us in support of our milestone report, is complete, true and correct.
- I declare that I have the authority to sign this milestone report and to provide this information.
- I understand that information presented to the Minister for the Environment and Ministry for the Environment is subject to disclosure under the Official Information Act 1982.
- I declare that the fund payment request (milestone claim form) accompanying this milestone report is complete, true and correct

s 9(2)(a)

	Date: 28th March 2013

Verification

As a duly authorised representative of the organisation I verify that the fund payment request (milestone claim form) and this milestone report is complete, true and correct, and that:

- costs making up the amount of this request are part of the eligible project costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by way of donation(s) or credit note(s).

Name of verifier		
Position of verifier		
Signature *by typing your name in the space provided you are electronically signing this milestone report.*		**Date:**

The declaration and verification must be signed by different people in your organisation.

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Checklist

Use the following checklist to confirm you have provided all the required information for your milestone claim.

- ☐ All sections of this milestone report completed
- ☐ Declaration and verification signed and dated by different people
- ☐ Milestone claim form completed and attached for this milestone
- ☐ Pre-printed deposit slip attached (first milestone report only)
- ☐ Final project report completed (final milestone only)
- ☐ Evidence of milestone deliverables attached, for example:
  - photographs of progress
  - monitoring and evaluation data
  - record log of activities
  - media coverage or other publicity
  - invoices
  - evidence of staff recruitment
  - receipts.
- ☐ Tax invoice from your organisation attached (the amount on the tax invoice must be the same as the payment due amount in the milestone claim form).

  The tax invoice must show the following information:
  - your organisation's GST number
  - the words 'tax invoice'
  - invoice number
  - funding deed number
  - total claim amount
  - GST component.
- ☐ Completed summary of expenses form
- ☐ Attached supplier invoices supporting the cash expenditure in this milestone of all capital assets over $10,000 (WMF only) and any item procured over $50,000. Each must show the following information:
  - invoice number
  - invoice date
  - supplier name
  - description
  - total amount (excluding GST).

  Note: Supplier invoices must be presented in the standard format that you/your company use to record this type of information.
- ☐ Copy of supplier contracts and RFPs, if applicable.

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Project Progress Status - DASHBOARD REPORT

Terax Demonstration Plant

Report Date				25/03/2013
Reporting Period	**From**		**To**	
Overall Status	☺	The objective of the Project is to deliver a safe, reliable and functional Plant which processes bio-solids from the Rotorua District Council (RDC) Waste Water Treatment Plant (WWTP) by reducing the volatile solids component and returning value added streams.		
Indicator Legend	☺ On Track	😐 Minor Problem	☹ Major Problem	
Recipients	PGG, MFE			
Report Author	s 9(2)(a)			

Status of Project	**Indicator Icon**	**Comments**
Budget	😐	CAPEX is still being estimated by TW. Expect this will be higher than that provided for in the concept design. Anticipate release of this CAPEX estimate to RDC by end of March 2013.
Schedule	☺	No problems percieved at this stage
Health & Safety	☺	The HSE aspects of the current phase of the project involves the ensuring the following hazard studies are undertaken as planned; • Hazard identification study (HAZID) and project risk workshop (completed) • Hazard and operability study (HAZOP) • Pre commissioning safety review • Operations safety review Future phases of the project will include: • constructability, operability and maintainability reviews • management of HSE during construction. Refer to Quarterly Project Management Progress Report for more detail
Resources	☺	No problems percieved at this stage

MAJOR Risks and Issues	**Indicator Icon**	**Date raised**	**Comments**
			There are no new issues or risks raised…refer to the Detailed Project Management Progress Report

Change Requests raised for this period

Change Request Num	**Description of area impacted**	**Priority**	**Resolution activities status**
No change requests			

Summary of significant activity

The objectives (from Project Framework) of tasks to date have been:
1. To gain clear understanding and agreement of the specific design parameters for the Project
2. To ensure that the safety, health and environmental issues are properly assessed, identifying significant hazards, and, providing the opportunity for their elimination by redesign
3. To gather all necessary data required to complete the engineering development of the Project

With the exception of the optioneering that remains (see "Scope" above) these objectives have been met. For the remaining optioneering there is clarity on what the next steps are to ressolve. This optioneering is expected to be ressolved early in Preliminary Engineering.

Incomplete activities this quarter are:
Capital cost estimate still outstanding - this is being internally reviewed by TW prior to issue. Expect release of this by end of March.

Formal proposal for Preliminary Engineering still outstanding - this is being internally reviewed by TW prior to issue. Expect release of this by end of March.

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Project Progress Status - DASHBOARD REPORT

TERAX™ MSW Research Project

Report Date	25/03/2013			
Reporting Period	**From**		**To**	
Overall Status	☺	This project is to eliminate the problematic disposal of sewage sludge and other organic wastes using the proprietary technology platform, TERAX™. This is a hybrid process combining biological and thermo-chemical approaches to improve the efficiency, effectiveness and economics of organic waste destruction and value recovery.		
Indicator Legend	☺ On Track	😐 Minor Problem	☹ Major Problem	
Recipients	RDC, Scion, MFE			
Report Author	s 9(2)(a)			

Status of Project	**Indicator Icon**	**Comments**
Budget	☺	No problems percieved at this stage
Schedule	☺	No problems percieved at this stage
Health & Safety	☺	This project is being run in accordance with Scion's Health & Safety policies and procedures. There are no current high/major risks/issues identified for this project. This quarters activity has been largely planning based, and as the project progresses to heavier experiemental workloads, more substantial H&S planning will be undertaken.
Resources	☺	Scion has recently employed a new Chemical Engineer to assist with the delivery of this project.

MAJOR Risks and Issues	**Indicator Icon**	**Date raised**	**Comments**
			No major risks or issues for Milestone 1 - year 1

Change Requests raised for this period

Change Request Num	**Description of area impacted**	**Priority**	**Resolution activities status**
No change requests			

Summary of significant activity

The TERAX™ MSW research project is tracking well with the first quarter now complete. A great deal of planning has been carried out, with detailed workplans and technical reports produced.
Key areas of activity were:
* Detailed workplans for all task areas have been developed.
* Providing a basis for technology selection on performance, cost, advantages and disadvatanges, as well as a desk-based exercise to provide key inventory information for the Rotorua Landfill have been key outcomes for the Characterisation and Assessment activities.
*Detailed planning and reviews have taken place for both the laboratory and pilot plant programme and techno-economic framework has been developed.

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Quarterly Project Management Progress Report

TERAX™ Demonstration Plant

Report Date	25/03/2013			
Description of Project	The objective of the Project is to deliver a safe, reliable and functional Plant which processes bio-solids from the Rotorua District Council (RDC) Waste Water Treatment Plant (WWTP) by reducing the volatile solids component and returning value added streams.			
Reporting Period	**From**	January 2013	**To**	End March 2013
Recipients	RDC			
Report Author	Transfield Worley			
Overall Status	☺ On Track	The following should be ressolved prior to commencement of Preliminary Engineering: 1. eliminating options for engineering (see "Scope" below) 2. quantification of project benefits and re-confirmation of the project business case (see "risks and issues" and "budget" below)		
Indicator Legend	☺ On Track	😐 Minor Problem	☹ Major Problem	

1 Progress for this Period

Key Indicators	Indicator Icon	Comments
Project schedule	☺ On Track	No problems percieved at this stage
Scope	😐 Minor Problem	Uncertainty of project scope still remains around the following aspects. These need to be fully ressolved early in Preliminary Design. **1. Systems to Manage Offgases** This is due to no existing consent requirements on gaseous emissions at the WWTP. RDC are currently investigating consenting requirements for gaseous emissions at the WWTP. **2. Fermenter Location** Locating the fermenter on the site of an existing digester presents a significant opportunity to save capital costs. RDC are currently procuring an assessment of the condition of the foundations of the existing digester. **3. Ammonia Separation System** The base case is for atmospheric flash and ammonia distillation. Scion are investigating the merit of producing an ammonia sulphate to improve the saleability of the nitrogen rich product.
Resources	☺ On Track	No problems percieved at this stage

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Risks and Issues	😐 Minor Problem	Recommend that the project business case should be re-confirmed prior to commencement of next phase. This business case needs to inclu CAPEX, OPEX and, project benefits.
Health & Safety	☺ On Track	The HSE aspects of the current phase of the project involves the ensuring the following hazard studies are undertaken as planned; • Hazard identification study (HAZID) and project risk workshop (completed) - a study to properly assess the HSE issues associated with the project, identifying significant hazards, and, providing for their elimination by redesign • Hazard and operability study (HAZOP) - a study which reviews the design and planned operating procedures to identify any hazards or obstacles to operability which could arise, particularly through deviations from the design intent. • Pre commissioning safety review - a study undertaken prior to energising of plant to ensure the plant is built as intended and systems and procedures are satisfactory for the safe operation of the plant • Operations safety review - undertaken when the plant is operating to confirm that operation is consistent with design intent and to check that the required HSE systems are complied with. Future phases of the project will include: • constructability, operability and maintainability reviews • management of HSE during construction.
Budget	😐 Minor Problem	CAPEX is still being estimated by TW. Expect this will be higher than that provided for in the concept design. Anticipate release of this CAPEX estimate to RDC by end of March 2013.

Major Issues requiring resolution and/or Change Requests raised for this period

Issue or Change Request	Description	Resolution activities
IS1	**The impact of consenting on the project.** After discussion with BoPRC there is an understanding that if the WWTP resource consents included gaseous emissions then there will be no further consenting requirements for the project in respect of gaseous emissions. As such the base case for the project is to provide a wet scrubber only for the processing of wet oxidation offgas - as proposed to BoPRC. There is a perception that any future consenting requirements of the WWTP might affect/change this.	RDC to obtain any necessary consents (or exemptions to) for the WWTP in respect of gaseous emissions.
IS2	**Optioneering** Uncertainty of project scope still remains around the following aspects. These need to be fully ressolved early in Preliminary Design. 1. Systems to Manage Offgases This is due to no existing consent requirements on gaseous emissions at the WWTP. RDC are currently investigating consenting requirements for gaseous emissions at the WWTP. 2. Fermenter Location Locating the fermenter on the site of an existing digester presents a significant opportunity to save capital costs. RDC are currently procuring an assessment of the condition of the foundations of the existing digester. 3. Ammonia Separation System The base case is for atmospheric flash and ammonia distillation. Scion are investigating the merit of producing an ammonia sulphate to improve the saleability of the nitrogen rich product.	1. Systems to Manage Offgases: Actions as for IS4. 2. Fermenter Location: RDC to procure condition of the foundations of the existing digester. 3. Ammonia Separation System: Scion to confirm characteristics of the nitrogen rich product to enable engineering to commence.

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IS3	**Business Case Review** In light of the process models that have been completed, along with the operational and capital cost estimates (latter to be submitted to RDC by end of March), RDC needs to re-confirm its business case for the Project. This should include quanitifying the "baseline" case (i.e. do nothing) and the total benefits of installing the Plant.	RDC to quanitify the "baseline" case (i.e. do nothing) and the total benefits of installing the Plant, then, reconfirm its business case for the project.

2 Project Summary

General overview of progress	The objectives (from Project Framework) of tasks to date have been: 1. To gain clear understanding and agreement of the specific design parameters for the Project 2. To ensure that the safety, health and environmental issues are properly assessed, identifying significant hazards, and, providing the opportunity for their elimination by redesign 3. To gather all necessary data required to complete the engineering development of the Project With the exception of the optioneering that remains (see "Scope" above) these objectives have been met. For the remaining optioneering there is clarity on what the next steps are to ressolve. This optioneering is expected to be ressolved early in Preliminary Engineering.
Completed activities in this period	Project Kickoff Workshop (held 6/9/12) Biowin Process Model - this is a biological model of the WWTP and provides the basis for various flow rates and compositions for the Project Aspen Plus Model - this is a thermodynamic model and provides the basis for ammonia separation, reactor control and heat integration of the Plant Hazard Studies 1&2 (held 10-11/12/12); HAZID (Hazard Identification) & Project Risk Workshop Site visit to Oceana Gold (28-29/11/12) to view the pressure oxidation process for a better understanding of the engineering and operational aspects of a plant of this nature. Lessons learnt registers from the Pilot Plant. Opex Model and Summary Memo - based on Scion process data and the process models. Preliminary process flow diagrams (PFDs) Basis of Design (Issued for Review)
Incomplete activities in this period	Capital cost estimate still outstanding - this is being internally reviewed by TW prior to issue. Expect release of this by end of March. Formal proposal for Preliminary Engineering still outstanding - this is being internally reviewed by TW prior to issue. Expect release of this by end of March.

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Planned activities for the next period	Preliminary Design and reporting, including: - Finalised key process drawings (P&IDs, PFDs and outline GAs) - Finalised energy and mass balances - Specification of long lead items (for procurement to commence in following phase) - Hazardous area classification - SIL/IPF Assessment - Preliminary equipment and instrument schedules - Preliminary MTOs Hazard Study 3 (HAZOP) Preliminary Design Review (covers constructability, operability, maintainability) Validation of the capital cost estimate

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Quarterly Project Management Progress Report

TERAX™ MSW Research Project

Report Date	25/03/2013				
Description of Project	This project is to eliminate the problematic disposal of sewage sludge and other organic wastes using the proprietary technology platform, TERAX™. This is a hybrid process combining biological and thermo-chemical approaches to improve the efficiency, effectiveness and economics of organic waste destruction and value recovery.				
Reporting Period	**From**	7/01/2013		**To**	28/03/2013
Recipients	RDC, Scion, MFE				
Report Author	s 9(2)(a)				
Overall Project Status for this Period	☺	Significant detailed planning of the project for year 1 has been the key focus for the first quarter of the TERAX™ MSW Research project. Four key task areas have been defined, comprising of Characterisation and Technology Assessment, Laboratory Studies, Scale-up and Techno-economic Modelling. This quarter investigation and evaluation of existing technology for MSW handling and pre-treatment, component characterisation and selection for trialling, review and identification of key modifications for the lab and pilot plants and a process economic model design have been carried out and completed.			
Indicator Legend	☺ On Track	😐 Minor Problem	☹ Major Problem		

1 Progress for this Period

Key Indicators	Indicator Icon	Comments
Project Schedule	☺	No problems percieved at this stage
Scope	☺	No problems percieved at this stage
Resources	☺	Scion has recently employed a new Chemical Engineer to assist with the delivery of this project.
Health & Safety		This project is being run in accordance with Scion's Health & Safety policies and procedures. There are no current high/major risks/issues identified for this project. This quarters activity has been largely planning based, and as the project progresses to heavier experiemental workloads, more substantial H&S planning will be undertaken.

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Risks and Issues	☺	One high risk identified as part of the project planning relating to feasibility of final design. Active mitigation through design of research program and continued monitoring.
Budget	☺	No problems percieved at this stage

1.1 Major Issues Requiring Resolution and/or Change Requests Raised for this Period

Issue or Change Request	Description	Resolution Activities
Nil	There are no issues or changes requests currently being raised	

2 Project Summary

General Overview of Progress	The TERAX™ MSW research project is tracking well with the first quarter now complete. A great deal of planning has been carried out, with detailed workplans and technical reports produced. Detailed workplans for all task areas have been developed. Providing a basis for technology selection on performance, cost, advantages and disadvatanges, as well as a desk-based exercise to provide key inventory information for the Rotorua Landfill have been key outcomes for the Characterisation and Assessment activities. Detailed planning and reviews have taken place for both the laboratory and pilot plant programme and techno-economic framework has been developed.
Completed Activities in this Quarter	• Investigation and evaluation of existing technology for MSW handling and pre-treatment, • MSW initial component characterisation and selection for trialling, • Review and modify lab and pilot equipment to handle MSW components • Establish a process economic model design to enable the results of trials to be captured and evaluated for scenario analysis.
Incomplete Activities in this Quarter	All activities were completed this quarter
Planned Activities for the next Quarter	• Selection of MSW handling and pre-treatment technology options for trialling, • Combined MSW component and potential contaminant evaluation, • Development of representative synthetic substrates for trials, • Laboratory scale trials on MSW components, • Complete development of first generation process economic model.

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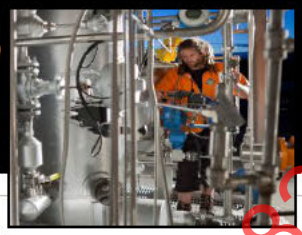
3 Upcoming Decisions

Date Decision Required	Description
	Nil

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TERAX™ Quarterly Technical Progress Report



Quarterly Technical Progress Statement for Q1- Milestone 1 – 2013

Date	25 March 2013
Author	s 9(2)(a)
Contributors	s 9(2)(a)
Task	All tasks
Milestone	1
Version	1.0

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Executive Summary

The WMF project on application of TERAX™ technology to municipal biosolids has completed its first quarter. This project is focussed on describing the efficacy of transferring the TERAX™ technology from a relatively simple feedstock (biosolids) to address the challenge of municipal solid waste (MSW) conversion. The work will be based around technology development using laboratory and pilot scale reaction engineering, alongside completion of a techno-economic analysis to address the financial efficacy of the developed process.

Significant outcomes from this first quarter have been:

Detailed technical planning. This has provided a solid base for moving through a technology development programme which has significantly greater complexity, than the earlier project largely due to the complexities associated with the incoming feedstock material. Integral to the plan is development of a staged approach to the project, with technical "hold-point" workshops inserted into the timeline at regular intervals. At these points, technical progress and challenges will be actively managed, to ensure the best opportunity for success.

Feedstock selection. The first technical focus will be on the Putrescibles waste category entering the landfill, composed largely of the food waste fractions. This category forms approximately 50% of the organic flows to the landfill. Further, it is amenable to both fermentation and wet oxidation, thus allowing the essential process flow of the original TERAX™ process to be tested, whilst accommodating new elements of feedstock pre-treatment and water inventory.

Pre-treatment technology identification. Along with contamination, particle size reduction has been identified as an important component of MSW pre-treatment. A database of commercial technologies have been identified which could achieve this task, and these will be both added to and evaluated for technology selection in the following Quarter.

Laboratory and pilot plant modifications. Along with some modification of plant and equipment for the new tasks, a recommendation has been made for purchase of a mid-sized hydrothermal reactor. If funding is secured via the Scion Capex process, this will be a significant boost to the development programme.



Process economics. A techno-economic model was developed within the previous MfE-funded TERAX™ project to provide an analysis of the TERAX™ process when used to treat sewage sludge. Treating municipal solid waste (MSW) requires increased complexity, and therefore the existing model is unlikely to be fit for purpose as it currently stands. Work in Quarter 1 has highlighted the aspects of the current model which are missing and sets out recommendations for model improvements.

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Overall Project Planning

Scion has spent a significant effort within the first quarter planning the technical approach and transforming the contracted proposal into workable detail.

Municipal Solid Wastes (MSW) can be viewed as described in Figure 1, below.

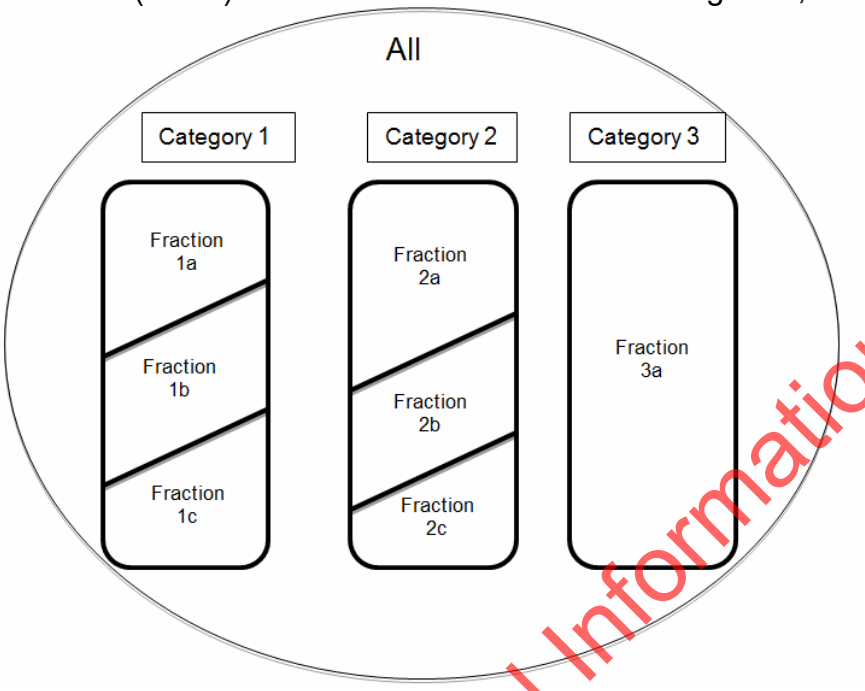


Figure 1: Classification of MSW fractions

Here a category is defined as an appropriate grouping of the waste e.g. Putrescibles, Paper, Construction and Demolition, closely aligned with SWAP categories (see http://www.mfe.govt.nz/environmental-reporting/report-cards/waste-composition/2009/index.html).

The category should consist of a relevant portion of the MSW which can be rationally collected and potentially treated on its own. For example, Category 1 could be Putrescibles, which may have fractions associated with household food waste (1a), food production industry (1b) and restaurant (1c). Category 3 could be Paper waste.

Approach to project

The Objective of the research portion of the project is to "*extend the hydrothermal technology platform to broader MSW organic waste streams*" as per the funding Deed.

To achieve this Objective, the approach for the TERAX™ MSW project will be:

1. Provide a thorough analysis of the relevant categories, identifying key opportunities and challenges for processing based on physico-chemical and inventory characteristics.

2. Initial technical focus on one particular category at a time, taking the technology development path via
    a. proof of concept laboratory trials
    b. pilot plant trials
    c. techno-economic analysis.

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Specifically, the first focus will be on a Putrescible category, composed largely of the food waste fractions. This category is amenable to both fermentation and wet oxidation, thus allowing the essential process flow of the original TERAX™ process to be tested, whilst accommodating new elements of feedstock pre-treatment and water inventory.

3. In parallel, provide a screening analysis of all of the categories and fractions, to give a broad-brush understanding of their amenability to fermentative and hydrothermal processing. This will give direction and priority to the subsequent waste
categories to be taken through the development pathway.

4. The project will work towards specific "hold-points" in the development pathway. At these hold-points, decisions will be made to:
    a. Continue the development for a particular category of material; or
    b. Modify the technical approach
        i. May include modification/elimination of process unit operations
        ii. May include incorporation of additional categories into the current processing approach;
    c. Cease the development on the current category of material and take up on the agreed subsequent waste category.

5. The project will use a similar structure as for the hold-points to determine whether to move on to addressing a subsequent waste category, either separately or in parallel development with the current category under assessment.

The rationale for category-by-category development:

I. It becomes increasingly clear that there is a huge range of factors which can be assessed when targeting municipal solid waste. The number of targetable components is extremely large, and there is a risk of not achieving anything substantial if we do not provide focus.

II. The approach of tackling particular categories as a whole, and attempting to analyse their performance in a subsequent reductive analysis (i.e. if category 1 doesn't ferment, then pick it apart to find out why, otherwise move on) has some attraction but suffers from a potential lack of detailed analysis.

III. Discussions with key players in the solid waste industry in NZ. From these discussions, the impression gained was that focussing on a technology which "does it all" is extremely risky as the landscape is littered with technologies which professed to do such and failed completely.

IV. There is a strong commercial driver to deal with food waste conversion coming from other parts of the country (e.g. Auckland). This gives some commercial impetus to the project right from the beginning.

V. Confronting contamination. It has become clear that dealing with contamination could be where a process will succeed or fail. Unlike biosolids, every batch of every category could be contaminated in different ways. If we deal with too many types of contamination, the project could lose focus and risk poor delivery.

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Critical aspects of the project

Critical to success will be the separation and size reduction steps, whereby non-process elements of the incoming waste are removed from the feedstock. This could include metal and plastic materials, although the latter could potentially be incorporated into the process feedstock, depending on the conditions of the hydrothermal process. We envisage a targeted adoption and adaption of commercially-available technologies to achieve the required separation and size reduction steps.

Methanogenesis (biological production of methane) is a logical first end-point for the soluble organics produced by TERAX™. Organic acids are readily converted into methane and the produced gas can integrate into existing infrastructure for methane capture present at many landfill sites. This does not, however, preclude other applications of the TERAX™ liquor organic acids, which will be dependent on market drivers.

The TERAX™ platform assessment is not rigidly fixed to the two-stage fermentation plus wet oxidation approach. Assessment may include modifications such as low level aeration of the fermentative front end, non-oxidative hydrothermal processing or single stage wet oxidation as alternative configurations.

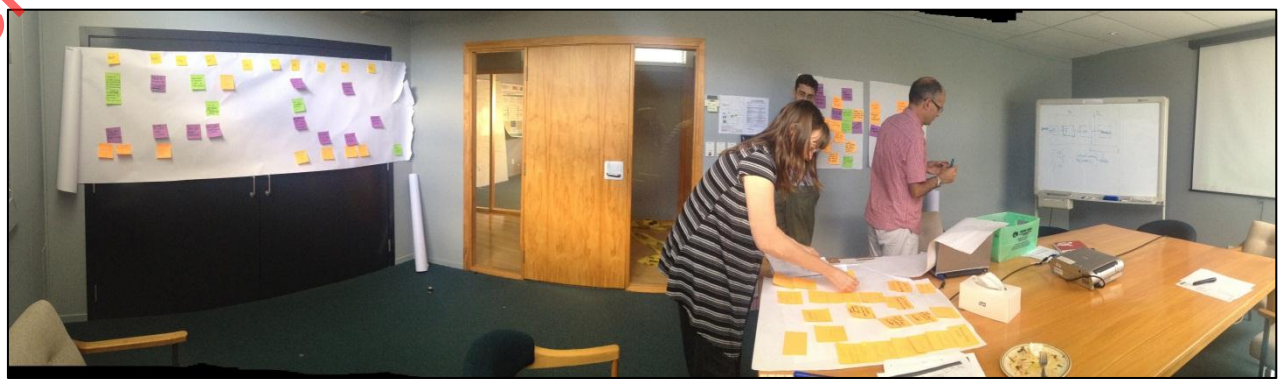
The construction of the techno-economic model will be at least as important as the technical work proposed. The process complexity and processing options will be significantly greater than the original sewage biosolids case. Nevertheless, building on the maturity of knowledge gained in the original TERAX™ work, the project should make a step-change in process modelling quality, including moving to a commercial process engineering software base, such as Aspen PLUS (Aspen Technology Inc. USA).

To support this transition, the project team have excellent in-house capability. There is also a strong link to leading New Zealand control and modelling expertise via Transfield Worley Ltd and the Industrial Information and Control Centre, AUT (I^2C^2, www.i2c2.aut.ac.nz). Indeed, Scion is currently embarking on detailed modelling simulation of our hydrothermal process plant via a postgraduate student supervised by I^2C^2 director s 9(2)(a)

Taking a combined technical and techno-economic modelling approach, we should be able to produce a confident recommendation as to the efficacy of taking TERAX™ hydrothermal deconstruction technology to the next, full-scale demonstration application for municipal landfill organics.

The high level approach to achieving this project's objectives is detailed below with key methods stated.

From the contracted plan, four Milestones are identified in the first year of the project (Milestones 1, 2, 3, and 5).



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Task reporting


http://claudiofocchi.com/services/seo-analysis/

The work programme has been broken into four major task areas:

- Characterisation and technology assessment
- Laboratory studies
- Scale-up
- Techno-economic modelling

These tasks provide the structure for the technical programme for a minimum of the first year. The following sections describe the results of task activities from Quarter 1, contributing directly to the MfE Project Milestone 1: *MSW Option Establishment*.

Task One – Characterisation and Technology Assessment

This task first provides focus to understanding MSW, its classification, physical, biological and chemical characterisation, contaminants and hazards. The second aspect of the task is to direct technology selection for initial sorting, de-contaminating and size reduction of the MSW feedstocks to the TERAX™ process.

Milestone Activities

Milestone activity 1: Investigation and evaluation of existing technology for MSW handling and pre-treatment.

The aim of the work has been to provide the basis for technology selection based on performance, cost and advantages and disadvantages. This initial analysis is to be added to in the following Quarter.

Key outcomes:

- Focus of the initial work has been on size reduction as a priority requirement for process development.
- Results from the pilot scale operation of the wet oxidation process suggest that particle sizes of 1-3/mm may be manageable, but above 3mm could cause significant problems with pumping to the high pressures required of a hydrothermal process, such as used in TERAX™. Thus size reduction to less than 3mm, and possibly less than 1mm is desirable.
- Any pre-treatment (e.g. size reduction) equipment must be able to handle significant levels of contamination. For example, food processing waste materials may be contaminated with metals, which may slip past primary sorting/ decontamination.
- Process design of the TERAX™ unit operations is likely to be critical to success in this project. Thus, it is recommended that attention be given to potential modification from the initial biosolids-base design to allow for larger sized materials processing and the presence of contaminants.

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- Size reduction may significantly improve fermentation and hydrothermal reaction rates, providing a benefit to the size reduction beyond simple plant protection.

- A number of technologies were identified which provide interesting capability in particle size reduction. These include:

    a. Muffin monster (JWC Environmental, USA, http://www.jwce.com/muni/products/)
    b. Mono A Muncher (Mono Pumps Ltd, UK, http://www.mono-pumps.com/Series_A_muncher_for_maceration)
    c. Vogelsang X-Ripper (Vogelsang GMBH, http://www.vogelsang.info/en/product/maceration-technology/vogelsang-x-ripper-twin-shaft-macerator/#c4750)
    d. Pulp master (Pulpmaster Australia, http://www.pulpmaster.com.au/pm_03.html)

    These technologies will be evaluated for selection, in the coming quarter. It is anticipated that this database of technologies will grow with time through the project.

Milestone activity 2: MSW initial component characterisation and selection for trialling

A desk-based exercise has been conducted to provide the inventory information for the Rotorua landfill, relative to the national situation. These were based largely on:

- SWAP surveys (WasteNot Consulting) completed Rotorua landfill in 2003, 2005 and 2009;
- SWAP analyses completed for other national sites
- Scion's national organic waste audit (2009)

The collated findings have been reviewed for this project. Also highlighted are some of the expected opportunities and challenges that could be encountered when treating various municipal solid waste components, using the wet oxidation unit operation of the TERAX™ process.

Key outcomes:

- Rotorua disposes of 40,000 tonnes solid waste per annum, excluding sewage sludge and cleanfill, equating to 574 kg waste per capita per year. Of this inventory, 12,000 tonnes (30%) was classified as putrescible waste (kitchen/food, greenwaste, and other [e.g. meat processing dead animals, wool scour]).

- Kerbside collection gathers approximately 50% of the putrescible waste.

- Values for Rotorua are close to nationwide median values for MSW disposal. Thus, the Rotorua site is quite representative of the nationwide landfilling activity.

- Based upon the MSW component description and a simplifying assumption that all material within a waste category will be able to be processed, a total of 19,000

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tonnes per year (48% of 40,000 tonnes) has a good likelihood of being effectively processed using wet oxidation, whilst a further 7,500 tonnes (19%) has some likelihood of effective processing.

- As the major fraction of organic wastes entering the landfill, and having high likelihood of being effective transformation within TERAX™, Putrescibles are clearly identified as a strong target for initial study in the project.

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[redacted]

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Task Two - TERAX™ MSW Laboratory



The laboratory work conducted within this project will be held within this task.

The task addresses the technical feasibility of processing MSW waste categories using biological fermentation and hydrothermal treatment. This is to:

- Ensure that it is appropriate to scale-up the technology for particular waste streams,
- Informs the techno-economic modelling; and
- Provides important outputs required in full-scale plant design.

Milestone activity 3: Review and modify laboratory and pilot equipment to handle MSW components

Activity in this quarter has been heavily loaded towards planning the laboratory programme for the year.

Key outcomes:

- Detailed workplans have been produced, outlining hydrothermal and anaerobic fermentation trial plans for the year. These will undergo review in early April for actioning work beginning in Quarter 2.

- Two key elements have been identified which require attention for hydrothermal processing trials:
    a. Safety re-analysis of hydrothermal laboratory. With this new project, the key equipment used for the hydrothermal processing is being evaluated afresh. Equipment modifications, which have occurred over a period of two years, will be studied. A hazop-style analysis will be undertaken to minimise risk of working with this high temperature/pressure reactor system. This is due for completion in April, 2013.
    b. funding a larger hydrothermal reactor. This is described in the Scale-up task below

- Laboratory fermentation trials require reactor systems capable of functioning at high solids concentrations (10-30% feed concentrations). This will be a challenge, and require some testing of our current facility and likely purchase of at least one system which is representative of high solids processing.

- None of the equipment modifications will prevent initiation of the laboratory trial activities of Quarter 2.

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Task Three – TERAX™ MSW Scale-up

This task focusses on technical scale-up of the process. In particular, the work will focus on the scale-up of laboratory processes from less than 1L scale, through to 3-5L, 10-50L (hydrothermal) and 1000L (fermentation) scales. Important to this task is pilot plant maintenance, development/modification, addition of pre-treatment technology as prescribed by other Tasks, and design and conduction of a pilot-scale experimental programme.

In the current Quarter, however, the activities have been preparatory, as described below.

Milestone activity 3: Review and modify laboratory and pilot equipment to handle MSW components

Key outcomes from the scale-up task have been:

- Maintain the fermentation pilot plant. This plant has had heavy use over the past year and requires some maintenance. Further, communications, the control system and feed handling capability of the plant has been poor, which requires addressing. The costs of plant maintenance and modification have been identified. Required expenditure will be agreed-to and actioned in Quarter 2, ready for utilisation in Quarter 3.

- Source a mid-sized hydrothermal reactor. The small 600mL reactor (Parr Instrument Company) is too small for some of the desired work, particularly when completing multiple sampling procedures and attempting continuous processing at smaller scale. The larger pilot plant (200L) is too large for some highly detailed work. For example, this plant is sometimes compromised by having very long heating times, confounding the results of batch processing by variable temperature profiles. Further, the resource and personnel requirements of any work at this scale are very high, having significant impact on experimental costs. To solve this, a funding application is being prepared to purchase a mid-sized (5-10L) hydrothermal reactor, which will be completed for submission to Scion in Quarter 2. This would be a significant investment by Scion into the project (well over $100,000). Initial pricing has been sought from a number of vendors, with full quotes pending.



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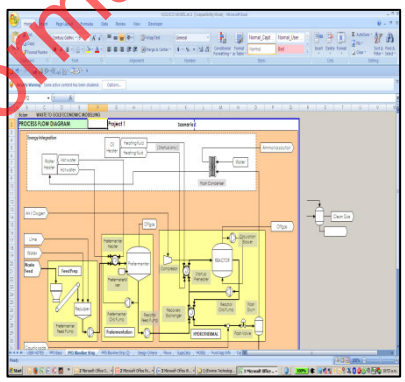
Task Four – Techno-Economic Modelling

In large-part, the techno-economic modelling binds this project together. Here, the technical aspects of a project are combined with economic analysis, to provide a financial indicator of the efficacy of a particular plant design.

The principle aim of the techno-economic modelling task is to assess the technical feasibility of processing MSW via the TERAX™ technology. The modelling will be used to inform further investment decisions and also to focus attention on elements of the technical programme which could yield significantly improvements to economic efficacy.

A techno-economic model was developed within the previous MfE-funded TERAX™ project to provide an economic analysis of the TERAX™ process when used to treat sewage sludge. Treating municipal solid waste (MSW) and the organic fraction of municipal solid waste (OFMSW) is a more complex industry and therefore the existing model is unlikely to be fit for purpose as it currently stands. Work in Quarter 1 has highlighted the aspects of the current model which are missing and sets out recommendations for model improvements.

Milestone activity 4: Establish a process economic model design to enable the results of trials to be captured and evaluated for scenario analysis.



The technical approach to this modelling task has been prepared. The key recommendations of the work are:

- To use multiple modelling tools as appropriate to the situation
    a. Biowin (EnviroSim Associates Ltd, Canada) in wastewater treatment;
    b. MicroSoft Excel (MicroSoft Corp, USA) generally, and
    c. Aspen (Aspen Technology Inc, USA).

    In the first instance the current Excel-based model will be used with modification to accommodate aspects of the new project requirements. It is anticipated that over the course of the project, Aspen software (or other engineering simulation software) will become the base technology for describing the process engineering aspects of TERAX™.

- To focus effort on comparing TERAX™ against the landfilling alternative;

- The scope of the effort should be put into costing activities after the waste has arrived at the gate, not costs for collection, delivery or materials recycling activities;

- Business case modelling should be separated from technical modelling, which is the focus of the current project.

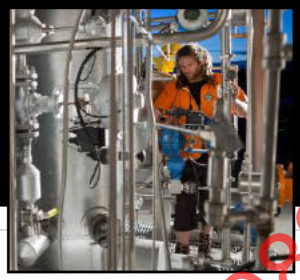
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TERAX™ Technical Report



MSW Scale Up Y1Q1

Date	19/03/2013
Authors	s 9(2)(a)
Contributors	
Task	MSW Scale Up
Milestone	1st Quarter
Version	1.0

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Executive Summary

The focus of the first milestone was to understand the work required to repair and modify the fermentation pilot plant so it can operate safely and effectively on MSW feedstocks. The second part of this milestone was to complete a rudimentary costing of a mid-sized scale hydrothermal reactor, as a beneficial addition to the project delivery.

The work consisted of emailing and phoning suppliers for costs of materials. It involved meeting with contractors on and off site and getting quotes for various jobs on the plant. It also involved meeting with suppliers and Scion staff to clarify detail around some plant specifications. Some detail is still outstanding.

The cost to maintain the fermentation plant to its previous level of operation and make necessary improvements for future operation on MSW feedstocks is estimated at approximately $55,000. This work is a necessity if MSW feedstocks are to be processed.

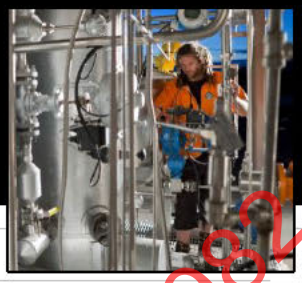
To purchase a mid-sized (5-10 litre) high pressure (150 Bar) high temperature (350 deg C) reactor and set up for continuous operation could cost between $200,000-300,000 for complete installation. This is currently an estimation, and will require some more work to develop accurate costings. This will be completed in April 2013 .

If actioned appropriately, there will be no risk to project delivery, as pilot plant operational deliverables do not occur until at least Quarter 3 of Year 1 of this project. A number of fall-back positions are identified, should capital expenditure not be forthcoming for the hydrothermal reactor purchase.

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TERAX™ Technical Report



Establishing the techno-economic framework

Date	26/03/2013
Authors	s 9(2)(a)
Contributors	
Task	Techno-economic modelling
Milestone	1st Quarter
Version	1.0

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Executive Summary

The principle aim of the techno-economic modelling task is to assess the technical feasibility of processing MSW via the TERAX™ technology. The modelling will be used to inform further investment decisions, and also to focus attention on elements of the technical programme which could yield significantly improvements to economic efficacy.

A techno-economic model was developed by within the previous WMF-funded TERAX™ project, to provide an economic analysis of the TERAX™ process when used to treat sewage sludge. Treating municipal solid waste (MSW) and the organic fraction of municipal solid waste (OFMSW) is a more complex industry and therefore the existing model is unlikely to be fit for purpose as it currently stands. Work in Quarter 1 has highlighted the aspects of the current model which are missing, and sets out recommendations for model improvements.

The technical approach to this modelling task has been prepared. The key recommendations of the work are:

- To use multiple modelling tools as appropriate to the situation
    a. Biowin (EnviroSim Associates Ltd, Canada) in wastewater treatment
    b. MicroSoft Excel (MicroSoft Corp, USA) generally,
    c. and Aspen (Aspen Technology Inc, USA);

  In the first instance, the current Excel-based model should be used, with modification to accommodate aspects of the new project requirements. It is anticipated that over the course of the project, Aspen software (or other engineering simulation software) will become the base technology for describing the process engineering aspects of TERAX™.
- To focus effort on comparing TERAX™ against landfilling alternative;
- The scope of the effort should be put into costing activities after the waste has arrived at the gate, not costs for collection, delivery or materials recycling activities;
- Business case modelling be separated from technical modelling, which is the focus of the current project.

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Quarterly Communications Report - Quarter 1 - Year 1

Future - Reactive & Responsive Communications Register
Project Name: TERAX 11 - Demonstration Plant - MSW Research Programme - Commercialisation

Comms Ref #	Date comms initiated	Communication Description	Communicating Company	Target audience	Communication channel	Date of release/activity	Date & Outcome / Progress Update	Comms status
	February	WasteMINZ indicated they may do an article on TERAX for their magazine	WasteMINZ	waste & resource recovery sector	Waste Awareness Magazine (electronic)		unknown	
	February	TCE magazine regarding article for there October Waste focus	TCE	Chemical Engineers	Technical prac icionors (electronic/hardcopy)		unknown	unknown

Closed Communications Register
Project Name: TERAX 11 - Demonstration Plant - MSW Research Programme - Commercialisation

Comms Ref #	Date comms initiated	Communication Description	Communicating Company	Target audience	Communication channel	Date of release/activity	Date & Outcome / Progress Update	Comms status
	Decembe r	TERAX Update No. 3	Scion	TERAX stakeholders and interested parties	Email, Scion website	20-Feb-13		Complete
	January	Media release to support Environment Minister's announcement	Scion & RDC	Public	media release to news media outlets and industy media	14-Feb-13		Complete
	January	TERAX funding article for MBIE	Scion	MBIE & its audiences	ar icle emailed to MBIE (Snr comms advisor)	15-Feb-13		Complete
	March	Media release to announce appointment of Terax Ltd directors	RDC & Scion	Public	media release to news media outlets and industy media	15-Mar-13		Complete
	February	NZBio Conference, Auckland	Scion	Conference delegates	s 9(2)(a) and display stand with process anima ion & print material	18 to 20 March 2013		Complete
	February	Front page ar icle in "Scion Connections"	Scion	industry, central and local government	quarterly newsletter - soft & hard	15-Mar-13		Complete
	March	RDC/Scion appoint directors to Terax Ltd	RDC/Scion joint	media	Media release	16-Mar-13		Complete
	February	MFE Govt $4.7m grant confirmed	Scion/RDC jo nt	media	Media release	16-Feb-13		Complete
	March	Meeting with Balance agri-nutrients regarding potential for nutrient recovery from TERAX process	Scion	Meeting	Meeting	March		Complete
	March	Meeting with Enviro-waste regarding commercial opportunities for TERAX within MSW sector	Scion	Meeting	Meeting	March		Complete
	March	BOP Regional Council - regard ng air emissions requirements for consenting.	Sion	Meeting	Meeting	March		Complete

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WMF Milestone Claim Form

Projects may have up to six milestones, and a separate tab has been created for each in this spreadsheet. This summary page is completed by your Fund Analyst, and the information populates the other tabs in this spreadsheet. Open the tab that corresponds with the current project milestone and complete the relevant sections.

WMF Reference:	WMF-559	**Funding deed no:**	20351
Project name:	Demonstration of the TERAX™ hydrothermal deconstruction process	**Grantee name:**	Rotorua District Council
Project Year:	Year 1	**WMF $ approved:**	$1,000,000
WMF % approved:	48.00%		

Name of milestone	Due date	Estimated total cash expenditure *(excl. GST)*	Estimated WMF cash payment *(% est. cost)*	Actual total cash expenditure *(excl. GST)*	Actual payment due	Comments
Milestone 1						
MSW Option Establishment	30/03/13	$223,000.00	$106,000.00	$223,000.00	$106,000.00	
Milestone 2						
Hydrothermal Component Trials	30/06/13	$229,000.00	$109,000.00	$0.00	$0.00	
Milestone 3						
Hydrothermal mixed MSW Trials	1/10/13	$270,000.00	$129,000.00	$0.00	$0.00	
Milestone 4						
Full-Scale Detailed Design	1/11/13	$1,000,000.00	$476,000.00	$0.00	$0.00	
Milestone 5						
Pre-treatment Trials Establishment	1/12/13	$278,000.00	$132,000.00	$0.00	$0.00	
Milestone 6						
Construction Procurement	15/12/13	$100,000.00	$48,000.00	$0.00	$0.00	
Totals *(excl. GST)*		$2,100,000.00	$1,000,000.00	$223,000.00	$106,000.00	

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Milestone 1

Interim Claim

WMF Reference: WMF-559 | **Project Year:** Year 1

Grantee: Rotorua District Council | **Deed No:** 20351

Project: Demonstration of the TERAXTM hydrothermal deconstruction process | **Due Date:** 30 March 2013

*This tab is for you to provide details of the cash income received, and the cash expenditure, for this milestone. Complete the **Cash Income (non-WMF)** and **Cash Expenditure** sections below (shaded sections only). When you have done this, the payment due for this milestone automatically calculates. Ensure that your figures are accurate and based on actual cash income received and actual cash spent, and then save your changes. Submit the entire claim form to your Fund Analyst with the milestone report and other required documentation for this milestone.*

Balance and actuals for this project year only (Ministry use only)

WMF Approved amount:	$1,000,000.00
WMF Funds paid to date:	$0.00
WMF Funds remaining at beginning of milestone:	$1,000,000.00

Milestone estimates (Ministry use only)

Estimated total expenditure for this Milestone:	$223,000.00
Estimated WMF payment for this Milestone:	$106,000.00

Cash income (non-WMF)

As part of your project plan, you estimated the cash income you would receive from other external sources (including partners). Record all actual cash income below, that you have received from other funding sources for this milestone only, excluding GST. This may include cash income not previously listed in your project plan. This page contains formulae to calculate the payment due. Do not add rows to this page. If you have multiple income streams, combine these to fit the rows provided.

Cash income from your organisation:	$67,000.00
[enter the name of the external funding source here]:	$50,000.00
[enter the name of the external funding source here]:	[enter actual amount received]
[enter the name of the external funding source here]:	[enter actual amount received]
Actual total cash income:	**$117,000.00**

Cash expenditure

*As part of your project plan, you estimated the cash expenditure for this milestone. Record all actual project costs (cash expenditure) for this milestone in the cost category rows below, excluding GST. Details of invoices in support your claim should be recorded on the **'Summary of Expenses'** form. This page contains formulae to calculate the payment due. Do not add rows to this page.*

Personnel:	$0.00
Administration:	$0.00
Consultants and contractors:	$223,000.00
Purchase of capital assets and other capital costs:	$0.00
Venue and equipment:	$0.00
Travel and accommodation:	$0.00
Promotion and dissemination of information:	$0.00
Financial, legal and information technology expenses:	$0.00
Other miscellaneous costs:	$0.00
Actual total expenditure:	**$223,000.00**

Payment calculated using the Interim Payment Calculation (Ministry use only)

*The **Payment due** amount is how much the WMF will pay you (excluding GST) after your milestone and its deliverables have been assessed and approved. Your payment due will be the lesser of A, B or C below, as per Section 1 of your funding deed. Contact your Fund Analyst for further information, if required.*

Maximum amount approved less 10% (A) =	$900,000.00
WMF contribution to actual total expenditure* (B) =	$107,040.00
Actual expenditure minus income (C) =	$106,000.00
Payment due: *(excl. GST)*	**$106,000.00**
Funds remaining after payment made	$894,000.00

** This is based on the WMF percentage contribution to the actual total expenditure*

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Ministry use only

Milestone assessment

Record the milestone claim assessment below.

Approved/declined for payment:

Name:	
Position:	
Date:	
Signed:	

Payment verified:

Name:	
Position:	
Date:	
Signed:	

Payment approved:

Name:	
Position:	
Date:	
Signed:	

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Te Papa Tipu Innovation Park
49 Sala Street, Private Bag 3020, Rotorua, New Zealand
Telephone: + 64 7 343 5899 | Facsimile: + 64 7 348 0952
Email enquiries@scionresearch.com | www.scionresearch.com

TAX INVOICE

Rotorua District Council
Private Bag 3029
Rotorua 3046

Customer Number:	00764	***GST Reg No (NZ):***	59-493-760
Customer Reference:	MFE CONTRA	***ABN No (Australia):***	512-1094-8677
Invoice Number:	**051366**	***Invoice Date:***	19/03/2013
Page :	1 of 1	***Due Date:***	20/04/2013

Particulars	MSW Option establishment as per TERAX Demonstration pland al	***Amount $***
MSW Option establishment as per TERAX Demonstration pland and further research contract 13/018 Includes TERAX Modelling, TERAX Feedstocks, TERAX Laboratory and TERAX Scaleup activities		223,000.00

Attention: s 9(2)(a)

Sub Total:	223,000.00
GST:	33,450.00
Invoice Total:	256,450.00

For any queries relating to this invoice, please contact Alex Chambers
For any payment queries, please contact accounts.receivable@scionresearch.com

s 9(2)(b)(ii)

Rotorua District Council **Amount:** 256,450.00

Card Number: __ __ __ __ - __ __ __ __ - __ __ __ __ - __ __ __ __ **Card Type:** Visa__ Mastercard__

Security Number: __ __ __ (Three digit number located on the back of your card

Cardholders Name: _____ **Expiry Date:** ___/___

Signature: _____ **Amount to Pay:** $_____

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Total Staff Hours TERAX™ II

Quarter 1 - Year 1 staff hours

s 9(2)(a)

	Quarter 1
	185
	228
	195
	9
	132
	222
	72
	70
	116
	3
	70
	6
	183
	16
	130
Total	**1637**

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DESTINATION ROTORUA
ROTORUA DISTRICT COUNCIL

Rotorua District Council
1061 Haupapa Street
Private Bag 3029, Rotorua Mail Centre
Rotorua 3046
Phone: 07 348 4199
Fax: 07 346 3143
Email: mail@rdc.govt.nz

TAX INVOICE

MINISTRY FOR ENVIRONMENT
PO BOX 10362
THE TERRACE
WELLINGTON 6143

PLEASE QUOTE YOUR CUSTOMER NUMBER

INVOICE No.	263387
DATE	27 Mar 2013
CUSTOMER No.	AR 221875

G.S.T. REG. No. 10-801-397

DESCRIPTION	AMOUNT
COMPLETION OF MILESTONE/WMF TERAX TM WASTE DECONSTRUCTION TECHNOLOGY	
As Per Attached Claim Form Att: Kathryn Howard	106,000.00

Please pay on invoice. No statement will be issued.

Rotorua District Council reserves the right to pass any unpaid accounts to its Collection Agency and any costs or expenses as a result shall become the responsibility of the client (as abovementioned)

ALL ENQUIRIES RELATING TO THIS INVOICE SHOULD BE REFERRED TO:-
s 9(2)(a)

SUB TOTAL	**$106,000.00**
G.S.T.	$15,900.00
TOTAL $	**$121,900.00**

No statement is issued, please pay on invoice.

PLEASE RETURN THIS PORTION TO ENSURE YOUR ACCOUNT IS CREDITED WITH THIS PAYMENT **DETACH HERE**

DESTINATION ROTORUA
ROTORUA DISTRICT COUNCIL

Rotorua District Council
Private Bag 3029
Rotorua Mail Centre
Rotorua 3046

MINISTRY FOR ENVIRONMENT
PO BOX 10362
THE TERRACE
WELLINGTON 6143

CUSTOMER NUMBER AR	
AR	221875

INVOICE NUMBER	263387
DATE DUE	17 Apr 2013
TOTAL	**$121,900.00**
AMOUNT ENCLOSED	

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DEPOSIT

Bank of New Zealand

Rotorua Branch

Tellers Stamp & Initials

Paid in by:

Signature

Credit

FOR ROTORUA DISTRICT COUNCIL
GENERAL FUND ACCOUNT

s 9(2)(b)(ii) [redacted]

Date

Notes

Coin

Total Cash

Cheques
AS ON REVERSE

$

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Ministry for the Environment
Manatū Mō Te Taiao

Community Environment Fund
&
Waste Minimisation Fund

Milestone Report

Organisation: Rotorua District Council

Project name: TERAX™ waste deconstruction technology

Deed number: 20351

Year: 1

Milestone: 2

Milestone due date: 30 June 2013

New Zealand Government

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Official Information

Important: Information presented to the Minister for the Environment or the Ministry for the Environment is subject to disclosure under the Official Information Act 1982 (OIA). Certain information may be withheld in accordance with the grounds for withholding information under the OIA. Further information on the OIA is available at www.ombudsmen.parliament.nz.

Information held by the Minister and Ministry may have to be released under the OIA in response to a request from a member of the public (or any other body) for that information. If you wish to provide sensitive information to the Minister or Ministry which you do not want released, it is recommended you consult with the Ministry as to whether the information is necessary for the application, and whether there may be grounds in the OIA for withholding the information. For instance, if release of the information would disclose a trade secret, or be likely to unreasonably prejudice the commercial position of the person who supplied or who is the subject of the information, then there may be grounds to withhold the information. The Ministry will endeavour to contact you to discuss an OIA request relating to your application if one is received, and what the implications of releasing your information are.

The grounds for withholding must always be balanced against consideration of public interest that may justify release. Although the Ministry does not give any guarantees as to whether information can be withheld under the OIA, it may be helpful to discuss OIA issues with the Ministry in advance, if information provided with an application is sensitive.

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Introduction

This milestone report provides the Ministry for the Environment with information about how the delivery phase of your project is going. It must be completed and submitted for each milestone by the dates agreed in your funding deed, unless otherwise discussed with your Fund Analyst.

> Ensure you have read the 'Milestone reporting and payments' section of the *Guide for grantees* before you complete this report.
>
> It is preferable to complete this report electronically, and submit it by email.
>
> You must discuss any problems, issues, or major changes to your project with your Fund Analyst before completing and submitting this report.

When your report is complete

Milestone reports should be submitted by the dates agreed in your funding deed, unless otherwise discussed with your Fund Analyst.

Email the following documents to your Fund Analyst:

- completed milestone report
- completed claim form
- completed invoice breakdown spreadsheet
- supplier invoices for any item over $50,000, and any capital costs of $10,000 value or more.

Alternatively, you can post these to: Community Environment Fund or Waste Minimisation Fund, Ministry for the Environment PO Box 10362, Wellington 6143.

What happens next?

Your Fund Analyst will assess the report to ensure that you have met the requirements for funding as specified in your funding deed. During your Fund Analyst's review of the report and supporting documentation, further information (including evidence confirming actual expenditure) may be requested. Allow at least seven working days for the assessment to take place. A report for a final milestone may take longer to assess, and may also be dependent on the results of an independent audit.

Once the Ministry for the Environment is satisfied that your milestone claim meets the funding requirements, your Fund Analyst will arrange payment with the Ministry's finance department.

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Section 1: Evaluation of this milestone

Complete the tables below to show how your project is tracking against this milestone in your project plan. Submit the following with this milestone report:

- *completed milestone claim form*
- *completed summary of expenses form*
- *final project report template (if this is the final milestone)*
- *evidence of the deliverables.*

Press the Tab key on your keyboard to add more rows to the tables, if required.

(1A) Activity *List the activities for this milestone as specified in your project plan*	**Summary of progress** *Provide a summary of the progress made for each activity associated with this milestone*
• Selection of MSW handling and pre-treatment technology options for trialling,	• A database has been created, and populated with identified pre-treatment technologies. The specifications of four shredder options were summarised, to a level where initial cost estimates could be provided. Costings for one unit are being investigated, for application within TERAX™ pilot plant trials. More detail provided in Quarterly Technical Progress Statement (QTPS).
• Combined MSW component and potential contaminant evaluation	• This activity focussed on physico-chemical characterisation of MSW putrescibles and potential putrescible contaminants. In particular, analysis was made of weight loss characteristics during thermo-gravimetric analysis (TGA). Whilst more work is required to confirm its effectiveness in screening for wet oxidation potential, the analysis has good scope to be utilised in providing a rapid mixed waste component evaluation. More detail provided in QTPS.
• Development of representative synthetic substrates for trials	• For standardisation purposes, two representative model substrates were created according to existing literature references. One of those substrates was an extensive mix of all food categories commonly found in MSW. The other was very simple – consisting of a commercially available dog food. These synthetic substrates were then characterised alongside a real food waste, sourced from the hospitality industry. These model food wastes provide an excellent platform for generating a representative, reproducible feedstock material for TERAX™ trialling. More detail provided in QTPS.
• Laboratory scale trials on MSW components	• A laboratory-based food waste fermentation was completed. The fermentation resulted in excellent destruction of organic solids, high production of organic acids, and production of hydrogen as a product. Laboratory hydrothermal trials were conducted, to screen the performance of potential MSW components within the hydrothermal unit operation of the TERAX™ process. Wet oxidation was able to solubilise the main components of MSW. Putrescibles components were readily converted under the standardised conditions. More detail provided in QTPS.
• Complete development of first generation process economic model	• The techno-economic model, which was initially developed within the previous MfE-funded TERAX™ project on sewage sludge, was significantly modified and adapted to allow an assessment to be made

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	of the anticipated costs of treating the putrescibles fraction of MSW. Amendments were made and preliminary assessment undertaken to understand some cost implications. More detail provided in QTPS.

(1B) Deliverable *List the deliverables for this milestone as specified in your project plan*	**Status** *Complete or incomplete?*	**Reason** *If not complete please let us know why*
• Quarterly PGG update report in dashboard format.	Yes	
• Quarterly Project management progress report	Yes	
• Quarterly technical progress statement describing trials undertaken, results to date and associated workplan progress	Yes	
• Techno-economic scenario updated as an output from the MSW process model.	Yes	
• Quarterly communication report	Yes	
• Milestone report • Milestone claim form • Documentation to support actual expenditure (i.e. receipts/invoice) • Tax invoice for claimed amount	Yes	

Section 2: Evaluation of Project Objectives

Delivery of each milestone will help you progress towards achieving your project's overall objectives. Complete the table below to show how your project is tracking against its objectives.

Your Project Objectives *List the project objectives from your project plan*	**Key performance indicators (KPIs)** *List the KPIs from your project plan.*	**Actual Measure** *Describe the current situation. This will show if you are on target to meet the project's objectives.* *If your project is not at the stage of measuring and reporting on this information, please provide a short statement to explain why.*

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Construct full scale TERAX™ plant at Rotorua Wastewater Treatment Plant	Plant constructed in 2014	Detailed design for full scale TERAX™ biosolids plant is currently underway and on schedule.
By 2014, reduce Rotorua sewage sludge offsite disposal (land or landfill) by >90%	8,500 Tonnes/year of sewage sludge processed	This will be achieved through the construction of the full scale TERAX™ biosolids plant which is on schedule for delivery.
By 2014, extend the hydrothermal technology platform to broader MSW organic waste streams	Production of a report on design parameters for the processing of municipal solid waste at full-scale. Will include concept design and cost details to proceed to full-scale plant for Rotorua district wider organic waste stream.	The first two quarters of this project have established the project framework for delivering the research project to extend the technology platform to MSW waste streams. Initial laboratory trials have been completed, and all Activities towards this Objective are currently on track.
By 2015, expand the implementation of the TERAX™ process to at least 2 new TLA or industry end-users	Number of new customers engaged	The engagement of a number of potential end-users has been maintained largely reactively to-date as the TERAX™ commercialisation structures have been formalised over the last quarter. These are now largely complete, enabling proactive end-user engagement going forwards.

Section 3: Additional information

Please provide any additional information that the Ministry should be aware of, please consider:

- *Successes you have had this milestone or particular progress you have made towards your project objectives*
- *Risks that have appeared or challenges faced this milestone and ways you plan to mitigate them*

No additional information is provided here. Quarterly Technical Progress Statement provides overview of project achievements thus far.

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Section 4: Procurement

Did you buy any major items or award contracts during this milestone (over $10,000)? If so please list the item or contract and briefly explain the procurement process you went through.

Attach a copy of all contracts, requests for proposals (RFPs), etc with this milestone report as supporting documentation.

*Press the **Tab** key on your keyboard to add more rows to the tables, if required.*

Supplier name	Description of good/work or service, and the procurement process you followed	Value	Date awarded

Section 5: Other sources of funding

Provide information about other external funding for this project (other than that from the WMF/CEF). Include all cash contributions and other funding listed in your project plan.

The amount paid towards this milestone (the amounts in the far-right column) must also be provided in your milestone claim form.

If you have more than three partners or external funding sources press the Tab key on your keyboard to add more rows to the tables.

Funder name	Total amount requested	Total amount approved	Amount received to-date	Amount paid towards this milestone
Scion	$50,000.00	$50,000.00	$50,000.00	$50,000.00
	$0.00	$0.00	$0.00	$0.00
	$0.00	$0.00	$0.00	$0.00

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Section 6A: In-kind contributions (only CEF projects to complete this section)

Provide information about the in-kind contributions that your project has received during this milestone, including what this is worth in dollars, excluding GST. Note that in-kind contributions are separate from the cash costs of the project.

	Description	**Total estimated in-kind contribution** *excluding GST*
Professional services and goods *calculate professional services using the actual hourly rate*		$0.00
Use/donation of equipment, etc		$0.00
Facilities provided		$0.00
Community volunteers/staff time *calculate at a rate of $30 per hour*		$0.00
	Total in-kind contribution	$0.00

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Section 6B: Waste minimised
(only WMF projects to complete this section)

Complete the table below. Provide the actual (net) values your project has reduced, reused, recycled and/or recovered during this milestone.

Tonnage data should be recorded once in the most appropriate category for the material being processed (i.e. material should not be reported in more than one of the reduce/reuse/recycle/recovered categories.

All figures should be reported in tonnes. Conversion factors are available in the Grantee Guide, if required.

		Definition
Reduced quantity	0 tonnes	To lessen the generation of waste, including by using products more efficiently, or by redesigning products. In relation to a product, this includes lessening the generation of waste.
Reused quantity	0 tonnes	To use waste or diverted material (in its existing form) further, for the original purpose of the materials or products that constitute the waste or diverted material, or for a similar purpose.
Recycled quantity	0 tonnes	To reprocess waste or diverted material to produce new materials.
Recovered quantity	0 tonnes	To extract materials or energy from waste or diverted material, for further use or processing.
Total quantity (this milestone)	0 tonnes	*This should be the total tonnage of material recycled/recovered/reused to date for this milestone only.*
Total quantity (project to date)	0 tonnes	*This should be the total tonnage of material recycled/recovered/reused to date for all milestones.*

If your project is not at a stage to report on this information (or if the actual tonnages fall short of the targets), explain why:

At quarter 2, milestone 2 of a 3 year project, this project is still very much in its infancy. Data of this nature will not be able to be reported on until construction and commissioning of the Demonstration Plant is complete.

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Declaration

As a duly authorised representative of the organisation:

- I declare that to the best of my knowledge, the information contained in all sections of this milestone report, or supplied by us in support of our milestone report, is complete, true and correct.
- I declare that I have the authority to sign this milestone report and to provide this information.
- I understand that information presented to the Minister for the Environment and Ministry for the Environment is subject to disclosure under the Official Information Act 1982.
- I declare that the fund payment request (milestone claim form) accompanying this milestone report is complete, true and correct.

s 9(2)(a)

space provided you are electronically signing this milestone report.	**Date:** 5th July 2013

Verification

As a duly authorised representative of the organisation I verify that the fund payment request (milestone claim form) and this milestone report is complete, true and correct, and that:

- costs making up the amount of this request are part of the eligible project costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by way of donation(s) or credit note(s).

s 9(2)(a)

electronically signing this milestone report.	**Date:** 5th July 2013

The declaration and verification must be signed by different people in your organisation.

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Checklist

Use the following checklist to confirm you have provided all the required information for your milestone claim.

☒ All sections of this milestone report completed

☒ Declaration and verification signed and dated by different people

☒ Milestone claim form completed and attached for this milestone

☒ Pre-printed deposit slip attached (first milestone report only)

☒ Final project report completed (final milestone only)

☒ Evidence of milestone deliverables attached, for example:

- photographs of progress
- monitoring and evaluation data
- record log of activities
- media coverage or other publicity
- invoices
- evidence of staff recruitment
- receipts.

☒ Tax invoice from your organisation attached (the amount on the tax invoice must be the same as the payment due amount in the milestone claim form).

The tax invoice must show the following information:

- your organisation's GST number
- the words 'tax invoice'
- invoice number
- funding deed number
- total claim amount
- GST component.

☒ Completed summary of expenses form

☒ Attached supplier invoices supporting the cash expenditure in this milestone of all capital assets over $10,000 (WMF only) and any item procured over $50,000. Each must show the following information:

- invoice number
- invoice date
- supplier name
- description
- total amount (excluding GST).

Note: Supplier invoices must be presented in the standard format that you/your company use to record this type of information.

☒ Copy of supplier contracts and RFPs, if applicable.

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Project Progress Status - DASHBOARD REPORT

Terax Demonstration Plant

Report Date	3/07/2013			
Reporting Period	**From**	1/04/2013	**To**	30/06/2013
Overall Status	😐	Definition of the process now at a stage suitable for commencement of engineering of each package. Most key process options have been assessed and selected with CAPEX abnd OPEX estimates refined as a result. Some levels of uncertainty remain with the process which will require close attention/management in the engineering phases of the project. Overall schedule is looking tight but still expected to be achievable.		

Indicator Legend	☹ Major Problem 😐 Minor Problem ☺ On Track
Recipients	PGG - Strategic Meeting
Report Author	Transfield Worley s 9(2)(a)

Status of Project	**Indicator Icon** ☹😐☺	**Comments** *Insert comments on the status of your BUDGET, SCHEDULE and RESOURCES - if a status indicator is red, provide explaination of what is being undertaken to address it.*
Budget	😐	Capital cost estimates and project benefits (OPEX savings) are less attractive than proposed in concept design.
Schedule	😐	Preliminary Engineering phase not yet commenced. Project business case still to be confirmed. Completion of MfE specific milestones ("detailed design" and "Engagement of Main Works Contractor") are expected to be achievable by end of 2013. Commencement of commissioning still expected to be achievable by end of 2014.
Resources	☺	No problems percieved.
Health & Safety	☺	No problems percieved.

Milestone	**Due Date**	**Indicator Icon** ☹😐☺	**Comments**
Project Initiation & Concept Refinement	1/03/13	😐	Commencement of commissioning still expected to be achievable by end of 2014.
Preliminary Design	1/06/13	☹	Business case is yet to be confirmed, but it iminent
Procurement of Long Lead items	1/09/13	☹	Long lead times for procurement will impact the date parts are received.
MfE Milestone Detailed Design	1/11/13	😐	Due to delays in the previous milestons, this delivery date may be impacted.

MAJOR Risks and Issues *Is this an issue or risk - select one*	**Date Raised**	**Comment**
		There are currently no major risks highlighted.

Overall Summary

The objectives (from Project Framework) of tasks to date have been:

1. To gain a clear understanding and agreement of the specific design parameters for the Project
2. To ensure that the safety, health and environmental issues are properly assessed, identifying significant hazards, and, providing the opportunity for their elimination by redesign
3. To gather all necessary data required to complete the engineering development of the Project

While these objectives have been met, it must be recognised that the following aspects of the process remain poorly defined and therefore pose risks in subsequent engineering phases of the project:

1. the most appropriate technology for solids recovery,
2. the fate of various forms of nitrogen through the wet oxidation process,
3. the potential for unknown precipitates forming in the product recovery systems, and,
4. the possibility for elevated levels of hazardous emissions in the process offgas.

Commencement of Preliminary Engineering on hold until the business case is confirmed and an instruction to proceed is recieved from RDC.

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Project Progress Status - DASHBOARD REPORT

TERAX™ MSW Research Project

Report Date	5/07/2013			
Reporting Period	**From**		**To**	
Overall Status	☺	This project is to eliminate the problematic disposal of sewage sludge and other organic wastes using the proprietary technology platform, TERAX™. This is a hybrid process combining biological and thermo-chemical approaches to improve the efficiency, effectiveness and economics of organic waste destruction and value recovery.		
Indicator Legend	☺ On Track	😐 Minor Problem	☹ Major Problem	
Recipients	RDC, Scion, MFE			
Report Author	s 9(2)(a)			

Status of Project	**Indicator Icon**	**Comments**
Budget	☺	No problems percieved at this stage
Schedule	☺	No problems percieved at this stage
Health & Safety	☺	This project is being run in accordance with Scion's Health & Safety policies and procedures. There are no current high/major risks/issues identified for this project. This quarters activity has involved increased levels of technical work which has been subject to hazard and operability analysis as required
Resources	☺	No problems at this stage, the coming months will involve a considerable degree of capability building in the form of equipment upgrades.

MAJOR Risks and Issues	**Indicator Icon**	**Date raised**	**Comments**
			No major risks or issues for Milestone 2 - year 1

Change Requests raised for this period

Change Request Num	**Description of area impacted**	**Priority**	**Resolution activities status**
No change requests			

Summary of significant activity

The TERAX™ MSW research project continues to track well against the overall objectives and is now 6 months into the 3 year program. The heavy emphasis on planning in the first quarter has proved highly beneficial, and has been demonstrated by the efficient delivery of technical tasks in the last period.

Key areas of activity were:

* MSW feedstock characterisation and pretreatment options development
* Laboratory fermentation trials on putrescible feedstocks, and hydrothermal screening on contaminants.
* Translation and upgrade of techno-economic model from a biosolids to an MSW feedstock basis

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Quarterly Project Management Progress Report

Terax Demonstration Plant

Report Date				3/07/2013
Description of Project	The objective of the Project is to deliver a safe, reliable and functional Plant which processes bio-solids from the Rotorua District Council (RDC) Waste Water Treatment Plant (WWTP) by reducing the volatile solids component and returning value added streams.			
Reporting Period	**From**	1/04/2013	**To**	30/06/2013
Recipients	Rotorua District Council			
Report Author	Transfield Worley			
Overall Project Status for this Period	😐	Definition of the process now at a stage suitable for commencement of engineering of each package. Most key process options have been assessed and selected with CAPEX abnd OPEX estimates refined as a result. Some levels of uncertainty remain with the process which will require close attention/management in the engineering phases of the project. Overall schedule is looking tight but still expected to be achievable.		
Indicator Legend	☺ **On Track**	😐 **Minor Problem**	☹ **Major Problem**	

1 Progress for this Period

Key Indicators	Indicator Icon	Comments
Project Schedule	😐	Preliminary Engineering phase not yet commenced. Project business case still to be confirmed. Completion of MfE specific milestones ("detailed design" and "Engagement of Main Works Contractor") are expected to be achievable by end of 2013. Commencement of commissioning still expected to be achievable by end of 2014.
Scope	😐	Some levels of uncertainty remain with the process which will require close attention in the engineering phases of the project, in particular; 1. the most appropriate technology for solids recovery, 2. the fate of various forms of nitrogen through the wet oxidation process, 3. the potential for unknown precipitates forming in the product recovery systems, and, 4. the possibility for elevated levels of hazardous emissions in the process offgas.
Resources	☺	No problems percieved.
Risks and Issues	😐	Key project issues around areas remaining with poor process definition (see "scope" above) and schedule (see "project schedule" above).
Budget	😐	Capital cost estimates and project benefits (OPEX savings) are less attractive than proposed in concept design.
Health & Safety	☺	No problems percieved.

1.1 Major Issues Requiring Resolution and/or Change Requests Raised for this Period

Issue or Change Request	Description	Resolution Activities
IS1	**Consenting of emissions from WWTP**	RDC to obtain any necessary consents (or exemptions to) for the WWTP in respect of gaseous emissions.
IS2	**Optioneering**	Scion to complete assessment of dewatering properties of Terax solids. TW to provide analysis of outstanding options and recommended option selection.
IS3	**Business Case Review**	RDC to quanitify the "baseline" case (i.e. do nothing) and the total benefits of installing the Plant, then, reconfirm its business case for the project.
IS4	**Ongoing Scientific Work**	Scion proceeding with experimental work (uncertain timeframes) Project team has proposed to freeze the concept for the Demonstration plant based on selected existing data only, and to address any opportunities to optimise the reactor process as in a "second generation" reactor concept.

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2 Project Summary

General Overview of Progress	The objectives (from Project Framework) of tasks to date have been: 1. To gain clear understanding and agreement of the specific design parameters for the Project 2. To ensure that the safety, health and environmental issues are properly assessed, identifying significant hazards, and, providing the opportunity for their elimination by redesign 3. To gather all necessary data required to complete the engineering development of the Project While these objectives have been met, it must be recognised that the following aspects of the process remain poorly defined and therefore pose risks in subsequent engineering phases of the project: 1. the most appropriate technology for solids recovery, 2. the fate of various forms of nitrogen through the wet oxidation process, 3. the potential for unknown precipitates forming in the product recovery systems, and, 4. the possibility for elevated levels of hazardous emissions in the process offgas. Commencement of Preliminary Engineering on hold until the business case is confirmed and an instruction to proceed is recieved from RDC
Completed Activities in this Period	The completed deliverables for Q2 of 2013 are: - Updated Biowin Process Model (biological systems) - Updated Aspen Plus Model (thermodynamic systems) - Addenda to OPEX Model (reflecting process developments from Q1 and Q2 of 2013) - CAPEX Model and Summary Memo - based on plant represented in Concept Design and process models. - CAPEX and OPEX Optimisation Workshops (dated 10/4/13 and 17/4/13) - Addenda to CAPEX Model (reflecting process developments from Q1 and Q2 of 2013) - Oxygen supply options analysis and memo - Thickening plant options analysis and memo - Nitrogen recovery plant options analysis and report - Simplified kinetic model for wet oxidation
Incomplete Activities in this Period	The incompleted deliverables from 2013 are: - Updated process flow diagrams (to be updated based on developments from Q1 and Q2 of 2013) - Updated basis of design (to be updated based on developments from Q1 and Q2 of 2013) - Updated equipment list (to be updated based on developments from Q1 and Q2 of 2013) - Fermenter options analysis - Solids recovery options analysis - Independant review of Biowin model (review has been completed but report still being drafted)
Planned Activities for the next Period	Completion of incomplete activities listed above (largely waiting on confirmation of dewatering properties for Terax solids product. Completion of procurement strategy and project execution plan (completion expected in July 2013) Commencement of Preliminary Engineering which includes: - Finalised key process drawings - Finalised energy and mass balances - Specification of long lead items - Hazardous area classification - SIL/IPF Assessment (if required) - Finalised equipment schedules - Preliminary MTOs - Hazard Study 3 (HAZOP) - Preliminary Design Review (constructability, maintainability, operability) - Validation of the capital cost estimate

3 Upcoming Decisions

Date Decision Required	Description
Jul-13	Confirmation of proposed procurement strategy (to be issued for review in July)
Jul-13	Agreement of revised basis of design and project execution plan (to be issued for review in July).
Jul-13	To commence Preliminary Engineering

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Quarterly Project Management Progress Report

TERAX™ MSW Research Project

Report Date				3/07/2013
Description of Project	This project is to eliminate the problematic disposal of sewage sludge and other organic wastes using the proprietary technology platform, TERAX™. This is a hybrid process combining biological and thermo-chemical approaches to improve the efficiency, effectiveness and economics of organic waste destruction and value recovery.			
Reporting Period	**From**	1/04/2013	**To**	30/06/2013
Recipients	RDC, Scion, MFE			
Report Author	s 9(2)(a)			
Overall Project Status for this Period	☺	Excellent technical progress has been achieved in this quarter. Each of the four key tasks-Characterisation and Technology Assessment, Laboratory Studies, Scale-up and Techno economic Modelling- have completed the required activities. Highlights include identification of a suitable pre-treatment technology for upcoming scale-up activity; selection of robust feedstocks for representing putrescible food waste; initiation of fermentation and hydrothermal laboratory trials. A modified techno-economic model has been developed, and scenarios for application of TERAX to municipal solid wastes have been described.		
Indicator Legend	☺ **On Track**	☺ **Minor Problem**	☹ **Major Problem**	

1 Progress for this Period

Key Indicators	Indicator Icon	Comments
Project Schedule	☺	On schedule, no problems perceived at this stage
Scope	☺	Scope under control, no problems perceived at this stage. More emphasis to be put on fate of nutrients and off-gases, in the following quarter. This fits within the current scope, but reflects the realisation that these aspects will be crucial to process development.
Resources	☺	New Chemical Engineer, s 9(2)(a), has proven his worth to the project team during the quarter. No problems perceived at this stage
Risks and Issues	☺	This project is being run in accordance with Scion's Health & Safety policies and procedures. Significant amount of effort has been put into H&S this quarter, with detailed Hazard and Operability studies conducted for a number of pieces of plant and equipment. A high level of consciousness is being maintained about the risks of working with contaminated samples, and this must continue throughout the project period, particularly as the project moves to scaling up and use of real wastes.
Budget	☺	One high risk identified as part of the project planning relating to feasibility of final design. Active mitigation through design of research program and continued monitoring.
Health & Safety	☺	No problems perceived at this stage

1.1 Major Issues Requiring Resolution and/or Change Requests Raised for this Period

Issue or Change Request	Description	Resolution Activities
Nil	There are no issues or changes requests currently being raised	

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2 Project Summary

General Overview of Progress	The TERAX™ MSW research project is tracking well with the second quarter now complete. • A database has been created, and populated with identified pre-treatment technologies. Costings for one unit are being investigated, for application within TERAX™ pilot plant trials. • Analytical focus has been on physico-chemical characterisation of MSW putrescibles and potential putrescible contaminants. The work has highlighted an opportunity for rapid assessment of waste characterisation and wet oxidation potential • Two representative model food wastes were created according to existing literature references. These model food wastes provide an excellent platform for generating a representative, reproducible feedstock material for TERAX™ trialling. • A laboratory-based food waste fermentation was completed, demonstrating excellent fermentability. • Laboratory hydrothermal trials were conducted, to screen the performance of potential MSW components within the hydrothermal unit operation of the TERAX™ process. Wet oxidation was able to solubilise the main components of MSW. Putrescibles components were readily converted under the standardised conditions. • The techno-economic model, which was developed within the previous MfE-funded TERAX™ project on sewage sludge, was significantly modified and adapted to allow an assessment to be made of the anticipated costs of treating the putrescibles fraction of MSW. Amendments were made and preliminary assessment undertaken to understand some cost implications.
Completed Activities in this Period	• Selection of MSW handling and pre-treatment technology options for trialling, • Combined MSW component and potential contaminant evaluation, • Development of representative synthetic substrates for trials, • Laboratory scale trials on MSW components, • Complete development of first generation process economic model. • Quarter technical progress and planning workshop
Incomplete Activities in this Period	Nil
Planned Activities for the next Period	• Establishment of MSW pre-treatment trial equipment to enable evaluation at a suitable scale • Assessment of risk and toxicity potential of hydrothermally deconstructing MSW components • Laboratory scale trials on MSW blends, • Pilot scale trials on selected MSW components, • Refinement and peer review of the process economic model.

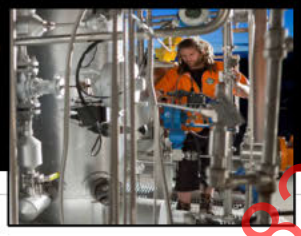
3 Upcoming Decisions

Date Decision Required	Description
	Nil

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TERAX™ Quarterly Technical Progress Report



Quarterly Technical Progress Statement for Q2- Milestone 2 – 2013

Date	5 July 2013
Author	s 9(2)(a)
Contributors	s 9(2)(a)
Task	All tasks
Milestone	2
Version	1.0

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Executive Summary

The WMF project on application of TERAX™ technology to municipal biosolids has completed its second quarter. This project is focussed on describing the efficacy of transferring the TERAX™ technology from a relatively simple feedstock (biosolids) to address the challenge of municipal solid waste (MSW) conversion. The work will be based around technology development using laboratory and pilot scale reaction engineering, alongside completion of a techno-economic analysis to address the financial efficacy of the developed process.

Significant outcomes from this first quarter have been:
Pre-treatment selection: a database has been created, and populated with identified pre-treatment technologies. Various commercial shredders were investigated, and the specifications of four shredder options summarised, to a level where initial cost estimates could be provided. Based on these specifications, one exemplar was identified as well suited as a pre-treatment option for TERAX™. Costings for this unit are being investigated, for application within TERAX™ pilot plant trials.

Synthetic feedstock selection: For standardisation purposes, two representative model substrates were created according to existing literature references. One of those substrates was an extensive mix of all food categories commonly found in MSW. The other was very simple – consisting of a commercially available dog food. These synthetic substrates were then characterised alongside a real food waste, sourced from the hospitality industry. These model food wastes provide an excellent platform for generating a representative, reproducible feedstock material for TERAX™ trialling.

Initiation of fermentation trials: A laboratory-based batch fermentation was completed, using food waste from an Auckland hotel. The anaerobic fermentation was conducted under mesophilic (36^{o}C). The fermentation resulted in excellent destruction of organic solids, high production of organic acids, and production of hydrogen as a product.

Scale-up activities: Significant work was conducted in preparation of plant and equipment for scale-up activities in following quarters. In this quarter, this task focussed on specification of modifications to hydrothermal pilot plant, modifications to fermentation pilot plant, and specification and internal capital request for a new mid-sized hydrothermal reactor.

Hydrothermal processing trials: Batch laboratory trials were conducted, to screen the performance of potential MSW components within the hydrothermal unit operation of the TERAX™ process. Wet oxidation was able to solubilise the main components of MSW with greater than 75% solids destruction. Putrescibles components were readily converted under the standardised conditions, and acetic acid was always found to be a major component of the liquor produced through the hydrothermal process. This is consistent with all of our previous work on biosolids. A small number of components demonstrated resistance to degradation, and these will be investigated more thoroughly during the next quarter.

Modified techno-economic model: The techno-economic model, which was developed within the previous MfE-funded TERAX™ project on sewage sludge, was adapted to allow an assessment to be made of the anticipated costs of treating the putrescibles fraction of MSW. Amendments were made and preliminary assessment undertaken to understand some cost implications.

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Task reporting

As described in the previous Progress Statement, a category-based approach has been taken to addressing the application of TERAX™. Putrescibles (food and green waste) form the first Municipal Solid Waste (MSW) category focus for the early phase of this project.

The work programme has been broken into four major task areas:

- Characterisation and technology assessment
- Laboratory studies
- Scale-up
- Techno-economic modelling

These tasks provide the structure for the technical programme for a minimum of the first year. The following sections describe the results of task activities from Quarter 2, contributing directly to the MfE Project Milestone 2: Hydrothermal component trials.

Task One – Characterisation and Technology Assessment

This quarter, the Characterisation and Technology Assessment task has:

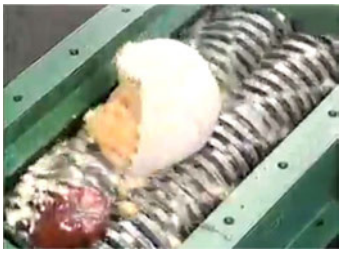
1. investigated the type of pre-treatment technology that would be required to successfully operate TERAX™ on the putrescibles fraction of municipal solid waste;
2. investigated the type of MSW components that are likely candidates and contaminants within TERAX™ treatment;
3. developed a standardised food waste, representative of actual food waste but having consistent composition-thus allowing effective experimental trialling.

Milestone Activities

Milestone activity 1: Selection of MSW handling and pre-treatment technology options for trialling

The aim of this activity was to document various pre-treatment options available to reduce MSW particle size, prior to entering the TERAX™ process and to select a viable pre-treatment option for pilot plant scale trials.

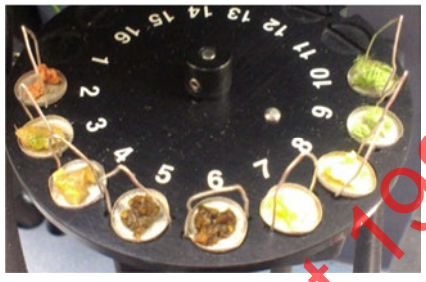
Key outcomes:



- a database has been created, and populated with identified pre-treatment technologies. This database will be updated and refined throughout the project.
- Shredder technology was the first focus of the database. These are suitable for size reduction of a wide range of municipal solid waste, to less than 3 to 5 mm.
- Various commercial shredders were investigated, and the specifications of four shredder options summarised, to a level where initial cost estimates could be provided.
- Based on these specifications, one exemplar (Muffin Monster, from JWC Environmental, USA) was identified as well suited for size reduction as a pre-treatment option for TERAX™. Costings for this unit are being investigated, for application within TERAX™ pilot plant trials.

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Milestone activity 2: Combined MSW component and potential contaminant evaluation



This activity (conducted in parallel with Milestone Activity 3, below) focussed on physico-chemical characterisation of MSW putrescibles and potential putrescible contaminants. In particular, analysis was made of weight loss characteristics during thermo-gravimetric analysis (TGA). This fast, small-scale method was tested to determine whether its results could be correlated against treatment performance through the TERAX™ process. If successful, this method could provide a fast screening methodology for treatment efficacy testing.

Key outcomes:

- A number of component evaluations will be adopted as standard practice throughout the project, including dry matter content, organic and ash content, nutrient, protein, fat, carbohydrate, elemental analysis, and calorific value.
- TGA methodology provides insight into material characteristics. Whilst more work is required to confirm its effectiveness in screening for wet oxidation potential, the test has good scope to be utilised in providing a rapid mixed waste component evaluation.

Milestone activity 3: Development of representative synthetic substrates for trials

For standardisation purposes, two representative model substrates were created according to existing literature references. One of those substrates was an extensive mix of all food categories commonly found in MSW. The other was very simple – consisting of a commercially available dog food. These synthetic substrates were then characterised alongside a real food waste, sourced from the hospitality industry.

Key outcomes:

- The model waste composition closely aligned to that of the real food waste.
- The dog food had higher organic matter, nutrients, salt and energy than the other model or real food waste.
- These model food wastes thus provide an excellent platform for generating a representative, reproducible feedstock material for TERAX™ trialling.









s 9(2)(a) [redacted]

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Task Two - TERAX™ MSW Laboratory

In this quarter, this task has focussed on:

1. a literature review of solid waste anaerobic digestion systems;
2. initial fermentation trials of a food waste sample;
3. a hydrothermal treatment screening study on MSW components.

Milestone Activities

Milestone activity 4: Laboratory scale trials on MSW components

Fermentation literature review: A literature review was conducted, to describe the landscape for fermentation of food waste and OFMSW. This highlighted the depth and breadth of literature available for digestion of these wastes and that numerous fully commercialised fermentation plants have been built. Of these, the majority use mesophilic, dry digestion (20 – 30% dry solids feed) and utilise both batch and continuous systems. Many of the systems are designed to optimise methane production, although the targeting of hydrogen production through 'dark fermentation' is widely reviewed. On the basis of the literature review, targeting a VFA production in the range 25 – 50g/l seems feasible and would have a beneficial impact on the viability of the process to treat organic waste streams.

Fermentation study: A laboratory-based batch fermentation completed, using food waste from an Auckland hotel. The anaerobic fermentation was conducted under mesophilic ($36^{o}C$) conditions.

Key outcomes:

- Excellent destruction of organic solids, with approximately 60% volatile suspended solids (VSS) destruction occurring in less than ten days;
- High production of organic acids, higher than was typical for municipal biosolids in previous TERAX™ work
- Gas analysis showed the presence of significant quantities of hydrogen, along with carbon dioxide.
- No methane production was detected.

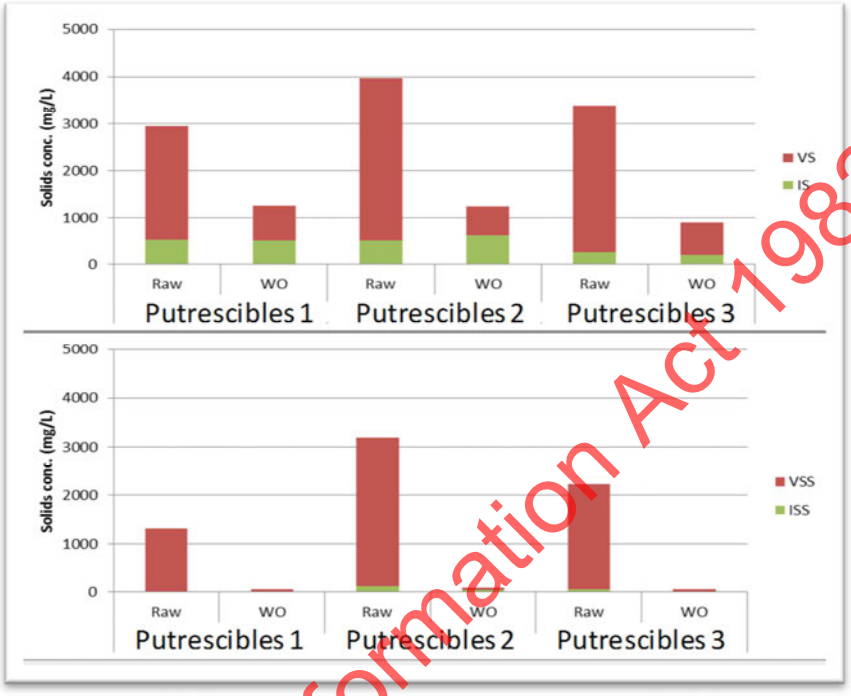
Hydrothermal trials: Batch laboratory trials were conducted, to screen the performance of potential MSW components within the hydrothermal unit operation of the TERAX™ process. Individual components were exposed to a standard set of wet oxidation conditions. The target outcome was to describe the degradation potential for each component at these conditions, and identify any materials which might provide contamination challenges within the system. Among the components analysed were:

i) Paper (office paper, newspaper)
ii) Textiles (acrylic, cotton, nylon)
iii) Putrescibles (Auckland airport hotel food waste, modelled food waste recipe, dog food)
iv) Clean wood waste
v) A number of synthetic polymers

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Key outcomes:

- Wet oxidation was able to solubilise the main components of MSW with greater than 75% solids destruction
- Putrescibles components were readily converted under the standardised conditions
- Acetic acid was a major component of the liquor produced through the hydrothermal process. This is consistent with all of our previous work on biosolids.



- A small number of components demonstrated resistance to degradation, and these will be investigated more thoroughly during the next quarter.

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Task Three – TERAX™ MSW Scale-up

Whilst this task had no specific Milestone Activities, this task focussed on preparation of plant and equipment for scale-up activities in following quarters. In this quarter, this task focussed on:

1. Modifications to hydrothermal pilot plant,
2. Modifications to fermentation pilot plant,
3. Specification and capital request for a new mid-sized hydrothermal reactor.

Activities

Hydrothermal Plant Modifications

Scion and an external consulting engineering firm (Transfield Worley Ltd) completed a one-day workshop to scope out the necessary improvements to the Hydrothermal Pilot Plant to improve operability, performance and safety for the ongoing use of the pilot plant.



A number of proposed modifications have been identified. These will impact on fluid dynamics, controllability of input variables, off-gas control, and overall plant safety.

The next stages of this work are to complete design, costing and implementation of the proposed changes. A staged approach to this work will be required, as the plant is likely to be required for trials during the following quarter.

Fermentation Plant Operability

From the initial quoting of upgrade work that was delivered in Quarter One, an application for a significant capital injection into the fermentation plant was made to Scion. This request has been approved and upgrade work has begun.



The main parts of work required on this plant are:

- Control system upgrade.
- Pump upgrade for abrasive materials.
- Improved bunding for containment of spillage.
- Chiller and storage system for feed samples and processed samples.
- Pressure relief for main reactor vessel.

The upgrade work is progressing well. The plant will be operational by mid to late July.

Mid-Sized Reactor design and purchase request

Quotes were received from three major suppliers of high pressure high temperature reactors. A Buchiglas reactor (Buchi AG, Switzerland) was chosen as the preferred

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option. The Buchiglas system has a 10 Litre reactor volume. Features of the system include:

- Solids injection port and burette.
- Site glass in reactor vessel wall.
- 7 ports on headworks and 1 drain valve in vessel.
- Liquid sampling system.
- Reflux condenser.



Demonstrating a balance between system controllability and scale of operation, this reactor is will provide a significant improvement to the hydrothermal processing capability for the current project. The substantial capital request for purchase of this item has been submitted to the Scion capital investment process. If successful, commissioning of this equipment will occur in Quarter 4 of the first year of this project.

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Task Four – Techno-Economic Modelling

The techno-economic model, which was developed within the previous MfE-funded TERAX™ project on sewage sludge, was adapted to allow an assessment to be made of the anticipated costs of treating the putrescibles fraction of MSW. Amendments were made and preliminary assessment undertaken to understand the cost implications.

Milestone activity 5: Complete development of first generation process economic model

AWT Water Ltd were commissioned to update the existing techno-economic model to allow an assessment to be made into the likely costs of treating the putrescibles fraction of solid waste going to the Atiamuri Landfill, Rotorua. From 2009 data this was in the region of 12,000 wet t/a.



The major changes made as part of this work were:

- To simplify the model by incorporating a yield based calculation approach. This will make it easier to apply experimental laboratory and pilot plant results
- Modification to nitrogen treatment
- Methanogenic fermenter to be added **after** the hydrothermal reactor, so the VFA produced can be converted to methane
- To incorporate costs for all major fermentation gases
- Sulphate (with associated COD) is incorporated into the model
- Adjustment of how nitrogen and soluble COD is calculated

Key outcomes:

- Demonstration of an economic impact of using 'dry' digestion as opposed to 'wet' digestion, due to changes in capital costs
- Quantification of the extent of the benefit which can be expected from the value-add components e.g. VFA, biogas, nitrogen and phosphorus
- Review of the predicted costs and benefits of incorporating a fermentation step before and after wet oxidation

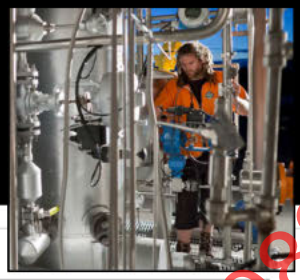
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TERAX™ Technical Report



Techno-economic scenario updated as an output from the MSW process model

Date	30/06/13
Authors	s 9(2)(a)
Contributors	
Task	MSW Modelling
Milestone	2
Version	1.0

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Executive Summary

AWT Water Ltd were commissioned to update the existing techno-economic model to allow an assessment to be made into the likely costs of treating the putrescibles fraction of solid waste going to the Atiamuri Landfill, Rotorua. From 2009 data this was in the region of 12,000 wet t/yr. Principal amongst this upgrade were the addition of a methanogenic stage after the wet oxidation process.

Some scenarios were undertaken after the model was delivered in order to understand the likely costs for applying the TERAX™ process. This demonstrated that the added value products (e.g. biogas, N, P) make a significant beneficial contribution to the economics. The post-fermentation step does not currently add significant benefit, although this must be investigated further, and does not necessarily imply that this stage could be removed.

It is clear from the analysis that the capital costs are significantly higher for a system treating wet feed material (~10% solids) compared to one treating dry feed material (~40% dry solids). Intermediate dry solids contents were not studied as part of this work.

Further work would be recommended, which includes the following analyses:

- To incorporate the impact of pre-treatment costs
- To confirm the costs of the value added benefits streams (biogas, H_2, N, P, soluble organics)
- To undertake sensitivity analyses for the commodity prices to understand what the cost level is required to be
- Confirm the yields obtained (VFA and gaseous) during each stage of the process and with different feedstock material
- To understand the difference in value obtained when optimising H_2 during the pre-fermentation stage

Introduction/Background

The TERAX™ process is a two stage fermentation/hydrothermal oxidation process for the destruction of organic waste. A techno-economic (TE) model has been developed to help determine what the costs are likely to be for the TERAX™ process. This is an Excel based model which has principally been developed by the consultancy AWT Water. This was initially developed to understand the costs associated with treating sewage sludge. There was therefore a need to adapt the existing model to be able to understand the costs associated with treatment of solid organic wastes.

Work Aim

The aim is to adapt the existing techno-economic model to be able to assess the economic impacts of treating food waste or OFMSW. To undertake preliminary economic assessment based on the revised model.

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Materials and Methods

Upgrade process

The model upgrade was undertaken by AWT Water, and had the following objectives:

- To simplify the model by incorporating a yield based calculation approach. This will make it easier to apply laboratory results which are observed
- Re-working of downstream nitrogen treatment
- Methanogenic fermenter to be added after the hydrothermal reactor, so VFA can be converted to methane
- To incorporate the potential for H_2 production from the pre-fermentation unit
- Sulphate (with associated COD) is incorporated into the model
- Soluble COD to be split into 'VFA' and 'other sCOD'
- TKN to be reported as 'NH_3-N' and 'Other KN'

Economic assessment

An economic assessment was undertaken upon submission of the revised TE-model. This was to understand the impact of the changes and make preliminary conclusions as the anticipated costs for treating solid organic waste. Amongst the assumptions used were:

- An annual tonnage of 12,000 wet t/yr was used corresponding to the reported putrescibles fraction entering RDC Atiamuri landfill. A 40% d.s content was assumed (4800tds/yr)
- Pre-processing costs (e.g. shredding, separation) are not included in these costs
- Costs associated with waste collection and delivery are not included in these costs
- Capex is based on a Lang factor of 4.5 which is considered conservative
- A biogas value of $10/GJ LHV has been used. This was not altered for varying composition of H_2 vs CH_4.

The scenarios analysed were:

1) The impact of feed dry solids
2) Capital vs operational costs

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Results

Impact of feed dry solids

The question of whether to utilise wet digestion or dry digestion has important consequences for the process and ultimately the costs of a projected plant. Figure 1 shows the impact on the capital costs of the decision to process the waste as a 10% solid concentration as opposed to a 40% (i.e. undiluted) solids concentration.

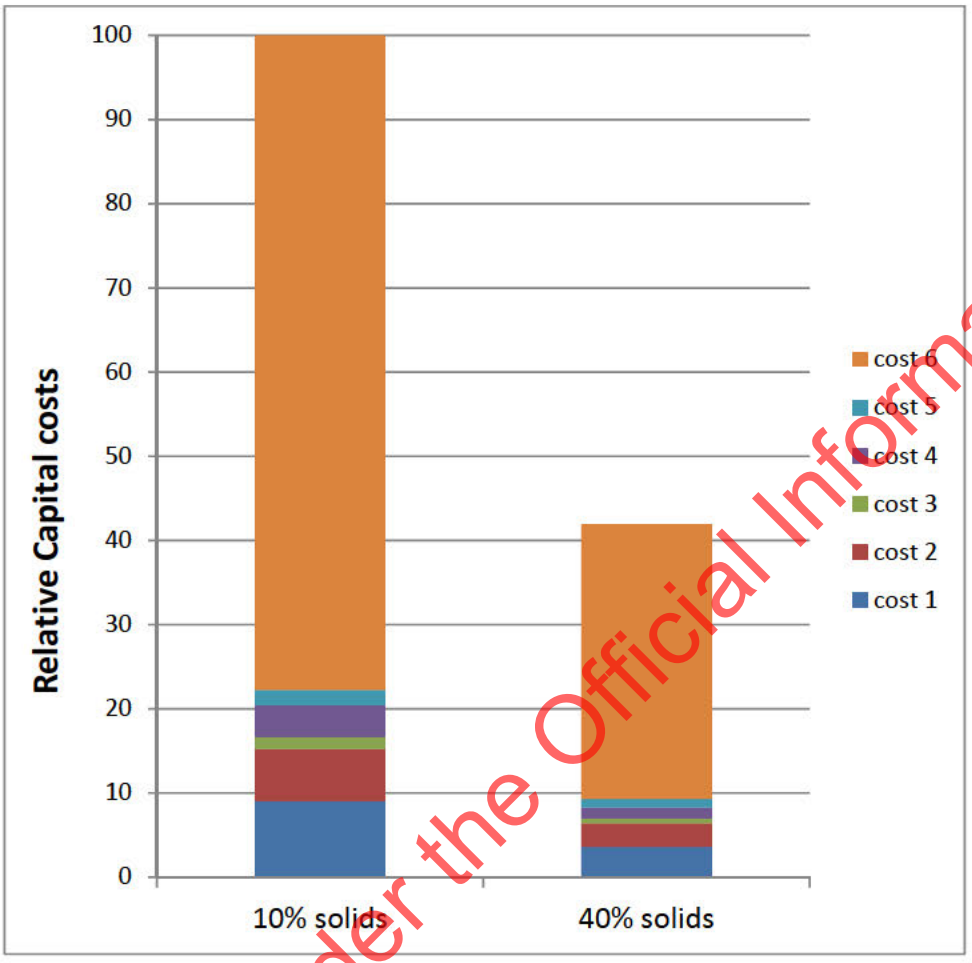


Figure 1: Comparison of relative capital costs between low solids and high solids system

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Capital versus operational costs

Using the costs associated with 40% dry solids fermentation feed, the relative capital costs and operational costs were compared. This comparison was made using the amortised capital costs (20 year life with 12% interest rate) and the annual operational costs.

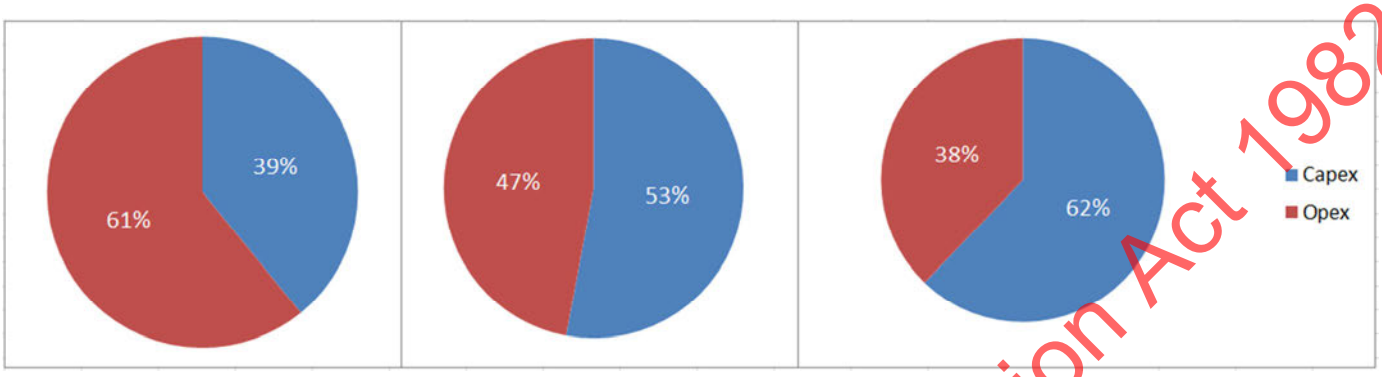


Figure 2: Opex vs Capex for a) no value add revenue, b) biogas revenue included, c) all value add (N, P, DOC, biogas) included

Discussion and Conclusion

The Excel based TE-model has been updated to allow an economic assessment of food waste treatment to be undertaken. A series of scenarios were undertaken to provide a preliminary analysis of the anticipated costs.

There is a clear negative impact on capital costs arising from diluting the feed material so that a wet digestion is used in the pre-fermentation step. It would therefore be recommended that a dry pre-fermentation system be promoted for food waste treatment. The boost in VFA production of this pre-fermentation step also shows that the presence of this stage is advantageous compared to when it is absent.

The ability to generate revenue from the value added products makes the process more economical.

The next steps should include the following:

- To incorporate the impact of pre-treatment costs
- To confirm the costs of the value added benefits streams (biogas, H_2, N, P, soluble organics)
- To undertake sensitivity analyses for the commodity prices to understand what the cost level is required to be
- Confirm the yields obtained (VFA and gaseous) during each stage of the process and with different feedstock material
- To understand the difference in value obtained when optimising H_2 during the pre-fermentation stage

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Quarterly Communications Report - Quarter 2 - Year 1

Future - Reactive & Responsive Communications Register
Project Name: TERAX 11 - Demonstration Plant - MSW Research Programme - Commercialisation

Comms Ref #	Date comms initiated	Communication Description	Communicating Company	Target audience	Communication channel	Date of release/activity	Date & Outcome / Progress Update	Comms status
	June	Branding work & website commissioned	Terax (2013) Ltd	all	New website	?		

Closed Communications Register
Project Name: TERAX 11 - Demonstration Plant - MSW Research Programme - Commercialisation

Comms Ref #	Date comms initiated	Communication Description	Communicating Company	Target audience	Communication channel	Date of release/activity	Date & Outcome / Progress Update	Comms status
	May	updated TERAX pages and documents on Scion website	Scion	public	Scion website	1-Jun-13		
	June	TERAX technology mentioned in broader article on Scion's sustainability technologies - copy sent 10/06/13	Scion	waste management sector	WasteMINZ Magazine	imminient		

Other Comments
A very lean quarter with respect to external communications while the project is in its early stages.

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WMF Milestone Claim Form

Projects may have up to six milestones, and a separate tab has been created for each in this spreadsheet. This summary page is completed by your Fund Analyst, and the information populates the other tabs in this spreadsheet. Open the tab that corresponds with the current project milestone and complete the relevant sections.

WMF Reference:	WMF-559	**Funding deed no:**	20351
Project name:	Demonstration of the TERAX™ hydrothermal deconstruction process	**Grantee name:**	Rotorua District Council
Project Year:	Year 1	**WMF $ approved:**	$1,000,000
WMF % approved:	48.00%		

Name of milestone	Due date	Estimated total cash expenditure *(excl. GST)*	Estimated WMF cash payment *(% est. cost)*	Actual total cash expenditure *(excl. GST)*	Actual payment due	Comments
Milestone 1						
MSW Option Establishment	30/03/13	$223,000.00	$106,000.00	$223,000.00	$106,000.00	
Milestone 2						
Hydrothermal Component Trials	30/06/13	$229,000.00	$109,000.00	$229,000.00	$109,000.00	
Milestone 3						
Hydrothermal mixed MSW Trials	1/10/13	$270,000.00	$129,000.00	$0.00	$0.00	
Milestone 4						
Full-Scale Detailed Design	1/11/13	$1,000,000.00	$476,000.00	$0.00	$0.00	
Milestone 5						
Pre-treatment Trials Establishment	1/12/13	$278,000.00	$132,000.00	$0.00	$0.00	
Milestone 6						
Construction Procurement	15/12/13	$100,000.00	$48,000.00	$0.00	$0.00	
Totals *(excl. GST)*		$2,100,000.00	$1,000,000.00	$452,000.00	$215,000.00	

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Milestone 2 — Interim Claim

*This tab is for you to provide details of the cash income received, and the cash expenditure, for this milestone. Complete the **Cash Income (non-WMF)** and **Cash Expenditure** sections below (shaded sections only). When you have done this, the payment due for this milestone automatically calculates. Ensure that your figures are accurate and based on actual cash income received and actual cash spent, and then save your changes. Submit the entire claim form to your Fund Analyst with the milestone report and other required documentation for this milestone.*

Milestone estimates (Ministry use only)

Estimated total expenditure:	$229,000.00
Estimated WMF payment:	$109,000.00

Balance and actuals (Ministry use only)

Initial balance:	$4,594,000.00
Actual paid to date:	$106,000.00
Actual total expenditure:	$229,000.00

Cash income (non-WMF)

*As part of your project plan, you estimated the cash income you would receive from other external sources (including partners). Record **all actual** cash income below, that you have received from other funding sources for this milestone only, excluding GST. This may include cash income not previously listed in your project plan. This page contains formulae to calculate the payment due. Do not add rows to this page. If you have multiple income streams, combine these to fit the rows provided.*

Cash income from your organisation:	$70,000.00
Cash income from Scion:	$50,000.00
[enter the name of the external funding source here]:	[enter actual amount received]
[enter the name of the external funding source here]:	[enter actual amount received]
Actual total cash income:	**$120,000.00**

Cash expenditure

*As part of your project plan, you estimated the cash expenditure for this milestone. Record **all actual** project costs (cash expenditure) for this milestone in the cost category rows below, excluding GST. You must provide invoices to support your claim. This page contains formulae to calculate the payment due. Do not add rows to this page.*

Personnel	$0.00
Administration	$0.00
Consultants and contractors	$229,000.00
Purchase of capital assets and other capital costs	$0.00
Venue and equipment	$0.00
Travel and accommodation	$0.00
Promotion and dissemination of information	$0.00
Financial, legal and information technology expenses	$0.00
Other miscellaneous costs	$0.00
Actual total expenditure:	**$229,000.00**

Payment calculated using the Interim Payment Calculation (Ministry use only)

*The **Payment due** amount is how much the WMF will pay you (excluding GST) after your milestone and its deliverables have been assessed and approved. Your payment due will be the lesser of A, B or C below, as per Section 1 of your funding deed. Contact your Fund Analyst for further information if required.*

balance brought forward less 10% max WMF amount (A) =	$4,124,000.00
% of actual total expenditure (B) =	$109,920.00
Actual expenditure minus income (C) =	$109,000.00
Payment due: *(excl. GST)*	**$109,000.00**
Maximum amount approved:	$4,700,000.00
Funds remaining after payment made:	$4,485,000.00

Ministry use only

Milestone assessment

Record the milestone claim assessment below.

Approved/declined for payment:

Name:	
Position:	
Date:	
Signed:	

Payment made:

Name:	
Position:	
Date:	
Signed:	

Payment approved:

Name:	
Position:	
Date:	
Signed:	

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Te Papa Tipu Innovation Park
49 Sala Street, Private Bag 3020, Rotorua, New Zealand
Telephone: + 64 7 343 5899 | Facsimile: + 64 7 348 0952
Email enquiries@scionresearch.com | www.scionresearch.com

TAX INVOICE

Rotorua District Council
Private Bag 3029
Rotorua 3046

Customer Number:	00764	***GST Reg No (NZ):***	59-493-760
Customer Reference:	MFE CONTRA	***ABN No (Australia):***	512-1094-8677
Invoice Number:	**052410**	***Invoice Date:***	30/06/2013
Page :	1 of 1	***Due Date:***	20/07/2013

Particulars	MSW Option establishment as per TERAX Demonstration pland al	***Amount $***
MSW Option establishment as per TERAX Demonstration pland and further research contract 13/018 - MFE Quarter 2 Includes TERAX Modelling, TERAX Feedstocks, TERAX Laboratory and TERAX Scaleup activities		229,000.00

Attention: s 9(2)(a)

Sub Total:	229,000.00
GST:	34,350.00
Invoice Total:	263,350.00

For any queries relating to this invoice, please contact Alex Chambers
For any payment queries, please contact accounts.receivable@scionresearch.com

Please detach and return with your remittance to Scion, Private Bag 3020, Rotorua, New Zealand or make payment to
s 9(2)(b)(ii)

Rotorua District Council **Amount:** 263,350.00

Card Number: __ __ __ __ - __ __ __ __ - __ __ __ __ - __ __ __ __ **Card Type:** Visa__ Mastercard__

Security Number: __ __ __ (Three digit number located on the back of your card)

Cardholders Name: _____ **Expiry Date:** ___/___

Signature: _____ **Amount to Pay:** $_____

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Total Staff Hours TERAX™ II

Quarter 2 - Year 1 staff hours

	Quarter 1	Quarter 2 Total
s 9(2)(a)	185	183
		4
	228	338
	195	77
	9	0
	132	296
	222	228
	72	130
	70	160
		159
	116	240
		10
		4
	3	6
	70	0
	6	1
		4
	183	0
	16	0
	130	141
		0
		0
		6
Total	**1637**	**1987**

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DESTINATION ROTORUA
ROTORUA DISTRICT COUNCIL

Rotorua District Council
1061 Haupapa Street
Private Bag 3029, Rotorua Mail Centre
Rotorua 3046
Phone: 07 348 4199
Fax: 07 346 3143
Email: mail@rdc.govt.nz

TAX INVOICE

MINISTRY FOR THE ENVIRONMENT
PO BOX 24441
MANNERS STREET
WELLINGTON 6142

PLEASE QUOTE YOUR CUSTOMER NUMBER	
INVOICE No.	276330
DATE	28 Jun 2013
CUSTOMER No.	AR 312062

G.S.T. REG. No. 10-801-397

DESCRIPTION	AMOUNT
WASTE MINIMISATION FUND	
Completion Of Milestone 2 Hydrothermal Component Trials	109,000.00
Att: Catherine Howard	
s 9(2)(a) [redacted]	

Please pay on invoice. No statement will be issued.

Rotorua District Council reserves the right to pass any unpaid accounts to its Collection Agency and any costs or expenses as a result shall become the responsibility of the client (as abovementioned)

ALL ENQUIRIES RELATING TO THIS INVOICE SHOULD BE REFERRED TO:-
s 9(2)(a) [redacted]

No statement is issued, please pay on invoice.

SUB TOTAL	**$109,000.00**
G.S.T.	$16,350.00
TOTAL $	**$125,350.00**

PLEASE RETURN THIS PORTION TO ENSURE YOUR ACCOUNT IS CREDITED WITH THIS PAYMENT — DETACH HERE

DESTINATION ROTORUA
ROTORUA DISTRICT COUNCIL

Rotorua District Council
Private Bag 3029
Rotorua Mail Centre
Rotorua 3046

MINISTRY FOR THE ENVIRONMENT
PO BOX 24441
MANNERS STREET
WELLINGTON 6142

CUSTOMER NUMBER AR	
AR	312062

INVOICE NUMBER	276330
DATE DUE	19 Jul 2013
TOTAL	**$125,350.00**
AMOUNT ENCLOSED	

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DEPOSIT

Bank of New Zealand

Rotorua Branch

Tellers Stamp & Initials

Paid in by:

Signature

Credit

FOR ROTORUA DISTRICT COUNCIL
GENERAL FUND ACCOUNT

s 9(2)
(b)(ii)

Date

Notes

Coin

Total Cash

Cheques
AS ON REVERSE

$

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Ministry for the Environment
Manatū Mō Te Taiao

Community Environment Fund
&
Waste Minimisation Fund

Milestone Report

Organisation: Rotorua District Council

Project name: TERAX™ waste deconstruction technology

Deed number: 20351

Year: 1

Milestone: 3

Milestone due date: 30 September 2013

New Zealand Government

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Official Information

Important: Information presented to the Minister for the Environment or the Ministry for the Environment is subject to disclosure under the Official Information Act 1982 (OIA). Certain information may be withheld in accordance with the grounds for withholding information under the OIA. Further information on the OIA is available at www.ombudsmen.parliament.nz.

Information held by the Minister and Ministry may have to be released under the OIA in response to a request from a member of the public (or any other body) for that information. If you wish to provide sensitive information to the Minister or Ministry which you do not want released, it is recommended you consult with the Ministry as to whether the information is necessary for the application, and whether there may be grounds in the OIA for withholding the information. For instance, if release of the information would disclose a trade secret, or be likely to unreasonably prejudice the commercial position of the person who supplied or who is the subject of the information, then there may be grounds to withhold the information. The Ministry will endeavour to contact you to discuss an OIA request relating to your application if one is received, and what the implications of releasing your information are.

The grounds for withholding must always be balanced against consideration of public interest that may justify release. Although the Ministry does not give any guarantees as to whether information can be withheld under the OIA, it may be helpful to discuss OIA issues with the Ministry in advance, if information provided with an application is sensitive.

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Introduction

This milestone report provides the Ministry for the Environment with information about how the delivery phase of your project is going. It must be completed and submitted for each milestone by the dates agreed in your funding deed, unless otherwise discussed with your Fund Analyst.

> Ensure you have read the 'Milestone reporting and payments' section of the *Guide for grantees* before you complete this report.
>
> It is preferable to complete this report electronically, and submit it by email.
>
> You must discuss any problems, issues, or major changes to your project with your Fund Analyst before completing and submitting this report.

When your report is complete

Milestone reports should be submitted by the dates agreed in your funding deed, unless otherwise discussed with your Fund Analyst.

Email the following documents to your Fund Analyst:

- completed milestone report
- completed claim form
- completed invoice breakdown spread sheet
- supplier invoices for any item over $50,000, and any capital costs of $10,000 value or more.

Alternatively, you can post these to: Community Environment Fund or Waste Minimisation Fund, Ministry for the Environment PO Box 10362, Wellington 6143.

What happens next?

Your Fund Analyst will assess the report to ensure that you have met the requirements for funding as specified in your funding deed. During your Fund Analyst's review of the report and supporting documentation, further information (including evidence confirming actual expenditure) may be requested. Allow at least seven working days for the assessment to take place. A report for a final milestone may take longer to assess, and may also be dependent on the results of an independent audit.

Once the Ministry for the Environment is satisfied that your milestone claim meets the funding requirements, your Fund Analyst will arrange payment with the Ministry's finance department.

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Section 1: Evaluation of this milestone

Complete the tables below to show how your project is tracking against this milestone in your project plan. Submit the following with this milestone report:

- *completed milestone claim form*
- *completed summary of expenses form*
- *final project report template (if this is the final milestone)*
- *evidence of the deliverables.*

Press the Tab key on your keyboard to add more rows to the tables, if required.

(1A) Activity *List the activities for this milestone as specified in your project plan*	**Summary of progress** *Provide a summary of the progress made for each activity associated with this milestone*
Establishment of MSW pre-treatment trial equipment to enable evaluation at a suitable scale	• A food waste recipe was developed and during this quarter, material was prepared using equipment at the foodbowl in Auckland. Material was cut, diced and blended to a small particle size using their equipment to generate 2m^3 of material of consistent texture. This enabled an evaluation of treatment equipment to be undertaken and allowed us to understand the nature of the material better. More detail provided in the Quarterly Technical Progress Statement (QTPS).
Assessment of risk and toxicity potential of hydrothermally deconstructing MSW components	• During this quarter, the toxicity of the wet oxidation liquor to aerobic degradation was investigated using electroly ic respirometers. This work identified the EC50, or the concentration at which a 50% response was observed. Acute toxicity of a wider range of wet oxidation liquors, derived from the screening study, was undertaken using the Microtox assay. More detail provided in the QTPS.
Laboratory scale trials on MSW blends	• Laboratory trials were continued by extending the screening study and looking at a wider range of contaminants found in MSW. Food waste blends and blends of food waste and green waste, representing the 'putrescibles' fraction of MSW, were included in this screening study. The putrescibles fraction was treated successfully via wet oxidation, as were many of the other contaminants tested. Materials resistant to degradation were identified such as polystyrene food trays and aluminium foil. More detail provided in the QTPS.
Pilot scale trials on selected MSW components	• A complete Terax process run, i.e. fermentation and wet oxidation, was conducted at pilot scale during this quarter. A 2m^3 food waste sample was developed from a recipe and prepared at the foodbowl in Auckland. A 1m^3 portion of this was anaerobically fermented at 36^{O}C for 8 days, during which solids destruction was observed and organic acid production increased. The output from the fermentation was then wet oxidised during which time >90% of the suspended solids were destroyed, and yielding acetic acid.

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Refinement and peer review of the process economic model.	• The anaerobic fermentation stages of the Terax techno-economic model was peer reviewed by NIWA during this quarter. The peer review identified areas where the costs should be amended and reviewed the calculations used to determine yields of products. The model was also further refined with the financial appraisal methods used expanded, and Lang factors added according to an approved method to allow a cost estimate range to be derived.

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(1B) Deliverable *List the deliverables for this milestone as specified in your project plan*	Status *Complete or incomplete?*	Reason *If not complete please let us know why*
• Quarterly PGG update report in dashboard format.	Yes	
• Quarterly technical progress statement describing trials undertaken, results to date and associated workplan progress	Yes	
• Techno-economic scenario updated as an output from the MSW process model.	Yes	
• Quarterly communication report	Yes	
• Milestone report	Yes	
• Milestone claim form • Documentation to support actual expenditure (i.e. receipts/invoice) • Tax invoice for claimed amount	Yes	

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Section 2: Evaluation of Project Objectives

Delivery of each milestone will help you progress towards achieving your project's overall objectives. Complete the table below to show how your project is tracking against its objectives.

Your Project Objectives *List the project objectives from your project plan.*	**Key performance indicators (KPIs)** *List the KPIs from your project plan.*	**Actual Measure** *Describe the current situation. This will show if you are on target to meet the project's objectives.* *If your project is not at the stage of measuring and reporting on this information, please provide a short statement to explain why.*
Construct full scale TERAX™ plant at Rotorua Wastewater Treatment Plant	Plant constructed in 2014	Detailed design for full scale TERAX™ biosolids plant is currently underway and on schedule.
By 2014, reduce Rotorua sewage sludge offsite disposal (land or landfill) by >90%	8,500 Tonnes/year of sewage sludge processed	This will be achieved through the construction of the full scale TERAX™ biosolids plant which is on schedule for delivery.
By 2014, extend the hydrothermal technology platform to broader MSW organic waste streams	Production of a report on design parameters for the processing of municipal solid waste at full scale. Will include concept design and cost details to proceed to full-scale plant for Rotorua district wider organic waste stream.	The first three quarters of this project have established the project framework for delivering the research project to extend the technology platform to MSW waste streams. Laboratory trials continue and pilot plant trials have now been run. All Activities towards this Objective are currently on track.
By 2015, expand the implementation of the TERAX™ process to at least 2 new TLA or industry end-users	Number of new customers engaged	The Terax commercialisation structure is now established through the formation of Terax 2013 ltd, the 50:50 joint venture between Scion and RDC. This company is currently developing licensee options for the technology and actively engaging with potential end-users.

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Section 3: Additional information

Please provide any additional information that the Ministry should be aware of, please consider:

- *Successes you have had this milestone or particular progress you have made towards your project objectives*
- *Risks that have appeared or challenges faced this milestone and ways you plan to mitigate them*

No additional information is provided here. Quarterly Technical Progress Statement provides overview of project achievements thus far.

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Section 4: Procurement

Did you buy any major items or award contracts during this milestone (over $10,000)? If so please list the item or contract and briefly explain the procurement process you went through.

Attach a copy of all contracts, requests for proposals (RFPs), etc with this milestone report as supporting documentation.

*Press the **Tab** key on your keyboard to add more rows to the tables, if required.*

Supplier name	Description of good/work or service, and the procurement process you followed	Value	Date awarded

Section 5: Other sources of funding

Provide information about other external funding for this project (other than that from the WMF/CEF). Include all cash contributions and other funding listed in your project plan.

The amount paid towards this milestone (the amounts in the far-right column) must also be provided in your milestone claim form.

If you have more than three partners or external funding sources press the Tab key on your keyboard to add more rows to the tables.

Funder name	Total amount requested	Total amount approved	Amount received to-date	Amount paid towards this milestone
Scion	$50,000.00	$50,000.00	$50,000.00	$50,000.00
	$0.00	$0.00	$0.00	$0.00
	$0.00	$0.00	$0.00	$0.00

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Section 6A: In-kind contributions (only CEF projects to complete this section)

Provide information about the in-kind contributions that your project has received during this milestone, including what this is worth in dollars, excluding GST. Note that in-kind contributions are separate from the cash costs of the project.

	Description	**Total estimated in-kind contribution** *excluding GST*
Professional services and goods *calculate professional services using the actual hourly rate*		$0.00
Use/donation of equipment, etc		$0.00
Facilities provided		$0.00
Community volunteers/staff time *calculate at a rate of $30 per hour*		$0.00
	Total in-kind contribution	$0.00

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Section 6B: Waste minimised
(only WMF projects to complete this section)

Complete the table below. Provide the actual (net) values your project has reduced, reused, recycled and/or recovered during this milestone.

Tonnage data should be recorded once in the most appropriate category for the material being processed (i.e. material should not be reported in more than one of the reduce/reuse/recycle/recovered categories.

All figures should be reported in tonnes. Conversion factors are available in the Grantee Guide, if required.

		Definition
Reduced quantity	0 tonnes	To lessen the generation of waste, including by using products more efficiently, or by redesigning products. In relation to a product, this includes lessening the generation of waste.
Reused quantity	0 tonnes	To use waste or diverted material (in its existing form) further, for the original purpose of the materials or products that constitute the waste or diverted material, or for a similar purpose.
Recycled quantity	0 tonnes	To reprocess waste or diverted material to produce new materials.
Recovered quantity	0 tonnes	To extract materials or energy from waste or diverted material, for further use or processing.
Total quantity (this milestone)	0 tonnes	*This should be the total tonnage of material recycled/recovered/reused to date for this milestone only.*
Total quantity (project to date)	0 tonnes	*This should be the total tonnage of material recycled/recovered/reused to date for all milestones.*

If your project is not at a stage to report on this information (or if the actual tonnages fall short of the targets), explain why:

At quarter 2, milestone 2 of a 3 year project, this project is still very much in its infancy. Data of this nature will not be able to be reported on until construction and commissioning of the Demonstration Plant is complete.

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Declaration

As a duly authorised representative of the organisation:

- I declare that to the best of my knowledge, the information contained in all sections of this milestone report, or supplied by us in support of our milestone report, is complete, true and correct.
- I declare that I have the authority to sign this milestone report and to provide this information.
- I understand that information presented to the Minister for the Environment and Ministry for the Environment is subject to disclosure under the Official Information Act 1982.
- I declare that the fund payment request (milestone claim form) accompanying this milestone report is complete, true and correct

s 9(2)(a)



milestone report.

Date: 5th September 2013

Verification

As a duly authorised representative of the organisation I verify that the fund payment request (milestone claim form) and this milestone report is complete, true and correct, and that:

- costs making up the amount of this request are part of the eligible project costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by way of donation(s) or credit note(s).

s 9(2)(a)



space provided you are electronically signing this milestone report.

Date: 5th September 2013

The declaration and verification must be signed by different people in your organisation.

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Checklist

Use the following checklist to confirm you have provided all the required information for your milestone claim.

☒ All sections of this milestone report completed

☒ Declaration and verification signed and dated by different people

☒ Milestone claim form completed and attached for this milestone

☒ Pre-printed deposit slip attached (first milestone report only)

☒ Final project report completed (final milestone only)

☒ Evidence of milestone deliverables attached, for example:

- photographs of progress
- monitoring and evaluation data
- record log of activities
- media coverage or other publicity
- invoices
- evidence of staff recruitment
- receipts.

☒ Tax invoice from your organisation attached (the amount on the tax invoice must be the same as the payment due amount in the milestone claim form).

The tax invoice must show the following information:

- your organisation's GST number
- the words 'tax invoice'
- invoice number
- funding deed number
- total claim amount
- GST component.

☒ Completed summary of expenses form

☒ Attached supplier invoices supporting the cash expenditure in this milestone of all capital assets over $10,000 (WMF only) and any item procured over $50,000. Each must show the following information:

- invoice number
- invoice date
- supplier name
- description
- total amount (excluding GST).

Note: Supplier invoices must be presented in the standard format that you/your company use to record this type of information.

☒ Copy of supplier contracts and RFPs, if applicable.

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Detailed Design Project Dashboard

Project Name:	Terax Demonstration Plant	**Funding Source:**	MfE
Project Description:	The objective of the Project is to deliver a safe, reliable and functional Plant which processes bio-solids from the Rotorua District Council (RDC) Waste Water Treatment Plant (WWTP) by reducing the volatile solids component and returning value added streams.	**Report Date:**	3/10/13
Report Recipients:	Rotorua District Council, Scion & Terax 2013 Ltd	**Report Author:**	Transfield Worley

Indicator Legend:

☹ **Project is off track and requires attention**

😐 **Project is at risk of going off track**

☺ **Project is on track**

MFE Milestone Ref	Overall Assessment		Project Assessment			Comments
	Last Month	This Month	Schedule	Budget	Resources	
4 & 6	☹	☺	☺	☺	☺	Last months report highlighted schedule issues. These have now been resolved with re-alignment of the project milestones. There remains some risk and uncertainty with the precipitator and product recovery plant; these will require close attention/management as engineering progresses.

Impacts

No issues/impacts expected on schedule.

Highlights

- Revised milestones now well aligned with project team and project stakeholders.
- Good progress being made with process and mechanical engineering.

Health and Safety

No major issues.

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Detailed Design Project Dashboard

Plant HSE Philosophy
This will provide the foundation for the development of a training plan for operators. This will draw on the outcomes of the risk and HAZID workshops (completed), and the outcomes of the Preliminary Engineering phase of the Project.

HAZOP
Main process HAZOP planned for 21 and 22 October in Wellington. This is to cover the main process through to, and including, wet oxidation to enable procurement of long lead items.
The product recovery process is intended to be HAZOP'd with suppliers. The utilities will be HAZOP'd in Detailed Design

Upcoming Decisions		
Description	**Due Date**	**By Whom**
Confirmation of the proposed procurement strategy for the plant	1/11/13	s 9(2)(a)
Review and validation of RDCs business case as a result of the outcomes of Preliminary Engineering	1/12/13	
Commencement of procurement of the plant, equipment, fabrication services and construction services.	13/1/14	

Overall Summary

Progress is steady. Milestones now aligned between project team and stakeholders.

There remains some risk and uncertainty with the precipitator and product recovery plant; these will require close attention/management as engineering progresses.

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The Scion Way

MSW Research Project - Project Status Report

Project Name:	Terax MSW Project	**Funding Source:**	MfE
Project Description:	The project is to assess the performance of the Terax™ Process to treat organic Municipal Solid Waste, to reduce volume, eliminate hazards and recover value	**Report Date:**	25/09/13

Indicator Legend:

- **Project is off track and requires attention** ☹
- **Project is at risk of going off track** 😐
- **Project is on track** ☺

Report Recipients:	Research Leader; Research Office; Project Manager	**Report Author:**	s 9(2)(a)

Primary I/O or KPI	Supporting I/O or KPI	Finance 1 Project ID	Overall Assessment		Project Assessment			Comments
			Last Month	This Month	Schedule	Budget	Resources	
IO5	5.1.3	548	☺	☺	☺	☺	😐	There was some shortage on resources this quarter. The detailed design support work may impact on this project over the next quarter.

Impacts

No issues/impacts expected on schedule.

Highlights

Pilot plant fermentation and wet oxidation runs were both successful

Health & Safety

- No major issues.

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The Scion Way

MSW Research Project - Project Status Report

Upcoming Decisions		
Description	**Due Date**	**By Whom**
Work planning for next quarter - pre-treatment trials establishment	04/10/13	s 9(2)(a)

Overall Summary
A batch fermentation run at the pilot plant was run under mesophilic conditions for 8 days. A 43% volatile solids destruction was observed after 8 days with VFA concentrations >8500mg/l being obtained and significant ethanol concentrations present. A pilot plant wet oxidation was then carried out on this liquor. The wet oxidation was carried out under conditions of high percentage oxygen. This lead to a 70% total solids destruction, 100% volatile suspended solids destruction and acetic acid as the predominant product. Electrolytic respirometers, monitoring oxygen uptakes rate, were used to test the toxicity of various wet oxidation liquors of MSW components. Results are to be submitted in a Technical Note. A Microtox assay is currently being used to assess acute toxicity. Wet oxidation liquors from 3 food waste samples, saw dust, newspaper, office paper, nappies, coffee, HDPE, polypropylene, PET and polystyrene are being assessed.

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Detailed Design Project Status Report

Project Name:	Terax Demonstration Plant	**Funding Source:**	MfE
Project Description:	The objective of the Project is to deliver a safe, reliable and functional Plant which processes bio-solids from the Rotorua District Council (RDC) Waste Water Treatment Plant (WWTP) by reducing the volatile solids component and returning value added streams.	**Report Date:**	3/10/13
Report Recipients:	Rotorua District Council, Scion & Terax 2013 Ltd	**Report Author:**	Transfield Worley

Indicator Legend:

- ☹ **Project is off track and requires attention**
- 😐 **Project is at risk of going off track**
- ☺ **Project is on track**

MFE Milestone Ref	Overall Assessment		Project Assessment			Comments
	Last Month	This Month	Schedule	Budget	Resources	
4 & 6	☹	☺	☺	☺	☺	Last months report highlighted schedule issues. These have now been resolved with re-alignment of the project milestones. There remains some risk and uncertainty with the precipitator and product recovery plant; these will require close attention/management as engineering progresses.

Milestone Description	Due Date	Indicator Icon	Comments
Full Scale Design - deliverables are: • Basis of Design; for Prelim Eng (*Complete*) • Hazard identification Workshop (*Complete*) • Project Risk Workshop (*Complete*) • Process Modelling (*Complete*) • Options Selection (*Complete*) • Pre design review (*Complete*) • Basis of Design; for Detailed Eng • Finalised PFDs • P&IDs • Functional Description • Plant HSE Philosophy	30/11/13	☺	Following deliverables are complete: • Basis of Design (approved for Preliminary Design) • Hazard identification Workshop • Project Risk Workshop • Process Modelling • Options Selection • Pre design review Following deliverables are in progress; expected to be completed in October 2013: • Finalised PFDs • P&IDs • Functional Description • Plant HSE Philosophy

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Detailed Design Project Status Report

Milestone Description	Due Date	Indicator Icon	Comments
• HAZOP Study of Main Process • Procurement Strategy • General Arrangement Drawings • Detailed capital cost estimate • Specifications for Long Lead Items • Preliminary Design Report			• Procurement Strategy • General Arrangement Drawings Following deliverables to be completed in November 2013: • Detailed capital cost estimate • Specifications for Long Lead Items • Preliminary Design Report
Procurement Stage 1 - deliverables are: • Approved shortlist of Main Works Contractors • Finalised tender documents and supply contracts for Long Lead items	13/1/14		No issues expected.
Procurement Stage 2 - deliverables are: • Finalised supply contracts for balance of plant and bulk materials • Finalised works contract for the Main Works Contractor	16/4/13		No issues expected.
Mechanical Completion - deliverables are: • Certificate of practical completion issued to Main Works Contractor	31/12/13		No issues expected.

Impacts
No issues/impacts expected on schedule.

Highlights
• Revised milestones now well aligned with project team and project stakeholders. • Good progress being made with process and mechanical engineering.

Health and Safety
No major issues. Key notes are as below.

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Detailed Design Project Status Report

Plant HSE Philosophy
This will provide the foundation for the development of a training plan for operators. This will draw on the outcomes of the risk and HAZID workshops (completed), and the outcomes of the Preliminary Engineering phase of the Project.

HAZOP
Main process HAZOP planned for 21 and 22 October in Wellington. This is to cover the main process through to, and including, wet oxidation to enable procurement of long lead items.
The product recovery process is intended to be HAZOP'd with suppliers. The utilities will be HAZOP'd in Detailed Design

Significant Project Risks (reviewed 3/10/13)				
ID	**Description**	**Impact**	**Owner**	**Treatment/Mitigation**
R-004	Detailed design identifies show-stopping issues	Project viability (Plant and process)	s 9(2)(a)	Proactive engagement between Suppliers, Constructors, TW, AWT and Scion. Full and rigourous process modelling completed. CAPEX and OPEX to be revalidated prior to commencement of each phase of the Project.
18	The security of the intellectual ownership may be compromised when subcontractors and suppliers are engaged.	Loss of IP / commercial opportunities	RDC s 9(	The strategy for ensuring innovation/IP is captured during the design development process, and, to maintain security of intellectual ownership to be discussed with Project Governance.
25	Technology scale-up risks (and influence on project by ongoing scientific work)	The Terax plant is a new technology, scaling up from laboratory scale via a pilot plant to a full scale plant.	TW s 9(	Ensure appropriate definition of the concept, and that it is appropriately backed up by experimental/laboratory/pilot plant work prior to engineering. Incorporate ability to "make design changes in after procurement and after start-up" into contracts with all parties. Robust change control processes to be implemented by TW.
IS1	Consenting Base case for the project is to vent offgases to a safe level for dispe sion. There is a perception that any future consenting requirements of the WWTP might affect/change this	Project viability	s 9(2)(a) - RDC	RDC to obtain any necessary consents (or exemptions to) for the WWTP in respect of gaseous emissions. Note that a consent application has recently been made for liquid effluent discharge from the WWTP (incl Terax). A future consent application is expected to be made for gaseous emissions from the WWTP (incl Terax).

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Detailed Design Project Status Report

Significant HSE Risks (due to construction and operation)				
ID	**Description**	**Impact**	**Owner**	**Treatment/Mitigation**
2.02	Loss of containment of high pressure process fluid	Risk of explosion, equipment failure etc. Injury or death	TW s 9(	Plant HSE philosophy to be developed and signed off within TW prior to procurement. Engagement of Worley Parsons to provide expert advice on pressure oxidation and materials selection.
9	Geotechnical Hazards	Due to the geological location, geothermal activity like earthquake or subsidence on or near the site is possible. The site is an old landfill.	RDC s 9(	To minimize the geothermal and earthquake hazards obtain appropriate geotechnical information and advice. Utilise this information in the civil design. To minimize the geothermal and earthquake hazards also ensure appropriate people are designing foundations.
11			TW s 9(	To minimize the geothermal and earthquake hazards, investigate the options for controlling failures like loss of containment under pressure.
19	Visitors The site will be a demonstration plant with a high rate of visitors. A hazardous process (high temperature and pressure, oxygen hazards, bacterial hazards etc) leads to high risk for the visitors.	Risk of injury/security for visitor to the site.	TW s 9(	A safety philosophy needs to be developed to allow for visitor safety and demonstration of process functions.
33	Risks associated with oxygen enrichment	A high purity of oxygen is used in the process. This can lead to an increased fire hazard.	TW s 9(	To limit the consequence of combustion resulting from oxygen enrichment; 1. Investigate the minimum inventory for oxygen service (including start up and shut down). Minimize the oxygen inventory as much as possible. 2. Install appropriate failsafe and shutdown systems 3. Install appropriate monitoring/control systems to prevent uncontrolled process To limit the probability of combustion resulting from oxygen enrichment; 1. Ensure appropriate contractors install plant (incl piping up to reactor) that is required for oxygen service 2. Determine appropriate protocols for turning on/off the oxygen supply to the reactor to prevent contamination of oxygen service plant by biosolids 3. Undertake comprehensive set of hazard studies (incl HAZOP)

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43	Gaseous emissions	Exposure risks to staff	TW s 9(	To control the vented gasses to the environment, investigate the safe location and height for the discharge vent to the air using dispersion calculations. Consider what monitoring systems are required to provide for safe startup and operation of the plant. Target an operating arrangement that minimises hazardous emissions during commissioning of the plant.
Ph4.02	Key Scion staff have limited availability	Delay in completion of engineering.	Scion s 9(2)(a)	Ensure PGG is clear on requirements
Ph4.06	Unknown precipitates forming downstream of the lime dosing plant.	Scaling in nitrogen recovery plant - or other areas of the process/WWTP. Impact on performance of the WWTP.	TW s 9(	To be addressed in collaboration with equipment manufacturers. Preliminary engineering will deliver a performance/functional specification for detailed design and fabrication. This spec will not define the specific technologies.

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Detailed Design Project Status Report

Upcoming Decisions		
Description	**Due Date**	**By Whom**
Confirmation of the proposed procurement strategy for the plant	1/11/13	s 9(2)(a) (requires deliverables from TW first)
Review and validation of RDCs business case as a result of the outcomes of Preliminary Engineering	1/12/13	s 9(2)(a) (requires deliverables from TW first)
Commencement of procurement of the plant, equipment, fabrication services and construction services.	13/1/14	s 9(2)(a) (requires deliverables from TW first)

Completed Activities this Period

Concept refinement activities completed:

- Fermenter concept finalised
- Independent review of Biowin model
- Finalised simplified kinetic model for wet oxidation
- Updated Biowin Process Model (biological systems)
- Updated Aspen Plus Model (thermodynamic systems)

Preliminary engineering activities completed:

- Project Execution Plan for Preliminary Engineering
- Updated basis of design for Preliminary Engineering
- Updated process flow diagrams and equipment list for Preliminary Engineering
- Preliminary engineering kickoff meeting
- Draft P&IDs and overall layout (issued for design review)
- Draft functional description (issued for design review)
- Multidiscipline design review
- Draft control system architecture, electrical single line diagram

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Detailed Design Project Status Report

Incomplete Activities this Period
• Solids recovery options selection has not been finalised • Completion of the procurement strategy for the plant (covering equipment supply, fabrication and construction services, and, supply of key operational consumables).

Planned Activities next Period

• Completion of Full Scale Design; including:
  ○ Basis of Design; for Detailed Eng
  ○ Finalised PFDs
  ○ P&IDs
  ○ Functional Description
  ○ Plant HSE Philosophy
  ○ HAZOP Study of Main Process
  ○ Procurement Strategy
  ○ General Arrangement Drawings
  ○ Detailed capital cost estimate
  ○ Specifications for Long Lead Items
  ○ Preliminary Design Report
• Estimating of TWs services through to completion of commissioning of the Plant.
• Completion of procurement strategy
• Commencement of procurement planning, including;
  ○ Prequalification and short listing of main works contractor (mechanical and structural) and long lead items suppliers
  ○ Drafting of non technical aspects of tender documents

Overall Summary
Progress is steady. Milestones now aligned between project team and stakeholders. There remains some risk and uncertainty with the precipitator and product recovery plant; these will require close attention/management as engineering progresses.

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The Scion Way

MSW Research Project - Project Status Report

Project Name:	Terax MSW Project	**Funding Source:**	MfE
Project Description:	The project is to assess the performance of the Terax™ Process to treat organic Municipal Solid Waste, to reduce volume, eliminate hazards and recover value	**Report Date:**	25/09/13

Indicator Legend:

- Project is off track and requires attention ☹
- Project is at risk of going off track 😐
- Project is on track ☺

Report Recipients:	Research Leader; Research Office; Project Manager	**Report Author:**	s 9(2)(a)

Primary I/O or KPI	Supporting I/O or KPI	Finance 1 Project ID	Overall Assessment		Project Assessment			Comments
			Last Month	This Month	Schedule	Budget	Resources	
IO5	5.1.3	548	☺	☺	☺	☺	😐	There was some shortage on resources this quarter. The detailed design support work may impact on this project over the next quarter.

Milestone Description	Due Date	Indicator Icon	Comments
Hydrothermal mixed MSW trials – establishment of MSW pre-treatment trial equipment to enable evaluation at a suitable scale	01/10/13	☺	The Auckland Foodbowl was used to generate sufficient food waste material to undertake a pilot plant scale run
Hydrothermal mixed MSW trials – assessment of risk and toxicity potential of hydrothermally deconstructed MSW components	01/10/13	☺	Respirometry work undertaken to assess degradability and toxicity of Terax liquors to aerobic biological activity
Hydrothermal mixed MSW trials – Laboratory scale trials on MSW blends	01/10/13	☺	A series of MSW components and putrescibles blend have been subject to wet oxidation
Hydrothermal mixed MSW trials – Pilot scale trials on selected MSW components	01/10/13	☺	Pilot scale batch fermentation and batch wet oxidation were achieved within the last month, using food waste as the feed material
Hydrothermal mixed MSW trials – refinement and	01/10/13	☺	NIWA have been commissioned to peer review the techno-economic model. The

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The Scion Way

MSW Research Project - Project Status Report

Milestone Description	Due Date	Indicator Icon	Comments
peer review of the process economic model			model has been further refined for assessing MSW waste streams.

Impacts
No issues/impacts expected on schedule.

Highlights
Pilot plant fermentation and wet oxidation runs were both successful

Concerns
Some discrepancies in the nutrient results with Terax liquors have been seen depending on how they are prepared for analysis. This is important for the full scale design work and further work is needed to develop a sound protocol.

Health & Safety
• No major issues. Key notes are as below.

MAJOR Risks and/or Issues	Description	Date Raised	Comments
Pilot plant fermenter stirrer	The stirrer seal on the pilot plant fermenter formed a leak. If not identified it could potentially release hazardous gases (methane, hydrogen)	Sep13	This was identified during routine safety checks, the seal has been replaced and the seal type is being explored for alternatives. This was recorded in our hazards system.

Upcoming Decisions		
Description	**Due Date**	**By Whom**
Work planning for next quarter - pre-treatment trials establishment	04/10/13	s 9(2)(a)

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The Scion Way

MSW Research Project - Project Status Report

Completed Activities this Period
• Preparation of food waste material at scale • Pilot plant fermentation of food waste • Laboratory wet oxidation screening study • Pilot plant wet oxidation of food waste • Assessment of risk and toxicity study • Techno economic model development and peer review

Incomplete Activities this Period
• Installation of mid-sized laboratory reactor has not occurred yet

Planned Activities next Period
• Understand fate of nitrogen better through Terax process • Laboratory fermentation of food waste and residues • Pilot plant fermentation • Reactor modifications • Techno-economic model development to incorporate ammonia stripping

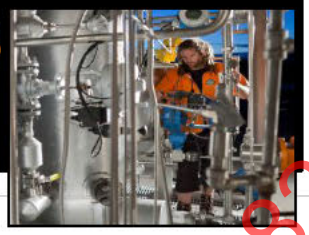
Overall Summary
A batch fermentation run at the pilot plant was run under mesophilic conditions for 8 days. A 43% volatile solids destruction was observed after 8 days with VFA concentrations >8500mg/l being obtained and significant ethanol concentrations present. A pilot plant wet oxidation was then carried out on this liquor. The wet oxidation was carried out under conditions of high percentage oxygen. This lead to a 70% total solids destruction, 100% volatile suspended solids destruction and acetic acid as the predominant product. Electrolytic respirometers, monitoring oxygen uptakes rate, were used to test the toxicity of various wet oxidation liquors of MSW components. Results are to be submitted in a Technical Note. A Microtox assay is currently being used to assess acute toxicity. Wet oxidation liquors from 3 food waste samples, saw dust, newspaper, office paper, nappies, coffee, HDPE, polypropylene, PET and polystyrene are being assessed.

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TERAX™ Quarterly Technical Progress Report



Quarterly Technical Progress Statement for Q3 – Milestone 3 - 2013

Date	27 September 2013
Author	s 9(2)(a)
Contributors	s 9(2)(a)
Task	All tasks
Milestone	3
Version (using the 0.1, 0.2 method and submitted version to SIDNEY as FINAL)	0.1

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Executive Summary

The WMF project on application of TERAX™ technology to municipal solid wastes has completed its third quarter in year one. The purpose of this project is to extend the application of TERAX™ into processing MSW organic wastes, following a path of combined laboratory and pilot plant trials, coupled with robust techno-economic analysis.

Significant outcomes from this first quarter have been:

Screening study: Batch laboratory trials were continued on a expanded variety of potential contaminant materials. Wet oxidation showed a good ability to break down and solubilise many of the component fractions with many achieving greater than 90% total suspended solids destruction. Acetic acid was typically the major soluble component remaining after we oxidation. This study provided an indication of components which were resistant to degradation and for which pre-treatment may be required for their removal.

Material preparation and pilot plant fermentation: A standard food waste recipe was developed and preparation of a $2m^3$ batch was undertaken at the Foodbowl's premises in Auckland. Material was cut and diced and blended to a small particle size with a consistent texture. This food waste was then batch fermented at the pilot plant running at $36^{O}C$ for 8 days. The fermentation gave high levels of dissolved organic carbon, such as volatile fatty acids and ethanol.

Pilot plant hydrothermal trial: The digested food waste was taken from the fermenter and subjected to wet oxidation. A batch experiment was conducted at $220^{O}C$ over 3 hours. This provided evidence that the process can effectively treat food waste at scale. A destruction of 70% of the input total solids was achieved and the major liquid product. These results correlated well with work on the same feed material conducted in the laboratory hydrothermal reactor.

Scale-up activities: Significant work was conducted in preparation of plant and equipment for scale-up activities and fixing problems identified during the initial trials. This included installing safety devices such as a burst disk on the fermenter and fixing leaks on the fermenter.

Modified techno-economic model: The techno-economic model was developed further during this quarter, to include aspects such as Lang Factors and making provision for pre-processing equipment. A peer review of the pre- and post-fermentation modules within the model was undertaken by NIWA who have appropriate expertise in this field. A simple process engineering model was also developed in Aspen of the wet oxidation system and used to undertake some initial analysis.

Risk and toxicity analysis: Toxicity of the wet oxidation liquor to aerobic degradation was investigated using electrolytic respirometers. Acute toxicity of a wider range of wet oxidation liquors was undertaken using the Microtox assay.

Sampling protocol methodology: The method used to sample the Terax liquors has the potential to impact nutrient results obtained. An experimental programme was developed to understand the impact of sampling and to develop a suitable protocol for sampling into the future. Ammonium analysis were the most sensitive to how the samples were prepared and stored. The complex matrices in the materials generated in the Terax process has an impact on the suitability of the methods as they currently stand.

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Task One - TERAX™ MSW Laboratory

In this quarter laboratory work has consisted of:

1. Upgrading of fermentation and hydrothermal equipment
2. Completion of the MSW-components screening study
3. Preliminary work on hydrothermal reactor configuration experiments

Activities

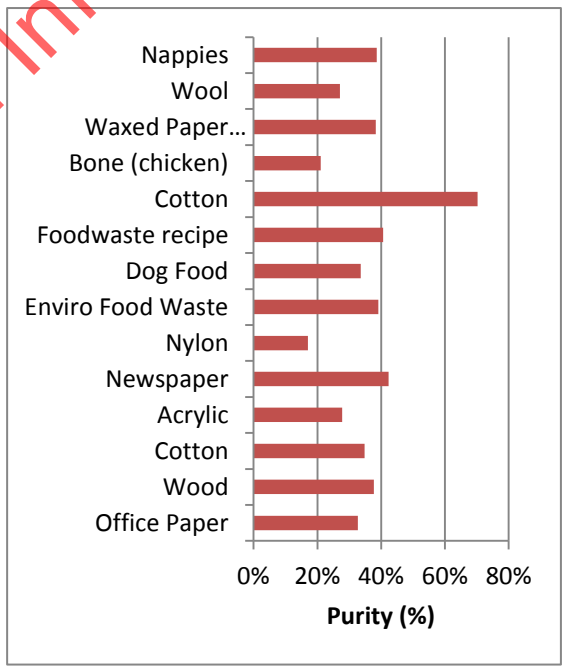
Upgrading of fermentation and hydrothermal equipment

The fermentation laboratory reactors have been upgraded during this quarter. A hazard assessment was undertaken, based on the potential of high levels of hydrogen and methane to be present. This highlighted the need for additional safety measures and therefore a burst disk and alternative gas venting system was introduced.

The hydrothermal Parr reactor was also modified. A condenser was installed which allows for the continuous flow of oxygen through the system, enabling potentially higher concentrations of waste to be treated. A revised sampling system has also been installed.

Screening study

A screening study has been completed on 21 components of municipal solid waste (MSW) e g polymers, textiles, to understand the potential impact of contamination of the MSW waste stream. This work showed that the solids content of many of the contaminant components could be reduced successfully with wet oxidation. Some of the materials, such as some polymers and textiles, were less susceptible to degradation. This therefore helps to inform the potential pre-treatment processes which will have to be employed to handle difficult materials



Reactor configuration experiments

The manner in which wet oxidation is carried out has the potential to alter the results obtained e.g. slow heat up versus adding material at temperature. This work has begun looking at the impact of how an experiment is carried out influences the results. Preliminary results have so far been obtained which will look to be confirmed and extended during the next quarter. This work has helped quantify the solids destruction occurring during initial heat up, the impact of non-oxidative conditions on subsequent wet oxidation and impact of stirrer speed on the results.

s 9(2)(a)

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Task Two – TERAX™ MSW Scale-up

This task included both the pilot plant operational activities and the work required to modify and make-ready the pilot plant equipment. Preparation of the food waste material using pre-processing equipment is also described.

Activities

Pre-treatment trial equipment

A representative food waste recipe was developed and, subsequently, samples were prepared at the Foodbowl's facilities in Auckland. Over 2 days a $2m^3$ sample of material was produced which had been reduced to approximately a <10mm particle size through slicing, dicing and mixing using the equipment made available. This was put under chilled storage and transported to Rotorua.



Fermentation Pilot Plant Operation

Scion undertook an 8 day mesophilic ($36^{O}C$) anaerobic fermentation of food waste using the 2000L pilot plant fermenter. A food waste recipe from the Foodbowl was used in the experiment.

The food waste was approximately 18% dry solids and therefore represented a semi-dry fermentation and considerably higher loading than was previously used with sewage sludge. Mixing was observed to be good, despite the high solids.

Following a 5 day lag period solids destruction increased to achieve a 43% volatile solids destruction by Day 8. The volatile fatty acid (VFA) concentration reached >8,500 mg/l and ethanol was also observed to be present, the trajectory indicated that the VFA concentration could rise further with a longer residence time. High concentrations of soluble chemical oxygen demand (sCOD) and dissolved organic carbon (DOC) were also observed.

This work demonstrated that fermentation of food waste was feasible under mesophilic conditions at pilot plant scale. The next stage of work will be to undertake further pilot plant work under thermophilic conditions and support development with laboratory fermentations.



Wet Oxidation Pilot Plant Operation

A digested food waste sample was subject to wet oxidation, at the pilot plant scale, in a batch operation, over 3 hours at temperature ($220^{O}C$). Reactions were observed to be occurring during the heat-up phase. A destruction of 70% of the input total solids was

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achieved and the major liquid product was acetic acid. These results correlated well with the laboratory Parr experiments and demonstrated that at scale food waste was treatable under wet oxidation conditions. Dissolved nitrogen concentrations rose during the reaction and dissolved phosphorus decreased, possibly due to precipitation with liberated cationic species.

Pilot plant modifications

Prior to running the Fermentation Pliot Plant in 2013 it underwent a minor upgrade. The control systems were rebuilt and touchscreen replaced. All valves on the plant were removed and serviced. One valve was replaced due to severe corrosion. All pumps were inspected for wear. Two pumps were sent back to the supplier for repairs and were completely overhauled. One required a new gearbox due to seal failure.



The 200 litre gas bag was replaced due to wear and tear. The gas bag enclosure and bag mounting system were also replaced to reduce premature damage to the bag. Modifications were made to the water trap inlet pipe to reduce fluctuations in offgas flowrates. The water trap was repaired and a second water trap is being built.

During the upgrade we also assessed the risks involved with running MSW in the fermenter reactor vessel. To avoid creating a pressure vessel we have installed a burst disc and vent line into the main reactor vessel.

Three platforms were built for the fermentation pilot plant to allow safer access to regularly used valves, manway cover and seal for the reactor mixer. All material used is stainless steel to cope with the corrosive atmosphere on the site. Any other badly corroded fittings were also replaced with plastic or Stainless Steel.

Once running the plant developed several leaks. The main leak was due to the failure of the gland packed seal on the reactor vessel stirrer. The stirrer is to be extracted for inspection of the seal and seal running surfaces. A maintenance schedule for this seal is to be put in place to avoid this type of failure in future.

s 9(2)(a)

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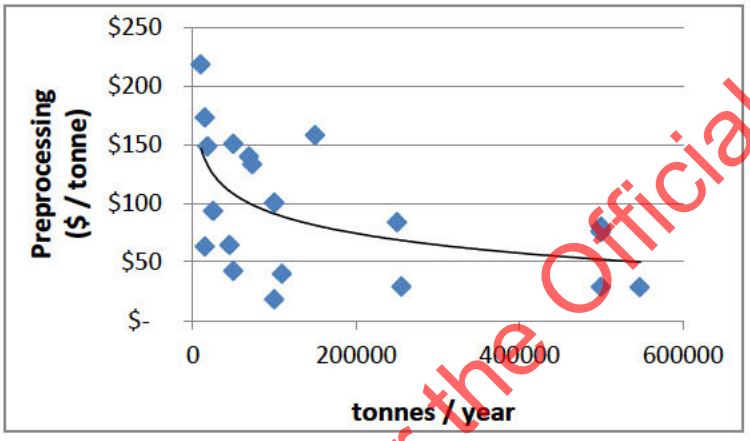
Task Three – Techno-Economic Modelling

The techno-economic model has been further refined this quarter and been subject to a peer review. Some initial work using dedicated process simulation software was commenced.

Activities

Refinement of techno-economic model

AWT Water Ltd were commissioned to further develop the techno-economic model. One of the major advances was the incorporation of Lang Factors into the model on an item-by-item basis, as previously recommended by Transfield Worley in their peer review completed last year. This gives a sound basis for estimating of additional project costs. Additional economic reporting metrics have been included in the model. There has also been incorporated provision for additional waste handling equipment i.e. pre-processing costs. Further iterations of the model will look at obtaining cost estimates for this pre-processing stage.



A broad level literature review of pre-processing costs for MSW was undertaken to understand the likely additional cost requirements for this aspect. Preliminary estimates are that additional pre-processing requirements could cost in the range of $20 – 100 / tonne. A target for future model development will be to collect real data from suppliers to refine the estimate of this.

Peer review of process economic model

NIWA were commissioned to undertake a peer review of the fermentation stages (pre and post fermentation) in the techno-economic model. This identified some areas of improvement and reviewed the appropriateness of the costs relate to these items. Work to implement the required changes will be undertaken early in the next quarter.

Development of Aspen-based process model

During this quarter work has been undertaken to start developing a process model of the wet oxidation stage using the commercial chemical process software Aspen. A simple first generation model was developed. This model was used to model the anticipated water losses under different process conditions. Future work will look at incorporating kinetic results into the model.

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Task Four – Characterisation and Technology Assessment

This quarter, the Characterisation and Technology Assessment task has:

1. Undertaken risk and toxicity analysis on hydrothermal deconstructed MSW components
2. Investigated the sampling methodology to gain confidence in the nutrient results

Activities

Risk and toxicity analysis

A series of experiments were undertaken to understand the degradability and toxicity of Terax effluent liquor. In order to test the potential impact that wet oxidation liquors may have on activated sludge biomass, respirometer tests were conducted in the presence of activated sludge sampled from the Rotorua District Council Bardenpho system.

Electrolytic respirometers were used to simultaneously compare samples of Terax liquor generated under different conditions for their oxygen uptake rate. The tests were performed under a constant level of dissolved organic carbon (DOC) but with different levels of wet oxidation liquors. Results were expressed on a TSS basis.



Runs were measured over 7 days always including a negative control (water with activated sludge), negative sterile control (acetate with no activated sludge) and positive control (acetate with activated sludge). The wet oxidation liquors were tested at 5 dilutions ranging from 0.1% to 10% and the point at which a 50% response was observed was determined.

The liquors tested were biosolids wet oxidation liquor, Envirowaste food waste sample wet oxidation liquor and model food waste wet oxidation liquor from the recent pilot plant run.

The acute toxicity of a range liquors produced by wet oxidation of individual MSW components was tested by submitting them to the Microtox assay. Microtox is a rapid metabolic respiration inhibition test that measured the light output of Vibrio fischeri. This test was chosen to screen the potential toxicity of MSW components after wet oxidation in order to determine at an early stage in the selection process, potentially toxic MSW components that may not be suitable for wet oxidation processing. The MSW components analysed were: 3 food waste samples, saw dust, newspaper, office paper, nappies and coffee wet oxidation liquors.

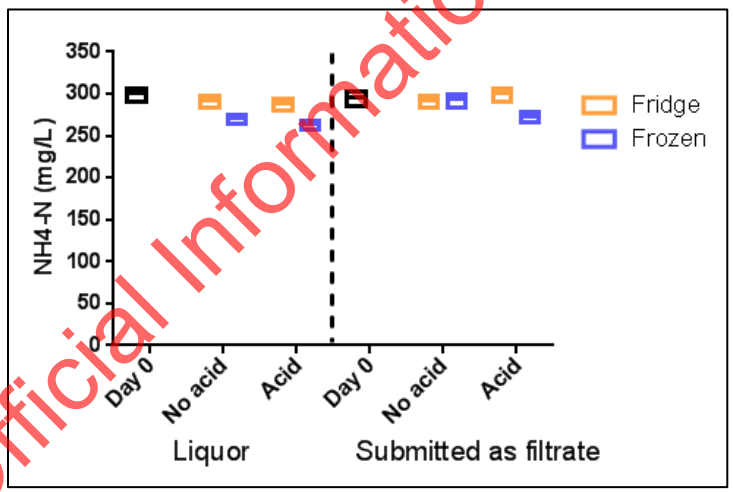
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Sampling protocol methodology

Understanding of the changing concentrations of nitrogen and phosphorus species through the Terax process is important for understanding its process efficacy and as a basis to derive suitable design costs. Given the unusual nature of these samples confidence is required to ensure that nitrogen and phosphorus species are being accurately measured and reported. Ultimately, this work is designed to lead to a consistent sampling protocol.

A wet oxidation was undertaken and the samples subdivided and analysed in 25 ways according to different conditions. Analyses of the samples after a variation of different filtering and storage option (e.g. refrigeration or freezing) could then be used to understand the processes taking place under storage.

Ammonium analyses were the most sensitive to the various storage protocols. Feed and liquor matrices responded quite differently and acidification could have an impact on the concentrations measured. Overall, with storing samples up to 9 days, refrigeration with no acidification and filtering immediately before analysis, seemed to yield results closest to the initial concentrations. Phosphorus levels were not significantly influenced by the various storage protocols.

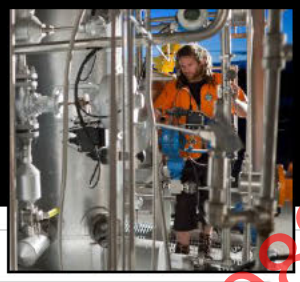


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TERAX™ Technical Report



Techno-economic scenario updated as an output from the MSW process model

Date	04/10/13
Authors	s 9(2)(a)
Contributors	
Task	MSW Modelling
Milestone	3
Version	0.1

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Executive Summary

AWT Water Ltd were commissioned to update the existing techno-economic model to allow an assessment to be made into the likely costs of treating the putrescibles fraction of solid waste going to the Atiamuri Landfill, Rotorua. From 2009 data this was in the region of 12,000 wet t/yr. Principal amongst this upgrade were the addition of Lang Factors, more extensive financial reporting and an update of capital costs based on more recent findings.

A peer review was carried out during this quarter which reviewed the costs used within the model and made comment on the suitability and appropriateness of the fermentation stages.

The estimated costs for the technology have risen compared to last quarter as they have become better understood or defined. This is principally due to an increase in the anticipated capital cost and a reduction in the operational benefits.

Further work is recommended to update the costs for the larger sized plant and to include an ammonia stripping system to align with the proposal for the full scale plant.

Introduction/Background

The TERAX™ process is a two stage fermentation/hydrothermal oxidation process for the destruction of organic waste. A techno-economic (TE) model has been developed to help determine what the costs are likely to be for the TERAX™ process. This is an Excel based model which has principally been developed by the consultancy AWT Water. This was initially developed to understand the costs associated with treating sewage sludge. The model has subsequently been adapted so that the costs associated with the treatment of solid organic waste can be readily determined. Previously this has required the model to have an additional fermentation stage after hydrothermal treatment included, as an alternative method for making use of the acetic acid product.

Work Aim

The aim of this work was to refine the techno-economic model and to undertake a peer review of the anaerobic fermentation stage of the process to give us confidence in the calculations. There aims to be initial modelling using the Aspen process modelling software during this quarter.

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Materials and Methods

Upgrade process

The model upgrade was undertaken by AWT Water, and consisted of the following amendments:

- expansion of the financial evaluation methods in the model to present a cost/ton on different bases
- addition of Lang factors for equipment items aligned with the approach in the publication *SCENZ, 2004. Process Capital Cost Estimation for New Zealand 2004*. Also, to give the user the ability to define the Lang Factor to provide an estimation of uncertainty in the derived costs.
- Inclusion for a provision for adjusting equipment prices where the pressure rating is significant
- Re-alignment of capital costs with the most recent costs coming out of detailed design work by the contracted consulting engineers (for Rotorua District Council biosolids TERAX™)
- Inclusion of provision in the spreadsheet for pre-processing costs to be added at a future date
- A summary report outlining the changes made to the model

Peer review of the model

The purpose of the peer review was to give a critical assessment to the anaerobic fermentation stages of the Terax project. Specifically, the peer review required:

- Confirmation that the pre-fermentation and post-fermentation stages are using the appropriate and correct calculations
- Confirmation that the calculations are free from error
- Confirmation that the yield conversions chosen are appropriate
- Confirmation that the costs attributed to the products of fermentation e.g. biogas, are reasonable

The peer review process highlighted over- and under-estimations with some of the costs which will subsequently be updated in the model.

Aspen modelling

An initial model was prepared in Aspen of the wet oxidation reactor. This was used to understand the conditions under which evaporation of water will become significant in wet oxidation. This has important consequences in terms of the heat balance and anticipated yields/concentrations of products. Further development of Aspen to expand the extent of the process being modelled is planned for the future.

Economic assessment

An updated economic assessment of the costs was undertaken based on the most recent changes to the model. This was as close a comparison to values obtained last quarter as was possible given the model changes made. Some of the assumptions in this estimate are:

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- An annual tonnage of 12,000 wet t/yr was used corresponding to the reported putrescibles fraction entering RDC Atiamuri landfill. A 40% d.s content was assumed (4800tds/yr)
- Pre-processing costs (e.g. shredding, separation) are not included in these costs to enable comparison to previous cost estimates
- Costs associated with waste collection and delivery are not included in these costs
- Capex is based on a derived Lang factor in the model
- Ammonia stripping is not included within the calculation
- A biogas value of $10/GJ LHV has been used. This was not altered for varying composition of H_2 vs CH_4.

Results

Impact of model changes

There was observed to be an increase in the estimated costs from the model as it stood at the end of the previous quarter. This rise is attributable to a higher estimation of the capital cost and a lower annual revenue from the products of wet oxidation / fermentation. These costs will continue to refined during the next quarter.

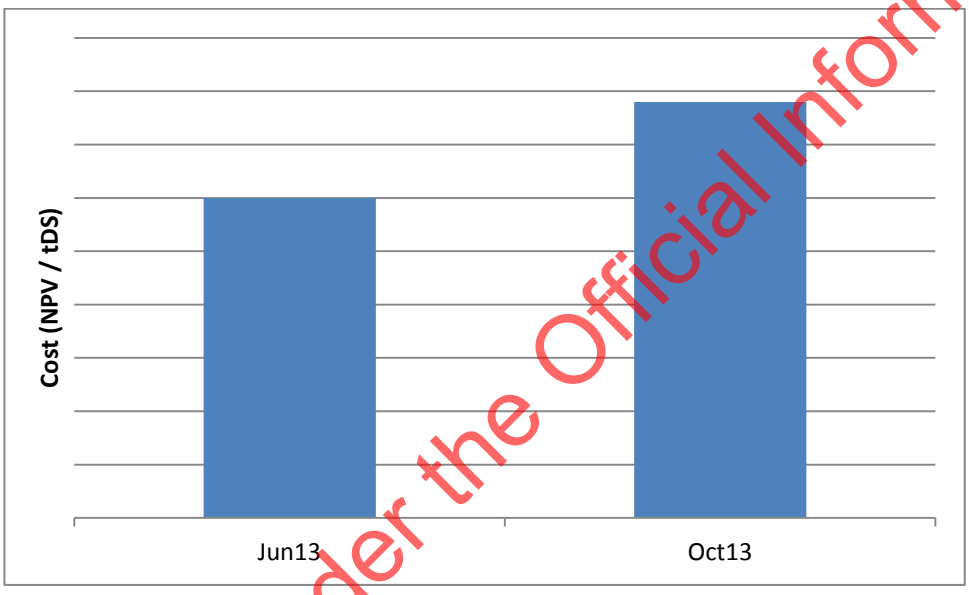


Figure 1: Comparison cost estimate between June 13 and October 13

Next steps

The next steps should include the following:

- To determine updated prices for the large scale plant used for scaling in the techno-economic model
- To understand the likely magnitude of pre-treatment costs
- To include ammonia stripping process as aligned with the latest full scale plant design
- To incorporate the most up to date yield data for Terax products to better refine the value proposition.

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Quarterly Communications Report - Quarter 3 - Year 1

Future - Reactive & Responsive Communications Register
Project Name: TERAX 11 - Demonstration Plant - MSW Research Programme - Commercialisation

Comms Ref #	Date comms initiated	Communication Description	Communicating Company	Target audience	Communication channel	Date of release/activity	Date & Outcome / Progress Update	Comms status
	1-Sep-13	Feature article submitted to The Chemical Engineer (international magazine)	Scion	Engineers globally	Trade magazine - The Chemical Engineer			awaiting to hear if accepted
	1-Sep-13	Preparation of new display banners, giveaways and print material	Terax Ltd	engineers, senior local authority and water utility managers, consultants, contractors and operations personnel at all levels	WasteMINZ; Water NZ conferences	16-18 Oct Water NZ; 21-24 Oct WasteMINZ	in final production	
	1-Sep-13	Mentions in Scion Annual Report (in Chair & CEO report and under research performance for IO5.	Scion	Minister of S&S, MBIE, MfE	Scion Annual Report 2013, page 36	wider distribution during early October		Tabled in Parliament on 2 Oct 2013

Closed Communications Register
Project Name: TERAX 11 - Demonstration Plant - MSW Research Programme - Commercialisation

Comms Ref #	Date comms initiated	Communication Description	Communicating Company	Target audience	Communication channel	Date of release/activity	Date & Outcome / Progress Update	Comms status

Other Comments

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Milestone 3

Interim Claim

WMF Reference: WMF-559 | **Project Year:** Year 1

Grantee: Rotorua District Council | **Deed No:** 20351

Project: Demonstration of the TERAXTM hydrothermal deconstruction process | **Due Date:** 1 October 2013

*This tab is for you to provide details of the cash income received, and the cash expenditure, for this milestone. Complete the **Cash Income (non-WMF)** and **Cash Expenditure** sections below (shaded sections only). When you have done this, the payment due for this milestone automatically calculates. Ensure that your figures are accurate and based on actual cash income received and actual cash spent, and then save your changes. Submit the entire claim form to your Fund Analyst with the milestone report and other required documentation for this milestone.*

Balance and actuals for this project year only (Ministry use only)

WMF Approved amount:	$1,000,000.00
WMF Funds paid to date:	$215,000.00
WMF Funds remaining at beginning of milestone:	$785,000.00

Milestone estimates (Ministry use only)

Estimated total expenditure for this Milestone:	$270,000.00
Estimated WMF payment for this Milestone:	$129,000.00

Cash income (non-WMF)

*As part of your project plan, you estimated the cash income you would receive from other external sources (including partners). Record **all actual** cash income below, that you have received from other funding sources for this milestone only, excluding GST. This may include cash income not previously listed in your project plan. This page contains formulae to calculate the payment due. Do not add rows to this page. If you have multiple income streams, combine these to fit the rows provided.*

Cash income from your organisation:	$91,000.00
[enter the name of the external funding source here]:	$50,000.00
[enter the name of the external funding source here]:	[enter actual amount received]
[enter the name of the external funding source here]:	[enter actual amount received]
Actual total cash income:	**$141,000.00**

Cash expenditure

*As part of your project plan, you estimated the cash expenditure for this milestone. Record all actual project costs (cash expenditure) for this milestone in the cost category rows below, excluding GST. Details of invoices in support your claim should be recorded on the **'Summary of Expenses'** form. This page contains formulae to calculate the payment due. Do not add rows to this page.*

Personnel:	
Administration:	
Consultants and contractors:	$270,000.00
Purchase of capital assets and other capital costs:	
Venue and equipment:	
Travel and accommodation:	
Promotion and dissemination of information:	
Financial, legal and information technology expenses:	
Other miscellaneous costs:	
Actual total expenditure:	**$270,000.00**

Payment calculated using the Interim Payment Calculation (Ministry use only)

*The **Payment due** amount is how much the WMF will pay you (excluding GST) after your milestone and its deliverables have been assessed and approved. Your payment due will be the lesser of A, B or C below, as per Section 1 of your funding deed. Contact your Fund Analyst for further information, if required.*

balance brought forward (less 10% max WMF amount) (A) =	$685,000.00
WMF contribution to actual total expenditure* (B) =	$129,600.00
Actual expenditure minus income (C) =	$129,000.00
Payment due: *(excl. GST)*	**$129,000.00**
Funds remaining after payment made	$656,000.00

** This is based on the WMF percentage contribution to the actual total expenditure*

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Milestone assessment

Record the milestone claim assessment below.

Approved/declined for payment:

Name:	
Position:	
Date:	
Signed:	

Payment verified:

Name:	
Position:	
Date:	
Signed:	

Payment approved:

Name:	
Position:	
Date:	
Signed:	

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WMF Milestone Claim Form

Projects may have up to six milestones, and a separate tab has been created for each in this spreadsheet. This summary page is completed by your Fund Analyst, and the information populates the other tabs in this spreadsheet. Open the tab that corresponds with the current project milestone and complete the relevant sections.

WMF Reference:	WMF-559	**Funding deed no:**	20351
Project name:	Demonstration of the TERAX™ hydrothermal deconstruction process	**Grantee name:**	Rotorua District Council
Project Year:	Year 1	**WMF $ approved:**	$1,000,000
WMF % approved:	48.00%		

Name of milestone	Due date	Estimated total cash expenditure *(excl. GST)*	Estimated WMF cash payment *(% est. cost)*	Actual total cash expenditure *(excl. GST)*	Actual payment due	Comments
Milestone 1						
MSW Option Establishment	30/03/13	$223,000.00	$106,000.00	$223,000.00	$106,000.00	
Milestone 2						
Hydrothermal Component Trials	30/06/13	$229,000.00	$109,000.00	$229,000.00	$109,000.00	
Milestone 3						
Hydrothermal mixed MSW Trials	1/10/13	$270,000.00	$129,000.00	$270,000.00	$129,000.00	
Milestone 4						
Full-Scale Detailed Design	1/11/13	$1,000,000.00	$476,000.00	$0.00	$0.00	
Milestone 5						
Pre-treatment Trials Establishment	1/12/13	$278,000.00	$132,000.00	$0.00	$0.00	
Milestone 6						
Construction Procurement	15/12/13	$100,000.00	$48,000.00	$0.00	$0.00	
Totals *(excl. GST)*		$2,100,000.00	$1,000,000.00	$722,000.00	$344,000.00	

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Te Papa Tipu Innovation Park
49 Sala Street, Private Bag 3020, Rotorua, New Zealand
Telephone: + 64 7 343 5899 | Facsimile: + 64 7 348 0952
Email enquiries@scionresearch.com | www.scionresearch.com

TAX INVOICE

Rotorua District Council
Private Bag 3029
Rotorua 3046

Customer Number:	00764	***GST Reg No (NZ):***	59-493-760
Customer Reference:	MFE CONTRA	***ABN No (Australia):***	512-1094-8677
Invoice Number:	**053001**	***Invoice Date:***	4/10/2013
Page :	1 of 1	***Due Date:***	20/11/2013

Particulars	MSW Option establishment as per TERAX Demonstration pland al	***Amount $***
MSW Option establishment as per TERAX Demonstration pland and further research contract 13/018 - MFE Quarter 2 Includes TERAX Modelling, TERAX Feedstocks, TERAX Laboratory and TERAX Scaleup activities		270,000.00
Attention: s 9(2)(a)	***Sub Total:***	270,000.00
	GST:	40,500.00
	Invoice Total:	310,500.00

For any queries relating to this invoice, please contact Alex Chambers
For any payment queries, please contact accounts.receivable@scionresearch.com

s 9(2)(a)

Rotorua District Council **Amount:** 310,500.00

Card Number: __ __ __ __ - __ __ __ __ - __ __ __ __ - __ __ __ __ **Card Type:** Visa__ Mastercard__

Security Number: __ __ __ (Three digit number located on the back of your card)

Cardholders Name: _____ **Expiry Date:** ___/___

Signature: _____ **Amount to Pay:** $_____

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DESTINATION ROTORUA
ROTORUA DISTRICT COUNCIL

Rotorua District Council
1061 Haupapa Street
Private Bag 3029, Rotorua Mail Centre
Rotorua 3046
Phone: 07 348 4199
Fax: 07 346 3143
Email: mail@rdc.govt.nz

TAX INVOICE

MINISTRY FOR THE ENVIRONMENT
PO BOX 24441
MANNERS STREET
WELLINGTON 6142

PLEASE QUOTE YOUR CUSTOMER NUMBER

INVOICE No.	287010
DATE	10 Oct 2013
CUSTOMER No.	AR 312062

G.S.T. REG. No. 10-801-397

DESCRIPTION	AMOUNT
WASTE MINIMISATION FUND	
Completion Of Milestone 3 Hydrothermal Mixed MSW Trials Att: Heather Penny	129,600.00

Please pay on invoice. No statement will be issued.

Rotorua District Council reserves the right to pass any unpaid accounts to its Collection Agency and any costs or expenses as a result shall become the responsibility of the client (as abovementioned)

ALL ENQUIRIES RELATING TO THIS INVOICE SHOULD BE REFERRED TO:-
s 9(2)(a)

SUB TOTAL	**$129,600.00**
G.S.T.	$19,440.00
TOTAL $	**$149,040.00**

No statement is issued, please pay on invoice.

PLEASE RETURN THIS PORTION TO ENSURE YOUR ACCOUNT IS CREDITED WITH THIS PAYMENT

DESTINATION ROTORUA
ROTORUA DISTRICT COUNCIL

Rotorua District Council
Private Bag 3029
Rotorua Mail Centre
Rotorua 3046

FOR DIRECT CREDIT
PLEASE PAY TO:
BNZ ROTORUA
s 9(2)(b)(ii)
PLEASE QUOTE INVOICE NUMBER AS REFERENCE

CUSTOMER NUMBER AR

AR 312062

INVOICE NUMBER	287010
DATE DUE	31 Oct 2013
TOTAL	$149,040.00
AMOUNT ENCLOSED	

MINISTRY FOR THE ENVIRONMENT
PO BOX 24441
MANNERS STREET
WELLINGTON 6142

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DESTINATION ROTORUA
ROTORUA DISTRICT COUNCIL

Rotorua District Council
1061 Haupapa Street
Private Bag 3029, Rotorua Mail Centre
Rotorua 3046
Phone: 07 348 4199
Fax: 07 346 3143
Email: mail@rdc.govt.nz

TAX INVOICE

SCION RESEARCH
PRIVATE BAG 3020
ROTORUA MAIL CENTRE
ROTORUA 3046

PLEASE QUOTE YOUR CUSTOMER NUMBER

INVOICE No.	286528
DATE	30 Sep 2013
CUSTOMER No.	AR 162888

G.S.T. REG. No. 10-801-397

DESCRIPTION	AMOUNT
TERAX RESEARCH CONTRIBUTION TO MILESTONE 3	
Attn: s 9(2)(a)	50,000.00

Please pay on invoice. No statement will be issued.

Rotorua District Council reserves the right to pass any unpaid accounts to its Collection Agency and any costs or expenses as a result shall become the responsibility of the client (as abovementioned)

ALL ENQUIRIES RELATING TO THIS INVOICE SHOULD BE REFERRED TO:-
s 9(2)(a)

SUB TOTAL	$50,000.00
G.S.T.	$7,500.00
TOTAL $	$57,500.00

~~No statement is issued, please pay on invoice.~~

PLEASE RETURN THIS PORTION TO ENSURE YOUR ACCOUNT IS CREDITED WITH THIS PAYMENT

DESTINATION ROTORUA
ROTORUA DISTRICT COUNCIL

Rotorua District Council
Private Bag 3029
Rotorua Mail Centre
Rotorua 3046

SCION RESEARCH
PRIVATE BAG 3020
ROTORUA MAIL CENTRE
ROTORUA 3046

FOR DIRECT CREDIT PLEASE PAY TO:
s 9(2)(b)(ii)
PLEASE QUOTE INVOICE NUMBER AS REFERENCE

CUSTOMER NUMBER AR
AR 162888

INVOICE NUMBER	286528
DATE DUE	21 Oct 2013
TOTAL	$57,500.00
AMOUNT ENCLOSED	

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Ministry for the Environment
Manatū Mō Te Taiao

Community Environment Fund
&
Waste Minimisation Fund

Milestone Report

Organisation: Rotorua District Council

Project name: TERAX™ waste deconstruction technology

Deed number: 20351

Year: 1

Milestone: 4

Milestone due date: 20th December 2013

New Zealand Government

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Official Information

Important: Information presented to the Minister for the Environment or the Ministry for the Environment is subject to disclosure under the Official Information Act 1982 (OIA). Certain information may be withheld in accordance with the grounds for withholding information under the OIA. Further information on the OIA is available at www.ombudsmen.parliament.nz.

Information held by the Minister and Ministry may have to be released under the OIA in response to a request from a member of the public (or any other body) for that information. If you wish to provide sensitive information to the Minister or Ministry which you do not want released, it is recommended you consult with the Ministry as to whether the information is necessary for the application, and whether there may be grounds in the OIA for withholding the information. For instance, if release of the information would disclose a trade secret, or be likely to unreasonably prejudice the commercial position of the person who supplied or who is the subject of the information, then there may be grounds to withhold the information. The Ministry will endeavour to contact you to discuss an OIA request relating to your application if one is received, and what the implications of releasing your information are.

The grounds for withholding must always be balanced against consideration of public interest that may justify release. Although the Ministry does not give any guarantees as to whether information can be withheld under the OIA, it may be helpful to discuss OIA issues with the Ministry in advance, if information provided with an application is sensitive.

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Introduction

This milestone report provides the Ministry for the Environment with information about how the delivery phase of your project is going. It must be completed and submitted for each milestone by the dates agreed in your funding deed, unless otherwise discussed with your Fund Analyst.

> Ensure you have read the 'Milestone reporting and payments' section of the *Guide for grantees* before you complete this report.
>
> It is preferable to complete this report electronically, and submit it by email.
>
> You must discuss any problems, issues, or major changes to your project with your Fund Analyst before completing and submitting this report.

When your report is complete

Milestone reports should be submitted by the dates agreed in your funding deed, unless otherwise discussed with your Fund Analyst.

Email the following documents to your Fund Analyst:

- completed milestone report
- completed claim form
- completed invoice breakdown spread sheet
- supplier invoices for any item over $50,000, and any capital costs of $10,000 value or more.

Alternatively, you can post these to: Community Environment Fund or Waste Minimisation Fund, Ministry for the Environment PO Box 10362, Wellington 6143.

What happens next?

Your Fund Analyst will assess the report to ensure that you have met the requirements for funding as specified in your funding deed. During your Fund Analyst's review of the report and supporting documentation, further information (including evidence confirming actual expenditure) may be requested. Allow at least seven working days for the assessment to take place. A report for a final milestone may take longer to assess, and may also be dependent on the results of an independent audit.

Once the Ministry for the Environment is satisfied that your milestone claim meets the funding requirements, your Fund Analyst will arrange payment with the Ministry's finance department.

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Section 1: Evaluation of this milestone

Complete the tables below to show how your project is tracking against this milestone in your project plan. Submit the following with this milestone report:

- *completed milestone claim form*
- *completed summary of expenses form*
- *final project report template (if this is the final milestone)*
- *evidence of the deliverables.*

Press the Tab key on your keyboard to add more rows to the tables, if required.

(1A) Activity *List the activities for this milestone as specified in your project plan*	**Summary of progress** *Provide a summary of the progress made for each activity associated with this milestone*
Pre-treatment technology trials at laboratory and pilot scale where appropriate	• During this quarter, a solids pre-treatment grinder was sourced and leased from a supplier. This was adapted to enable better control and to improve operability and safety. A wide range of materials commonly found in MSW was processed through the equipment. The equipment trialled could successfully process all the feeds that were tested, including vegetable matter, textiles, plastics, meat and bone, glass, stainless steel forks and mixed household garbage. The addition of water was required to move some material through. The ability of the material to pump after grinding was also assessed. The equipment trialled would be successful at handling contaminants which may be present in source-segregated food waste. More detail is provided in the Quarterly Technical Progress Statement (QTPS).
Laboratory-scale trials on mixed MSW with selected contaminants	• Laboratory fermentations were undertaken using food waste as a substrate. Both mesophilic (36^{O}C) and thermophilic (55^{O}C) temperatures were studied in duplicate using batch reactors over a period of 30-40days. This demonstrated the potential to produce organic acids, ethanol and hydrogen as valued products from food waste. The potential process contaminants (e.g. plastics) assessed during the screening study were further analysed this quarter using Nuclear Magnetic Resonance (NMR). This analytical technique allowed detailed identification of reaction products from the wet oxidation process. The work demonstrated that NMR will be useful for improving our understanding of the fate of contaminants and any potentially hazardous breakdown products as they are processed under high temperature and pressure in wet oxidation. More detail is provided in the QTPS.
Pilot scale trials on selected MSW blends	• A pilot plant, 1m^3 scale, anaerobic fermentation was carried out during this quarter. At this scale the reaction products (organic acids, ethanol, hydrogen) were similar to what was observed at the laboratory scale. This provides confidence that the fermentation process is scalable and the results from the laboratory are thus a good indicator of performance at larger scale. High VFA production

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	was observed in days 1-3, with gas yields rising by day 12. More detail is provided in the QTPS.
Refine process economic model to integrate trial results and initiate the development of a full-scale design.	• During this quarter the techno-economic model was developed further to incorporate ammonia stripping. This model is now well aligned with the process configuration proposed for the Rotorua waste water treatment works. The model was updated with the latest results from the laboratory fermentation. Scenarios were run which showed some sensitivity of the costs to high pre-processing requirements. Reduction in operating costs also has a beneficial impact on the economic viability of the process when treating food waste. More detail is provided in the QTPS.
Evaluating, selecting, and contracting a suitable engineering design firm	• An engineering firm was engaged by RDC to undertake design and construction of the demonstration plant in accordance with RDC's procurement strategy. The methodology used was Brooks Law which is used for specialised work when the best possible consultant is required to be appointed. Evaluation is all on non-priced attributes and price is able to be negotiated. Worley Parsons an engineering consultancy experienced in high pressure and temperature process engineering and with capacity within the firm to access specialist advice on all aspects of the process was engaged.
Design review of concept design	• The concept design was reviewed initially as part of the WorleyParsons project 120027. The findings of this project are set out in the WorleyParsons report 120027-RPT-X0001. • Subsequently during Preliminary Engineering (WorleyParsons project 120037) another Design Review was unde taken to review the main process up to and excluding the Precipitator (as the detail of this item is not yet defined). The utilities and services were not included in the Design Review as the maturity of those was not sufficiently developed to be reviewed in this phase. • It is expected that a further design review will be undertaken during Detailed Engineering on the plant areas that were not included in the first design review.
Detailed design elements and specifications for process, mechanical, electrical, and civil engineering requirements	• The design has been developed to a point where the heat and mass balances have been finalised, P&IDs and functional descriptions have been developed, key process risks mitigated where possible, and detailed specifications for the Long Lead Items finalised and ready for tendering. • The attached file (appendix 21 of WorleyParsons Milestone 4 Engineering Report; 120037-RPT-X0047) sets out all the deliverables for the Project completed during Preliminary Engineering.
Detailed equipment and construction schedules	The following document set out the schedules required for procurement and construction of the Project (WorleyParsons document number is included for cross reference). • Equipment list (120037-EQL-M0001)

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	• Valve list(120037-LST-M0001) • Instrument List(120037-LST-I0001) • Pipe Line List (120037-LNL-M0001) • Pipe specifications (120037-DSH-M0001, -M0002, -M0003, -M0004, -M0006, and -M0010) • Electrical Load List (included in 120037-EQL-M0001) These documents were developed as part of the Preliminary Engineering phase of the Project and will require review and approval during detailed design and prior to procurement. The major equipment for the project are included as Long Lead Items (LLIs). These have been fully specified and are currently been tendered. Each LLI has a detailed specification that sets out the functional and performance requirements of the plant. The LLIs (along with their relevant specification documents) are: • Macerator ("Trade Package 001") • Drum Thickener ("Trade Package 002") • Fermenter ("Trade Package 003") • Solids Recovery Plant ("Trade Package 004") • Wet Oxidation Feedpump (120037-DSH-M0007) • Wet Oxidation Pre heat Exchanger (120037-DSH-M0009) • Wet Oxidation Vessel (120037-DSH-M0008) • Wet Oxidation Agitators (120037-DSH-M0005) • Level Control Valve (120037-DSH-P0003) • Wet Oxidation Heat Recovery Exchangers (120037-DSH-M0011&-M0012) • Ammonia Removal Package (120037-SPC-P0001) • Oxygen Supply Plant (120037-SPC-P0002)
Control system philosophy and design	Summarised below is the control system philosophy and design requirements as set out in section 5.4 of the Basis of Design for the Project (WorleyParsons document 120037-BOD-X0014) "The plant is intended to be continuously operated 24 hours per day, 7 days per week, 365 days per year. The operating philosophy for the plant shall be as for the WWTP, that is: a) The plant will be controlled and monitored from the existing WWTP control facility which

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has the following “normal attendance”:

i) Day shift: 0800 hrs to 1630 hrs; Mondays to Fridays (excluding public holidays)

ii) Weekend shift: 0700 hrs to 1000 hrs during weekend days and statutory holidays,

b) All local equipment monitoring and manual testing will be carried out during the normal attendance listed above

c) The plant will operate automatically at all times outside of the normal attendance listed above with major alarms and shutdowns using the existing communications systems to alert the operators on call.

d) In general the hydrothermal reactor will be automatically shut down on any faults or operating conditions outside safe parameters (the acceptable safety parameters will be confirmed at the start of Phase 5).

e) In general the hydrothermal reactor will automatically go to a “on hold” state, be shut down on any faults or operating conditions outside normal operating parameters. (the acceptable operating parameters will be confirmed in Phase 5). This is to avoid a full system shut down should a minor problem be encountered.

f) Unless stated otherwise all effluent pipe lines and equipment will be provided with CIP functionality. This may consist of flush and drain points for portable hoses, fixed flush and drain systems or a combination of both.

g) Maintain the ability to keep the reactor operating when the fermenter is offline, and, maintain the ability to keep the fermenter operating when the reactor is offline.”

It is the objective to have no operator intervention during normal operation due to the high temperatures and pressures within the Plant. To achieve this there will be increased automation, monitoring and control of the process. Operator intervention will only be required during normal maintenance or abnormal operation; device or equipment failure.

Liaison with the preferred site control system integrator, Horizon Technology Ltd, confirms that there is spare capacity within the existing control system for the new Plant PLC and associated signals.

The control of the Plant will be through a series of dedicated SCADA screens from within the main plant control room. A second SCADA terminal will be provided in the TERAX™ MCC Room for local access when

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	required. No allowance has been made for local control of the plant. It is the intention to enable Scion, and other third parties as required, to view the TERAX™ process plant parameters and download historical data for analysis via remote access. The remote access will be view only with no ability to change parameters, reset alarms or control the process in any way. The control system architecture to integrate the Plant and the remote access has been reviewed and agreed with both Horizon Technology Ltd and the RDC IT Senior Network Engineer (as set out in the Control System Architecture drawing RDC-DWG-0002).
Hazard & Operability studies (HAZOP). (Legislative requirement for operation of high temperature and pressure plant.)	• A HAZOP workshop was undertaken for Preliminary Engineering. The scope of the HAZOP was to review the main process up to and excluding the Precipitator. With Long Lead Items having to be specified at the end of Phase 4, the focus was to cover the nodes that related to those LLI's to aid with the development of the specifications. • The main process downstream of the precipitator includes vendor designed packages which are not established in sufficient detail to be included in the HAZOP. These will be reviewed with the vendor at a later date. • The utilities and services (including oxygen recovery) were not included in the HAZOP as the maturity of those was not sufficiently developed to be reviewed during Preliminary Engineering. These will be reviewed at a later date as part of a detailed design HAZOP. • The HAZOP was held in Wellington with key stakeholders from WorleyParsons, AWT, Scion and RDC attending and contributing to the workshop. The workshop was held over two days with minutes and actions from the workshop are documented on the WorleyParsons document 120037-HAZ-P0001. • A total of 252 actions were taken from the HAZOP of which 66 were high priority (meaning they impacted the specifications of the LLIs, or, were deemed critical for the safety of the plant/project). At the end of Preliminary Engineering, a total of 14 high priority actions remain open; these are expected to be resolved early in the next phase of the Project.
Construction & procurement strategy	• A detailed procurement strategy (covering the procurement of all plant, materials and construction works) has been finalized and approved by the Rotorua District Council. This is

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<table>
<tr><td></td><td>documented in the WorleyParsons document 120037-RPT-X0046 and is consistent with the requirements of local government procurement.
• In general all suppliers and contractors will subject to a pre-qualification process that assesses financial, quality and HSE performance.
• Prequalified suppliers and contractors are then invited to tender for given supply packages (equipment and materials) or contract works packages. Tenders are then evaluated using a weighted attribute process that assesses tender price, after sales support, technical capability, and, experience/track record.</td></tr>
<tr><td>Detailed capital cost estimation</td><td>The latest capital cost estimate is set out in the WorleyParsons report 120037-RPT-X0048. This estimate was developed at the end of the Preliminary Engineering phase of the project and allows for the maturity of the design at this point.

The following sets out a breakdown of this estimate:

<table>
<tr><td>Equipment Supply</td><td>$4,629,688</td></tr>
<tr><td>Bulk Materials</td><td>$1,320,450</td></tr>
<tr><td>Contract Works</td><td>$2,636,439</td></tr>
<tr><td>Civil Works Contract</td><td>$891,371</td></tr>
<tr><td>Main Works Contract</td><td>$1,532,628</td></tr>
<tr><td>Electrical Works Contract</td><td>$91,747</td></tr>
<tr><td>Systems Integration Contract</td><td>$120,694</td></tr>
<tr><td>Total Indirect Costs</td><td>$3,226,095</td></tr>
<tr><td>TW Costs</td><td>$3,000,695</td></tr>
<tr><td>Other Indirect Costs (P&G, geotech, civil and struct design)</td><td>$225,400</td></tr>
<tr><td>Other Costs</td><td>$128,148</td></tr>
<tr><td>Contingency</td><td>$894,643</td></tr>
<tr><td>TOTAL</td><td>$ 12,835,464</td></tr>
</table>

The estimate has a declared accuracy of +15% / -10%.</td></tr>
<tr><td>Securing consents (if any)</td><td>• In respect of consenting requirements for the Project, WorleyParsons is only responsible for providing any relevant technical information to RDC. RDC will complete/manage all necessary consenting and permitting.
• RDC to complete further details as appropriate.</td></tr>
</table>

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Confirm air discharge consenting requirements	• In respect of consenting requirements for the Project, WorleyParsons is only responsible for providing any relevant technical information to RDC. RDC will complete/manage all necessary consenting and permitting. • Air discharges from the Plant have been defined from pilot plant and laboratory data, published reference data, and, process modeling outputs. These physical characteristics (temperature, pressure, flow rate, composition) of these discharges are set out in the WorleyParsons calculations 120037-CAL-P020 (for the Fermenter offgas) and 120037-CAL-P039 (for the wet oxidation and nitrogen recovery offgas) • Consequence modelling was then undertaken undertaken by specialist engineers from WorleyParsons Australia. The intent of this exercise was to understand the potential impact of the atmospheric off-gas vents proposed for the Fermenter Vessel, Wet-Oxidation System, and Ammonia removal System on the Plant • The modeling is detailed in the WorleyParsons document 120037-MMO-C0002. The key finding from this exercise is that there is no flammability risk associated with the off-gas and, regardless of the ambient conditions the toxic components of the vapour plumes from all three vents remain buoyant. As such the primary mitigation for any toxicity hazard is to ensure the release height exceeds the elevation of any occupied areas on the WWTP site, and on the surrounding public land. • The scope of the assessment has been limited to consideration of the potential health and safety impact of the off-gas streams, for both onsite personnel and members of the public in surrounding areas. Any potential environmental impact and/or resource consenting issues are excluded from the current scope.
Development of process model	The process engineering for the Plant commenced with the development of two process engineering models; these are: • Biowin process model; this is a biological model of the WWTP and TERAX™ and, informs the effect (benefit) that the Plant has on the performance of the waste water treatment plant. This model has been peer reviewed by Envirosim (the developers of the Biowin software). • Aspen process model; this is thermodynamic model of the wet oxidation plant and product recovery packages (solids recovery and ammonia removal). The input parameters to this model have largely

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	been defined by experimental and pilot plant test results undertaken by Scion. These inputs and assumptions are set out in WorleyParsons process calculation 120037-CAL-P002. The key outcome of the above models is an agreed process flow diagram (PFD) which includes a heat and mass balance for the Plant.

(1B) Deliverable *List the deliverables for this milestone as specified in your project plan*	**Status** *Complete or incomplete?*	**Reason** *If not complete please let us know why*
• Quarterly PGG update report in dashboard format.	Yes	
• Quarterly communication report	Yes	
• Year 1 project report describing outcomes of the research activities and recommendations for moving forwards.	Yes	
• Year 2 Project Plan	Yes	
• End of year meeting with MfE to discuss Year 1 progress and plan Year 2 work plan	Yes	Scheduled 20th February 2014
• Milestone report • Milestone claim form • Documentation to support actual expenditure (i.e. receipts/invoice) • Tax invoice for claimed amount	Yes	

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Section 2: Evaluation of Project Objectives

Delivery of each milestone will help you progress towards achieving your project's overall objectives. Complete the table below to show how your project is tracking against its objectives.

Your Project Objectives *List the project objectives from your project plan.*	**Key performance indicators (KPIs)** *List the KPIs from your project plan.*	**Actual Measure** *Describe the current situation. This will show if you are on target to meet the project's objectives.* *If your project is not at the stage of measuring and reporting on this information, please provide a short statement to explain why.*
Construct full scale TERAX™ plant at Rotorua Wastewater Treatment Plant	Plant constructed in 2014	Detailed design for full scale TERAX™ biosolids plant is currently underway and on schedule.
By 2014, reduce Rotorua sewage sludge offsite disposal (land or landfill) by >90%	8,500 Tonnes/year of sewage sludge processed	This will be achieved through the construction of the full scale TERAX™ biosolids plant which is on schedule for delivery.
By 2014, extend the hydrothermal technology platform to broader MSW organic waste streams	Production of a report on design parameters for the processing of municipal solid waste at full scale. Will include concept design and cost details to proceed to full-scale plant for Rotorua district wider organic waste stream.	The first four Quarters of this project have established the project framework for delivering the research project to extend the technology platform to MSW waste streams. Laboratory trials continue and pilot plant trials have now been run. All Activities towards this Objective are currently on track.
By 2015, expand the implementation of the TERAX™ process to at least 2 new TLA or industry end-users	Number of new customers engaged	The Terax commercialisation structure is now established through the formation of Terax 2013 Ltd, the 50:50 joint venture between Scion and RDC. This company is currently developing licensee options for the technology and actively engaging with potential end-users.

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Section 3: Additional information

Please provide any additional information that the Ministry should be aware of, please consider:

- *Successes you have had this milestone or particular progress you have made towards your project objectives*
- *Risks that have appeared or challenges faced this milestone and ways you plan to mitigate them*

The Quarterly Technical Progress Statement provides an overview of the project achievements thus far. In addition to this amongst the further successes were:

- The Terax team won the Scion Science Engineering award for the Terax biosolids project.

Some of the challenges faced during this milestone were:

- Considerable effort was applied this quarter to mitigate the inherent risks in dealing with high pressures and temperatures and with pure oxygen environments. Equipment modifications were made to minimise the potential risks, resulting in some downtime and availability of equipment. This focus on safety will continue in the new year and is anticipated to be improved further when the mid-sized reactor is installed and operational.

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Section 4: Procurement

Did you buy any major items or award contracts during this milestone (over $10,000)? If so please list the item or contract and briefly explain the procurement process you went through.

Attach a copy of all contracts, requests for proposals (RFPs), etc with this milestone report as supporting documentation.

*Press the **Tab** key on your keyboard to add more rows to the tables, if required.*

Supplier name	Description of good/work or service, and the procurement process you followed	Value	Date awarded
Hickey Contractors	Removal of existing old digestor tank to reuse base for new Terax digestor	$60,000.00 (which was $30,000 below budget)	December 2013

Section 5: Other sources of funding

Provide information about other external funding for this project (other than that from the WMF/CEF). Include all cash contributions and other funding listed in your project plan.

The amount paid towards this milestone (the amounts in the far-right column) must also be provided in your milestone claim form.

If you have more than three partners or external funding sources press the Tab key on your keyboard to add more rows to the tables.

Funder name	Total amount requested	Total amount approved	Amount received to-date	Amount paid towards this milestone
Scion	$50,000.00	$50,000.00	$50,000.00	$50,000.00
	$0.00	$0.00	$0.00	$0.00
	$0.00	$0.00	$0.00	$0.00

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Section 6A: In-kind contributions (only CEF projects to complete this section)

Provide information about the in-kind contributions that your project has received during this milestone, including what this is worth in dollars, excluding GST. Note that in-kind contributions are separate from the cash costs of the project.

	Description	**Total estimated in-kind contribution** *excluding GST*
Professional services and goods *calculate professional services using the actual hourly rate*		$0.00
Use/donation of equipment, etc		$0.00
Facilities provided		$0.00
Community volunteers/staff time *calculate at a rate of $30 per hour*		$0.00
	Total in-kind contribution	$0.00

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Section 6B: Waste minimised
(only WMF projects to complete this section)

Complete the table below. Provide the actual (net) values your project has reduced, reused, recycled and/or recovered during this milestone.

Tonnage data should be recorded once in the most appropriate category for the material being processed (i.e. material should not be reported in more than one of the reduce/reuse/recycle/recovered categories.

All figures should be reported in tonnes. Conversion factors are available in the Grantee Guide, if required.

		Definition
Reduced quantity	0 tonnes	To lessen the generation of waste, including by using products more efficiently, or by redesigning products. In relation to a product, this includes lessening the generation of waste.
Reused quantity	0 tonnes	To use waste or diverted material (in its existing form) further, for the original purpose of the materials or products that constitute the waste or diverted material, or for a similar purpose.
Recycled quantity	0 tonnes	To reprocess waste or diverted material to produce new materials.
Recovered quantity	0 tonnes	To extract materials or energy from waste or diverted material, for further use or processing.
Total quantity (this milestone)	0 tonnes	*This should be the total tonnage of material recycled/recovered/reused to date for this milestone only.*
Total quantity (project to date)	0 tonnes	*This should be the total tonnage of material recycled/recovered/reused to date for all milestones.*

If your project is not at a stage to report on this information (or if the actual tonnages fall short of the targets), explain why:

At quarter 2, milestone 2 of a 3 year project, this project is still very much in its infancy. Data of this nature will not be able to be reported on until construction and commissioning of the Demonstration Plant is complete.

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Declaration

As a duly authorised representative of the organisation:

- I declare that to the best of my knowledge, the information contained in all sections of this milestone report, or supplied by us in support of our milestone report, is complete, true and correct.
- I declare that I have the authority to sign this milestone report and to provide this information.
- I understand that information presented to the Minister for the Environment and Ministry for the Environment is subject to disclosure under the Official Information Act 1982.
- I declare that the fund payment request (milestone claim form) accompanying this milestone report is complete, true and correct.

s 9(2)(a)		
electronically signing this milestone report.		**Date:** 20th December 2013

Verification

As a duly authorised representative of the organisation I verify that the fund payment request (milestone claim form) and this milestone report is complete, true and correct, and that:

- costs making up the amount of this request are part of the eligible project costs
- we have paid, or will pay, all invoices with this payment request in full
- no money has been returned to us by way of donation(s) or credit note(s).

s 9(2)(a)		
by typing your name in the space provided you are electronically signing this milestone report.		**Date:** 20th December 2013

The declaration and verification must be signed by different people in your organisation.

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Checklist

Use the following checklist to confirm you have provided all the required information for your milestone claim.

☒ All sections of this milestone report completed

☒ Declaration and verification signed and dated by different people

☒ Milestone claim form completed and attached for this milestone

☒ Pre-printed deposit slip attached (first milestone report only)

☒ Final project report completed (final milestone only)

☒ Evidence of milestone deliverables attached, for example:

- photographs of progress
- monitoring and evaluation data
- record log of activities
- media coverage or other publicity
- invoices
- evidence of staff recruitment
- receipts.

☒ Tax invoice from your organisation attached (the amount on the tax invoice must be the same as the payment due amount in the milestone claim form).

The tax invoice must show the following information:

- your organisation's GST number
- the words 'tax invoice'
- invoice number
- funding deed number
- total claim amount
- GST component.

☒ Completed summary of expenses form

☒ Attached supplier invoices supporting the cash expenditure in this milestone of all capital assets over $10,000 (WMF only) and any item procured over $50,000. Each must show the following information:

- invoice number
- invoice date
- supplier name
- description
- total amount (excluding GST).

Note: Supplier invoices must be presented in the standard format that you/your company use to record this type of information.

☒ Copy of supplier contracts and RFPs, if applicable.

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