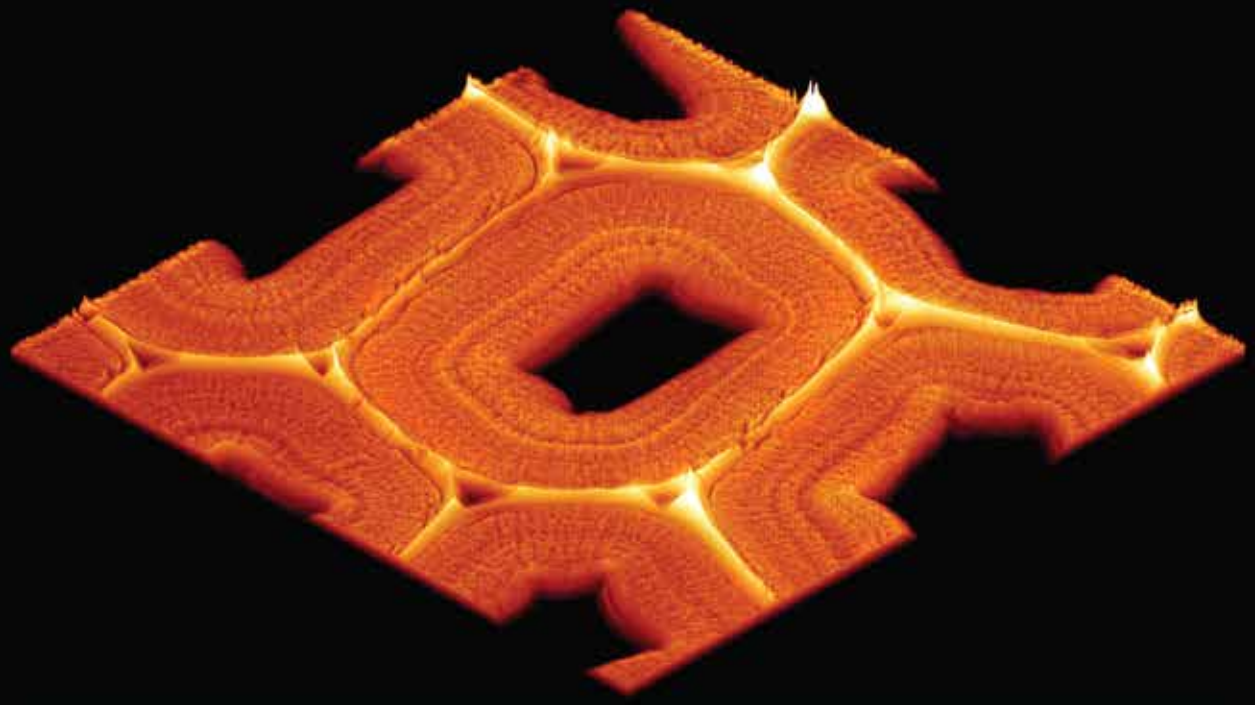
Statement of Corporate Intent 2022-2025

Prosperity from trees – Mai i te ngahere oranga



Wood cell wall (magnified 4500x). Photo by Dr Lloyd Donaldson.

SCION™
FORESTS ▪ PRODUCTS ▪ INNOVATION

Statement of Corporate Intent 2022-2025

Prosperity from trees – Mai i te ngahere oranga

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Our profile

New Zealand Forest Research Institute Limited	New Zealand Forest Research Institute Limited – trading as Scion
Ownership	Crown owned entity (established under the Crown Research Institutes Act 1992)
Head office	Te Papa Tipu Innovation Park, Tītokorangi Drive, Rotorua
Postal address	Private Bag 3020, Rotorua 3046
Web address	www.scionresearch.com
Governance	Shareholder-appointed Board: Dr Helen Anderson QSO (2018) (Chair); Brendon Green (2022), Greg Mann (2017), Stana Pezic (2017), Dr Jon Ryder (2016), Steve Wilson (2016); Future Director Dr Melinda Webber (2022)
Executive Management	Dr Julian Elder (Chief Executive), Dr Florian Graichen (GM Forests to Biobased Products), Cameron Lucich (GM People, Culture and Safety), Hēmi Rolleston (GM Te Ao Māori and Science Services), Dr Tara Strand (GM Forests and Landscapes), Justine Wilmoth (GM Finance and Corporate Services), vacant (GM Forests to Timber Products)
Staff	332 full-time-equivalent staff at three sites: Rotorua (293), Christchurch (37), Wellington (2), as at 30 May 2022
Vision	Prosperity from trees – Mai i te ngahere oranga
Core purpose	To drive innovation and growth from New Zealand's forestry, wood product and wood-derived materials and other biomaterial sectors, to create economic value and contribute to beneficial environmental and social outcomes for New Zealand
Values	Ingenuity, Collaboration, Excellence, Manaakitanga
Reporting	Financial and non-financial performance against SCI targets is reported to the Shareholder quarterly and to the public via a six-month and annual report
Shareholder funds	Total book value of $53.047 million at 30 June 2021

Shareholdings

Company	Company type	Scion shareholding %
Te Papa Tipu Properties Limited	A land holding subsidiary	100.00
Biopolymer Network Limited	An incorporated joint venture	14.56
Kiwi Innovation Network Limited	A limited company funded by MBIE and owned collectively by the CRIs, some universities and other public research organisations	6.67
WQI Limited (in liquidation) (T/A Solid Wood Innovation)	An MBIE-industry partnership in wood processing. WQI Limited is in voluntary liquidation and is not trading	5.05
Terax Limited Partnership (in liquidation)	A limited partnership to commercialise the Terax technology	50.00
Terax (2013) Limited (in liquidation)	The General Partner in Terax Limited Partnership	50.00
Sala Street Holdings Limited	Holds Scion's 50% share in both Terax (2013) Limited and Terax Limited Partnership	100.00

Contents

Chair and Chief Executive overview

The climate crisis is here. The latest Intergovernmental Panel on Climate Change (IPCC) report, which assesses global climate science, starkly warns that action is needed immediately to avoid catastrophic outcomes.

It is time to unleash the power of forestry as a vital means of tackling climate change in Aotearoa New Zealand. Forestry will play its part in two ways: removing CO_2 from the atmosphere and reducing greenhouse gas emissions by substituting products, fuels and energy made from fossil-fuels with wood- and fibre-based solutions.

The IPCC report shows us that now is the hour for all countries to truly embrace the United Nations Sustainable Development Goals to meet their emission reduction targets. New Zealand, like other forest-rich economies, can do this by putting forests at the heart of a low-carbon, biological-based future way of living.

Scion's Strategy to 2030 is clear and concise: Right tree, right place, right purpose. Having this formula drive our work is enabling Scion to make a difference to our economy, wellbeing and environment by helping transition New Zealand to a circular bioeconomy.

Achieving our research goals will deliver national benefits for New Zealand that align with many of the Government's priorities. We hold critical research capabilities in indigenous forestry, bioenergy and new environmentally friendly biomaterials that are vital to sustainable development. How well we can employ and expand these capabilities is the multi-million-dollar question we face.

We have raised the constraints of our current funding many times, and we have engaged in work with the Ministry for Business, Innovation and Employment (MBIE) on securing a long-term funding solution.

As pointed out in the science review, the work proposed in our strategy spans many government agencies, and a solution will require input from a variety of them to explore the options that we have put forward. MBIE has agreed to expand the Long-Term Funding Solution Working Group to bring the right parties into developing solutions that will allow Scion to drive its strategies and contribute to the Government's objectives. Without long-term funding Scion will continue to be inhibited in how we deliver on our core purpose and our strategy.

We present our position simply as:

- With current funding we are making ends meet, but we are delivering limited impact and hampered by the need to chase contestable grants to retain our core capability.
- With a long-term funding solution, we can focus on maintaining and enhancing critical capability and make good progress with circular bioeconomy related R&D.
- With an additional capital injection from our owner (the Crown), we can replace our aged infrastructure and become transformative with circular bioeconomy focussed R&D.

In this Statement of Corporate Intent, we present our financial

scenario for out-years that allows us to pursue mission-led science to find the solutions New Zealand needs to respond to climate change and build a sustainable, prosperous and healthy future for all.

Pursuit of Scion's strategy and success in achieving goals means sound backing is needed by way of investment in the science and innovation system that will address the challenges and crises New Zealand can no longer ignore.

We are aware that the Government has been signalling funding in areas such as the climate emergency response, the emissions reduction plan, the initiatives around sustainable aviation fuels, the increase in the waste levy and the Plastics Innovation Fund to tackle the challenges and opportunities in front of New Zealand. We look forward to seeing how our research capability can be supported through those initiatives.

We are also part of a group that continues to promote the case for the missing scale up infrastructure ("the Biopilot") that New Zealand needs to see research get through to adoption and the development of new solutions and new industries.

Scion and the other six Crown research institutes deliver nationally important and relevant science for the sectors we serve. We all need adequate stable funding to future proof our core research capability and capacity to ensure we can deliver long-term impact.

To that end, we welcomed the chance to have a say on the future of New Zealand's research, science and innovation system through the *Te Ara Paerangi – Future Pathways Green Paper consultation* process. We look forward to further participation in the review.

We are excited by the research we are currently undertaking and the research programmes we are embarking on. Our partners are key to our success and we will continue to work hard to ensure existing partnerships are nourished and new ones welcomed and nurtured. With our new Māori Research and Partnerships Team we can now lead and support co-innovation partnerships with Māori, and we are already seeing great outcomes from this approach. Together, with the backing of all our stakeholders, we can confidently follow our mission "Enhancing New Zealand's prosperity, wellbeing and environment through trees – Kia piki te ora, te taiao me te whai rawa o Aotearoa mā te ngāherehere.

Dr Helen Anderson QSO
Chair

Dr Julian Elder
Chief Executive

Our role and purpose

Scion is one of seven Crown Research Institutes that carry out scientific research for the benefit of New Zealand.

Our core purpose

To drive innovation and growth from New Zealand's forestry, wood product and wood-derived materials and other biomaterial sectors, to create economic value and contribute to beneficial environmental and social outcomes for New Zealand.

Our vision

Prosperity from trees - Mai i te ngahere oranga

Our mission

Enhancing New Zealand's prosperity, wellbeing and environment through trees - Kia piki te ora, te taiao me te whai rawa o Aotearoa mā te ngāherehere.

Our context

Trees are arguably New Zealand's greatest renewable and sustainable resource.

New Zealand has 10.1 million hectares of forests covering 38% of the land. This tree-clad area comprises 8 million hectares of indigenous forest and 2.1 million hectares of plantation forestry (mostly *Pinus radiata*).

The value of all forestry exports is around $6 billion a year, providing 1.6% of our GDP. Around 35,000 people are employed in the forestry industry, including wood production, processing and commercialisation.

Forests are a renewable resource with the scale needed to sequester significant amounts of carbon, provide New Zealand with low-emissions materials and fuels to help meet our climate change commitments, grow and transform the economy and improve environmental and social outcomes. They provide a range of ecosystem services, from supporting biodiversity and water quality, to helping support New Zealanders' wellbeing through landscape amenity and recreation, including in our urban treescapes.

Our forests are an essential part of New Zealand's future as we shift to a low-carbon, circular bioeconomy. Scion has a pivotal role in helping make the transition happen.

Climate change response must be the priority

New Zealand's climate change targets are to be carbon zero by 2050. To meet these targets New Zealand must move to low, zero and carbon-neutral emissions technologies.

Traditionally forests have been used as a temporary sink for carbon emissions, but they are also part of the permanent solution as a replacement for fossil fuel-based or high-emissions technologies.

We can respond to the climate crisis, as acutely described

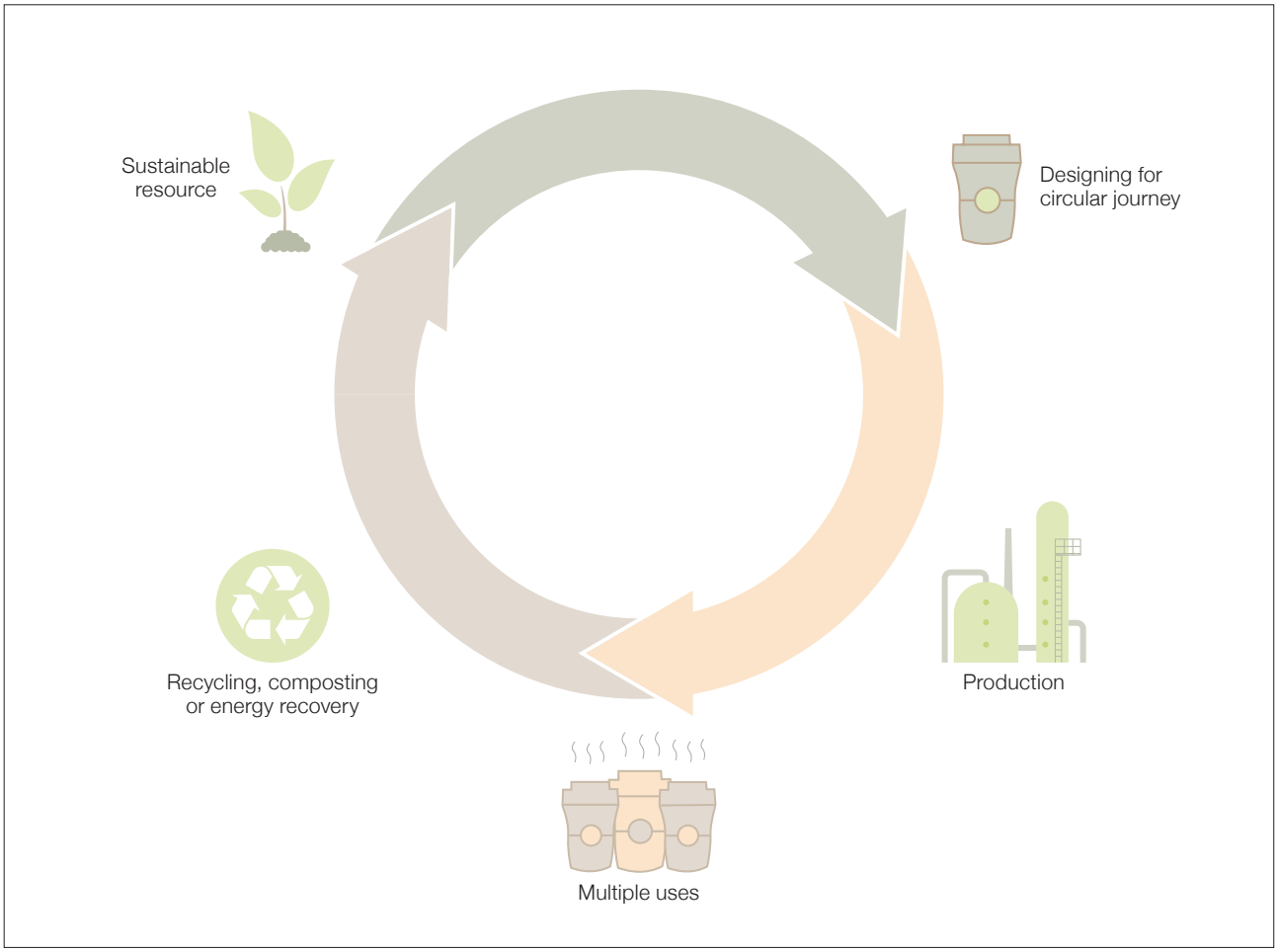

Figure 1: *A circular bioeconomy – prosperity in harmony with nature.*

in the latest Intergovernmental Panel on Climate Change report, by using forests to meet our emission reduction targets as other forest-rich economies are doing.

New Zealand is blessed with its forests – both our long-standing indigenous forests and those that are planted to be harvested. Our forests collectively are a massive renewable resource with the scale needed to provide New Zealand with low-emissions materials and fuels to help meet our climate change commitments, grow and transform the economy and improve environmental and social outcomes.

Climate change is the challenge of our generation but let us not miss the opportunity of our generation to transition to a circular bioeconomy.

Circular bioeconomy provides the positive way forward

"Anything made from fossil-based materials today can be made from a tree tomorrow."

Stora Enso[1]

A circular bioeconomy is centred around people and nature – getting the most value out of renewable biological resources while minimising waste. The essential concept at the heart of the circular bioeconomy is to ensure we can unmake everything we make in a clean non-polluting and regenerative way. For designers and product developers, that creates new opportunities. Instead of take, make, waste we now need to think about how the product will be used and what its whole 'life' will be – waste is a concept not found in nature.

This is not a new or untested approach. The market for materials and products made from renewable resources, particularly forestry, is developing fast. It is the way other large forest-rich economies are going in Europe and North America. Trees are the source of over 5000 products we use every day and more are added daily. New Zealand could become a global hub for a new high-value biomanufacturing sector, addressing both the challenge and opportunity of our generation.

By delivering fully on our core purpose and our Strategy to 2030, Scion will make a difference to New Zealand's wellbeing, economy and environment by helping the transition to a circular bioeconomy. This is an enormous opportunity that could add as much as $30 billion annually to our GDP as we transition away from a linear, fossil-fuel based economy.

New Zealand can and should take advantage of this opportunity to embrace a circular bioeconomy strategy. We have a strong biological-based economy already, an extensive plantation forestry resource, and a high proportion of renewables in our existing energy mix. Scion can help make this transition, replacing materials and energy derived from fossil-fuel with low-carbon renewable alternatives.

But we, New Zealand, must act quickly or risk getting left behind other countries' responses to the opportunity. And, we must act quickly to enable the just and positive future we wish for next generations.

Significance to Māori

Forests and trees are culturally significant to Māori. They are central to the distinct worldview that is Te Ao Māori. Māori are a key resource holder and are intergenerational.

New Zealand's forests also are economically and socially important for Māori. Through forestry, Māori contribute hugely to New Zealand's economy. Since 1997 more than 70 state-owned forests have been returned to iwi in Crown Treaty settlements. Māori ownership of land and forests will increase as settlements conclude and more Māori-owned businesses in the value chain emerge.

We are seeing a significant shift in terms of respecting the value that mātauranga Māori can assist and partner in terms of our research. This is leading to very authentic, world-leading and exciting programmes of work in partnership with Māori. In some cases, Māori are the lead partner.

There is sincere acknowledgement of the importance of having genuine and strategic relationships with mana whenua and we have been on this journey with our hapū partners.

Regional economic development

As a regionally headquartered Crown Research Institute, Scion is uniquely placed both to understand the regional nature of forestry, wood processing, biobased industries and what might be needed to create new and innovative regional development opportunities.

We are co-located with our industries and close to major forests. Scion's campus – Te Papa Tipu – is an innovation park with over 30 different organisations and companies, including Te Uru Rākau – New Zealand Forest Service, Department of Conservation, Timberlands, Oji Fibre Solutions and PF Olsen.

The relationship between Scion and regional New Zealand is particularly pertinent in Rotorua, physically, economically and culturally. As one of the largest employers in Rotorua,

many people rely on Scion staff directly and indirectly for their livelihood. Scion provides a wide variety of jobs including highly skilled science roles and a range of corporate, technical, nursery and field support roles.

Scion has strong links and strengthening partnerships with local iwi, including Ngāti Hurungaterangi, Ngāti Taeotu, Ngāti te Kahu, and our wider iwi of Ngāti Whakaue and Te Arawa.

A bioeconomy pilot network to scale-up new bioeconomy enterprises

The New Zealand bio-innovation system has a key gap that constrains new product development. From promising lab-scale development we hit a roadblock. Lack of pilot facilities to scale-up and test new technology at pre-commercial scale hampers deployment and investment in ideas that will underpin a circular bioeconomy.

Scion is committed to closing this gap. We are working with our key partners in government and industry to demonstrate the feasibility of developing a new bioeconomy pilot network. This would see an expanded network of open-access test bed and pre-commercial scale-up infrastructure, with a hub in Rotorua with the ideas, technology and equipment needed to transform bio-feedstocks into the new compounds and materials needed to pivot to a fossil carbon-free bioeconomy.

Our industry partners tell us there is an urgent need for scale-up infrastructure like this to overcome the development lag in the pathway from the lab to final products. This initiative is currently led by Rotorua Economic Development, with input from Te Uru Rākau, Ministry of Business, Innovation and Employment, Ministry for the Environment and Callaghan Innovation.

Our operating environment

Supporting key government priorities

Scion's Strategy to 2030 will support government priorities in primary sector and regional economic development, climate change, and sustainable, productive, and inclusive economic growth. Our research and innovation can underpin national priorities that will help build a productive and sustainable circular bioeconomy, eliminating waste, building and empowering mātauranga Māori, and boosting regional economic growth.

Our work can help deliver government economic development policy around industry transformation, centred on six industry transformation plans (ITP). We are actively contributing to this work on two plans relevant to Scion: the Forestry and Wood Processing ITP and the Advanced Manufacturing ITP.

Scion is working closely alongside Te Uru Rākau – New Zealand Forest Service on the Forestry and Wood Processing ITP to gain wide stakeholder perspectives on the ITP and ensure our relevant portfolios are aligned with those perspectives and our knowledge and expertise are applied to its development. Similarly, we are continuing to engage with the Ministry for Business, Innovation and Employment on the Advanced Manufacturing ITP.

We are also working with other government departments as they continue to develop policies that can be supported by Scion's existing capability and expertise, and by outcomes generated from our work to deliver our Strategy to 2030. We are in active discussions with the Ministry for Business, Innovation and Employment, the Ministry for Primary Industries (particularly Te Uru Rākau) and the Ministry for the Environment, among others.

A future-fit science and innovation system

Change to New Zealand's research, science and innovation (RS&I) system is necessary and overdue. The *Te Ara Paerangi – Future Pathways* process is an opportunity to build an RS&I system that works better and helps create a better future for everyone in New Zealand.

Scion will continue to participate fully in the consultation process to advance that opportunity. It is an opportunity to better deliver on Te Tiriti partnership, protecting and promoting Māori aspirations. But truly transforming the RS&I system can only be done when the system is supported with a significant increase in investment from government and the private sector, aligned to deliver the outcomes expected of a New Zealand RS&I system.

Our impact focus

Over the past two years we have been on a journey to rebuild our organisation to better drive impact and achieve our strategic vision for New Zealand. In that time, we have transformed who we are and how we work, aligning our capability to deliver three major impact areas that focus where we will apply our expertise to provide maximum impact for New Zealand.

Within those three impact areas we identified 11 research portfolios and worked with stakeholders to create research roadmaps across 36 research programmes. Those roadmaps have been informed and co-designed in a series of in-person and online workshops with key stakeholders from central and local government, iwi/hapū, industry, researchers and members of the public.

The co-design process strengthened our commitment to work in partnership with Māori. We are taking care in 'how' we operate and deliver, and are working in partnership with the hapū who are tāngata whenua at our main campus in Rotorua, Ngā Hapū e Toru o Ngāti Whakaue (Ngāti Hurungaterangi, Ngāti Taeotu me Ngāti Te Kahu) to give effect to that.

Now we are sequencing and aligning our capability and resources with our co-designed research priorities as we determine how we can best deliver our Strategy to 2030 through our co-designed programmes. Once priorities are set, funding is needed so we can commit to achieving them. The level of support that aligns with our purpose and priorities needs to increase.

We have spelled out in our response to the *Te Ara Paerangi – Future Pathways* consultation that the current funding system risks undermining the delivery of impact. It is too short-term in focus and encourages competition among institutions and researchers, rather than the collaboration with stakeholders needed to address complex, systemic challenges.

The challenges of the current funding system are exemplified in the wildfire research Scion delivers. The fire team needs continual funding support to provide consistent scientific research, ability to deliver applied research in a short timeframe and to respond and assist on active wildfires when requested. Continual bidding takes a toll on the small team and individuals. While the Endeavour Programme has enabled high-impact research that will benefit the way firefighters respond and communities mitigate against extreme wildfire it pulls researchers away from the applied science that is requested and expected by our stakeholders. Secure funding would enable a better balance between the applied

and stretchy science, better meeting New Zealand's needs, and alleviate the pressure felt every five years to write a successful proposal.

COVID-19 impacts continue to be felt

While the dynamics of the COVID-19 pandemic look to be settling into a 'new normal', its impacts continue to be significant.

Global supply-chain disruption and uncertainties have increased the costs of science delivery, and isolation and COVID-19 management framework settings have delayed work and made international connectivity more challenging. We have felt this acutely in Rotorua, where ongoing challenges facing New Zealand's tourism sector have had a disproportionately large effect on our local economy and operating environment.

Our strategy

Since our beginnings 75 years ago Scion has promoted forests and forestry for multiple benefits. Looking ahead, we know that forests will be at the heart of a low-carbon, biological-based future New Zealand. We know too that forests will offset greenhouse gas emissions on a scale unmatched by any current technologies. And we know that renewable materials derived from trees will replace those from fossil fuels.

Now is the time to unleash the power of forestry.

To inspire us, we made some ambitious aspirations for New Zealand that we believe are achievable through the power of forests to transform how we live.

In 2050, we want New Zealand to have:
- 10-fold increase in GDP from forests and manufacturing
- Zero carbon emissions
- All erodible land planted in permanent forests
- Zero water quality issues from land use
- Sustainable communities and economies in all regions
- High OECD household net wealth ranking
- Much improved living standards.

To reach this future point, Scion has set research impact goals for 2030 as stepping-stones along the road to 2050.

Strategy to 2030

Right tree, right place, right purpose

We will make a difference to our economy, wellbeing and environment by **helping transition New Zealand to a circular bioeconomy.**

A circular bioeconomy is about getting the most value out of renewable biological resources while minimising waste.

This approach is well tested around the world. The market for materials and products made from renewable resources, particularly forestry, is developing fast. It is the way other large, forest-rich economies are going in Europe and North America. Trees are the source of >5000 products used daily.

New Zealand can and should take this opportunity to embrace a circular bioeconomy strategy. We have a strong biobased economy already, an extensive plantation forestry industry and relatively low infrastructure and economic dependence on fossil fuels.

The circular bioeconomy is estimated to be a $30 billion per year opportunity for New Zealand[2].

"The world responding to climate change by moving towards a circular bioeconomy future is perhaps the largest opportunity this country has ever had."

Dr Julian Elder, CEO, Scion

We will help New Zealand transition to a circular bioeconomy through our research outcomes in three impact areas:
- **Forests to biobased products.** Development of products, processes, manufacturing, trees, other biomaterials and healthy, resilient forests to replace petrochemicals and non-sustainable materials.
- **Forests to timber products.** Development of products, manufacturing, high-value trees and healthy, resilient forests that capture an increasing share of the global high-end market for timber.
- **Forests and landscapes.** Growing healthy, resilient forests that are planted primarily for their standing forest benefits.

Our research is organised within these impact areas under research portfolios. Each portfolio has shared and distinctive stakeholders who participate in designing, co-developing and delivering research programmes.

Critical to all our work is having a genuine, trusted partnership with Māori. Forests and trees are culturally significant to Māori. They, and the land which enriches them, are central to the worldview that is Te Ao Māori.

Figure 2: *Summary of Scion's path to contributing to New Zealand's goals.*

Our investment

We will be investing our revenue across the three impact areas as shown in Figure 3. Our investment for Financial Year 2022/23 has increased in every impact area.

Figure 3: *Scion's budgeted research revenue for Financial Year 2022/23 split across the impact areas.*

Delivering on our strategy

Scion's strategy is to help New Zealand realise the global opportunity that will come from its permanent forests and natural landscapes, timber products and biobased products.

The strategy is designed to help New Zealand transition to a circular bioeconomy through new permanent forests that sponge up carbon and provide increased biodiversity and ecosystem services; forests grown for timber products that sequester and lock the carbon; and, forests that are grown to replace petroleum-based fuels and products, like fleece jackets, sourcing the carbon from a renewable source.

It is this balance of the monetary and non-monetary benefits that is New Zealand's global opportunity.

Scion's science is organised under three research impact areas with 11 associated portfolios. Each portfolio has research programmes that deliver the goals of the portfolio and the impact area. Over the past year, these research programmes and portfolios were defined by internal consultation, industry workshops, stakeholder engagements and a strategic science review.

Partnering with Māori

We have embedded Māori partnerships throughout the organisation. We have done this in a number of ways including specific criteria within our strategic decision-making tool that requires articulation around contribution to Māori. This includes Māori-led portfolios within our impact areas, and we have a Māori partnerships team that leads Scion's Māori research and supports the organisation with Māori partnerships.

We have a direct relationship with Ngā Hapū e Toru who hold mana whenua on the Scion campus Te Papa Tipu. This relationship includes a future director appointment and a hapū operations manager. Alongside that, together, we have drafted a Kawenata (Covenant), to formalise the relationship. We are already seeing the fruits of this relationship with a number of joint projects and we are excited about the potential to do research together both in terms of the land opportunities on the campus, partnering with science, research and mātauranga Māori as well as career opportunities.

We see an exciting future with all our current and future Māori partnerships developed and leading to ground-breaking research opportunities where Māori as significant partners will work alongside us to help unlock these opportunities. This future is particularly promising with Māori being a constant, a huge resource owner and providing mātauranga Māori.

Impact Area:
Forests to biobased products

Goals. Targeting solutions that impact several industrial value chains resulting in:

- Unlocking future investment for new infrastructure such as biorefineries.
- $20 billion sustainable GDP growth driven through existing and new companies.
- 2500 new regional and rural jobs.
- Substituting fossil energy and materials with sustainable alternatives.
- 10 million tonne reduction in CO_2 equivalents.

Four portfolios will achieve these impacts.

Trees are the source of thousands of products we use every day and we can manufacture some or even all of these products in New Zealand. We can create a climate– and nature-positive economy replacing fossil energy with renewable energy and replace carbon-intense materials and products with sustainable alternatives.

"Anything [and more] made from fossil-based materials today can be made from a tree tomorrow."

Stora Enso[1]

This impact area is at the forefront of turning New Zealand into a global hub for the circular bioeconomy. This vision is underpinned by New Zealand's natural competitive advantage growing sustainable biomass linked with a high-value emerging biomanufacturing sector.

Our work aims to both mitigate climate change – the challenge of our generation – and create prosperity from this transformation – the opportunity of our generation.

All activities in this impact area are needed to deliver New Zealand's net-zero 2050 emissions aspirations. While 55% of greenhouse gas emissions can be tackled by the transition to renewable energy, the remaining 45% of emissions comes from the way we make and use products and food and manage land.

Success in this impact area is not possible without using renewable biobased materials and energy that replaces and outperforms current carbon-intense equivalents. Scion is working with partners to accelerate solutions that impact industrial value chains that will create regional jobs, unlock investments and put New Zealand well on track to meet our global climate commitments.

The forests to biobased impact area includes:

- Expanding circular product and process opportunities in the natural fibre, pulp, plastic, packaging and biochemical sectors derived from renewable resources.
- Reducing the fossil fuel reliance of New Zealand's businesses by using bioenergy from forest and waste biomass.
- Creating thriving regions through distributed manufacturing and customised product design.
- Accelerating the industry transformation with new or repurposed infrastructure underpinned by new value chains.

Our science is ground-breaking but to have real impact requires so much more. We are working with stakeholders including industry, government, iwi and the wider community to ensure uptake in New Zealand.

Opportunities are clear and renewed ambition levels are positive. Shifting the system is a challenge. We need scale and we need it quickly. This shift will give us the power to not only reduce waste, pollution and greenhouse gas emissions but also to grow prosperity, jobs and resilience.

High-value biorefineries portfolio

Vision: Making high-value chemicals and materials in New Zealand from sustainably sourced trees and other biomass.

This portfolio is about ensuring that New Zealand companies are fit to benefit from the global shift to sustainable and ecologically responsible chemical resources. Biorefineries will be at the heart of new industries producing novel chemicals derived from radiata pine, indigenous and exotic plants. These refineries will become the centre piece of a new cross-sectorial, high-value biomanufacturing industry. The scope of this work will deliver impact in GDP growth and regional high-value jobs. Products will feature high-value bioactive compounds and specialty/fine chemicals largely for export into global chemical supply chains.

Indigenous biomass-based biorefineries programme

A Te Ao Māori-led programme to design indigenous high-value biorefineries that interweave Māori leadership, knowledge and ownership supported by science and building a novel sector underpinned by our unique indigenous feedstocks defined with a Māori worldview in mind.

Pine and other exotic forestry-based biorefineries programme

Transformation of today's pulp and paper mills into bioproducts mills and biorefineries, beyond pulp and paper and into economic resilience. We will explore emerging biorefinery opportunities with exotic species and work wider than the established forestry and pulp and paper sector and use virtual biorefineries to optimise and assess the technical and sustainability impacts of different biorefinery approaches.

Alternative sustainable biomass-based biorefineries programme

Working with industries across the value chain to maximise value from current and future biomass sources such as seaweed and microbial biological resources. We will work with a broad range of companies and partner with research providers to explore and deploy leading edge technologies.

Bioproducts and packaging portfolio

Vision: Enabling onshore manufacturing of bioproducts and packaging from New Zealand's natural resources for global markets.

In this portfolio we are working with and enabling New Zealand designers, companies and consumers to create, manufacture and use bioproducts and packaging for a sustainable future. Seeking to have bioproducts, biopolymers and sustainable packaging solutions made in New Zealand. Minimising the environmental impact of plastics, increasing GDP and high-value job growth.

Bioplastics made in New Zealand programme

Accelerate the development of a thriving bioplastics industry by identifying and developing commercially viable opportunities with feedstocks and polymers, working with the industry to realise commercial success. The research includes bioprocess development, bioplastics such as polyhydroxyalkanoates (PHAs) and high-value monomers and polymers using synthetic biology.

The programme will encourage onshore production of new bioproducts developing easy transfer of technology to New Zealand companies.

Compostable and recyclable packaging programme

More than $100 billion of New Zealand products are packaged for export each year. Clear regulatory signals from importing nations indicate that all packaging must meet future environmental and functional standards. We support New Zealand industry's transition toward sustainable and circular packaging. Adjusting to a fast-changing global policy landscape ensures that these alternatives are high-performance and truly sustainable at end-of-life. Focus is on improved properties of fibre/cardboard-based materials, improving and understanding packaging end-of-life, reducing waste with digitalisation and ensuring regulatory compliance.

Sustainable composite products programme

Increase the value of composite industries in New Zealand through innovation. Develop new sustainable high-performance products for various applications and help support the sector implement new fibres, polymers and technologies. Focus on improved fibre design, adhesives and coatings and developing novel biocomposites.

Distinct products from indigenous fibres

Develop new and innovative Māori-led opportunities in indigenous fibres. Create an environment that instils trust and confidence from our Māori partners to work with us to explore and apply mātauranga Māori and kaupapa Māori approaches. Identify new opportunities and reduce the risk of commercialisation associated with indigenous fibre-based products.

Distributed and circular manufacturing portfolio

Vision: Kick-starting a distributed, circular bioeconomy that brings economic, social and environmental benefit to our regions by using the resources of today and tomorrow.

Accelerating and contributing to thriving regions through de-centralised, distributed and circular manufacturing approaches is our focus. A distributed, circular bioeconomy brings economic, social and environmental benefit to the regions by using the resources of today and tomorrow. In this portfolio, we work with regional and district councils, economic development agencies and iwi for maximum impact.

Distributed biomass conversion programme

Develop technology that turns biomass into products at its origin to use our resources, displace non-renewables and start a distributed bioeconomy in New Zealand. This programme includes the development of small-scale and modular biorefining processes, collaborating with regional partners to co-develop opportunities in new value chains and markets, and designing holistic value-flow systems for regional communities.

Eco-industrial regions programme

Design a future fusion of land-use and distributed production systems and describe intricate 'value' webs that accelerate the formation of a human wellbeing-centred bioeconomy. The programme uses adaptive systems modelling to describe distributed systems and mātauranga-based measures of wellbeing at a regional scale. It defines the networks and value-webs of future regional symbiotic networks and aims to identify new value measures from symbiosis clusters.

Modular and circular manufacturing programme

Bring New Zealand manufacturing into the forest-based circular bioeconomy to make it an integral part of a regenerative future for our country. To achieve this, we develop and implement small-scale and modular circular manufacturing technology that enables distributed part and bioproduct manufacturing. In parallel, we intend to establish supply-chain models and manufacturing pathways for forestry and biobased communities to facilitate added-value manufacturing through symbiosis.

Integrated bioenergy portfolio

Vision: Positioning bioenergy as part of the transition away from fossil fuels.

Modern bioenergy is an essential component of the future low-carbon global and New Zealand energy systems if global climate change commitments are to be met. Bioenergy is the main source of renewable energy today, contributing to energy used in power generation, heat for industry and buildings and for transport

Transport biofuels programme

Support the New Zealand aviation industry to transition towards the use and domestic production of sustainable aviation fuels (particularly biofuels). In conjunction with a range of New Zealand stakeholders, develop technology that can convert biomass residues into marine biofuels. Understand the socio-economic benefits for biofuels produced here in New Zealand compared with imported equivalents.

Process heat bioenergy programme

Develop technologies that allow the replacement of fossil fuels, in particular coal and natural gas, for the generation of heat in a range of industrial processes. Develop drop-in solid biofuels, derived from wood and other biomass residues, that have similar energy characteristics to coal. Develop and improve existing technologies that produce gaseous biofuels, such as biomethane and biohydrogen, from biomass residues to replace natural gas.

Bioenergy feedstocks programme

Enable bioenergy value chains with biomass resources that are abundant, fit for purpose and efficiently utilised. Develop and maintain tools that allow us to understand the availability of biomass resources across New Zealand and over time. We will understand the best approach towards short rotation forestry for bioenergy feedstocks in New Zealand, while minimising impact on environment, maintaining land productivity and lowering risk. We will understand the most efficient use of bioenergy in the New Zealand energy system and support new Māori value chains.

Impact Area:
Forests to timber products

Goals. Via the forest, manufacturing and construction industries we aim to:

- Increase GDP by $10 billion through low emissions, forest diversity, timber products and sustainable and healthy communities.
- Reduce CO_2 emissions by 1 million tonnes from the adoption of circular principles.
- Have two New Zealand communities adopt circular living concepts.

Four portfolios will achieve these impacts.

The full benefit of productive forests can be realised by developing wood-based products, manufacturing and end uses that maximise the potential of wood-based and digital solutions. Diverse, resilient productive forests will support communities to regenerate with enduring wellbeing for New Zealand and New Zealanders.

This impact area underpins our forest, wood manufacturing and timber construction sectors as our country aims for carbon neutrality, regional growth and improvements to the wellbeing of all New Zealanders.

Trees sequester carbon, and when wood is used in products and buildings that carbon is further locked away. Forestry and wood processing is a regional activity and has long-established positive impacts on communities, economies and the environment.

This impact area aims to address how to mitigate the potential forest growing, value chain and consumer perception risk associated with our single radiata pine species.

Given complex, changing and sometimes conflicting market environments, research aims to make decision-making more timely, responsive and precise across the value chain with reduced sectoral risk and increased value capture from forest to product.

This impact area addresses the question of how we can transition the forestry sector from the familiarity of a linear economy to the circular economy. The tools and pathways to achieve this transition in New Zealand are explored.

Being an active science contributor in the regulatory environment and having an informed public view of productive native and exotic forests is essential to realise the full benefits of these forests.

Digital technology is evolving faster than we can adapt. How can we foster workforce agility and new ways of working that enable us to benefit from these new technologies?

Trees to high-volume wood products portfolio

Vision: Supporting the backbone of our forest-based economy in New Zealand to deliver highly productive and sustainable forests that produce high-volume wood products.

Managing value chain system risk programme

By developing contingencies to cope with a disruption to the value chain through biosecurity or market

disturbances, this research addresses the forestry industry's concentration risk caused by a dependency on a limited number of exotic species, markets and products.

Climate adaptive forest management programme

This research aims to increase resilience in the forest estate to biotic and abiotic stress in trees, forests and landscapes to mitigate the effects of climate change.

Sustainable forest productive management programme

We will develop forestry management and design frameworks to minimise environmental impacts and maximise site productivity to address negative perceptions of radiata pine forestry compromising sectoral social licence to operate and limiting benefit from ecosystem services, integrated land use, climate change mitigation and the circular bioeconomy.

Managing resilient forests for productivity and wood quality programme

Adapt the radiata pine production systems to improve wood quality and productivity in the face of climate change to reduce uncertainty in log, fibre and feedstock supply.

Trees to high-value wood products portfolio

Vision: Delivering low-carbon built environments, regenerative communities and intergenerational wellbeing in New Zealand through trees to high-value wood products.

Shaping future forestry, processing and built environments programme

Partner with our stakeholders to explore productive forest transitions to mixed species, continuous cover, selective harvesting and integrated land-use. Research will support diversification of commercial tree species and integrated landscape approaches for high-value outcomes. Identify and facilitate adoption of emerging wood technologies and circular, low-environmental impact manufacturing approaches for high-value products. Partner with national and international innovators and research networks to support timber construction and low-carbon regenerative built environments and communities.

Quality, performance and innovations programme

Advance wood science and technology to add value, durability and fit-for-purpose performance to a variety of exotic tree species and their wood products. We will explore innovative biotechnologies, timber engineering, wood treatment, modification and functionalisation techniques. We will support advancement in processing, design and construction best-practices through independent performance verification of exotic tree species, wood quality, wood products and building systems. We will collaborate with research and industry partners to develop high-value wood products that will support our society to embrace a circular and low-carbon emission bioeconomy.

Removing barriers and enhancing values through partnerships programme

Engage with industry, community and consumers to identify barrier-breaking solutions for complex industrial, market, regulatory, economic, educational and socio-cultural challenges to diversify forests and use wood. We will use complex modelling to map interdependencies of benefits, risks and opportunities between our forests, our processors, our products, our communities, the climate and the planet. We will map the nexus of social, economic and environmental value and benefits from the forest to the community, linking priorities and the different decision-making frameworks to intergenerational goals. We will partner with our stakeholders and communities, promoting and using culturally grounded approaches to identify transition pathways.

Distinct value indigenous wood products portfolio

Vision: Mō te oranga o ngā uri whakatupu a Tāne Mahuta – for the wellbeing, sustenance and regeneration of future generations depending on Tāne Mahuta.

Nuanced indigenous forest-to-wood-product paradigms programme

Focus and reset existing and new indigenous wood systems to leverage the mana and mauri of the many forest products grown on Māori and private land. Model, design and communicate the distinct value of indigenous wood in a 2030 circular bioeconomy.

Reinforcing intergenerational economics programme

Deliver a tangata whenua inspired theoretical framework for the carbon economy enabling dynamic stocks and flows through actively managed complex functional systems on Māori and private land, over (forest) cycles of time. Explore reinstating te mana me te mauri o te taiao and customary kaitiakitanga practice in equitable post-2030 forest partnerships to service a circular bioeconomy.

"Wood with meaning" indigenous wood product futures lab programme

Research that takes place in an incubator to support the aspirations of Te Ao Māori enhancing the distinct value wood properties and timber quality of New Zealand indigenous trees. Use approaches that intentionally grow indigenous timber value chains and certified market segments aligning to next generation values. Prioritise interior appearance, luxury furniture and exterior cladding.

New value digital forest and wood sector portfolio

Vision: Transforming our forest and wood product ecosystem in New Zealand through digitisation and automation enabling new players, platforms and jobs.

Supply connectivity programme

Enable development of smart, connected supply chains for the forestry and wood products sector in New Zealand by visualising and quantifying information flows from germplasm through to wood products, identifying automation opportunities and introducing data traceability and protectability for enhanced and new value chains.

Intelligent forestry systems programme

Bring together data and intelligent analysis to visualise New Zealand's national productive estate and simulate change under current and future conditions using modelling, advanced sensing and deep learning delivering digital forest experiences through mixed realities.

Precision forestry at scale programme

Use advanced tissue culture methods and a phenotyping platform that matches genotypes to site and facilitates precision forestry to transform the way the forestry industry selects, plants and manages trees.

Future-proofing forestry programme

Digital-led forestry and wood processing transformation to support the existing workforce and attract more diverse people into new highly skilled jobs that enhance safety, increase productivity, job satisfaction and deliver greater environmental outcomes. This will be achieved through innovation and demonstration of future systems approaches from silviculture through to harvest and processing.

Impact Area:
Forests and landscapes

Goals. Via permanent standing forests we aim to achieve:

- 100% increase in afforestation of highly erodible red zone land.
- 8 million tonnes increase in sequestered above and below ground carbon storage in new forests.
- 80% increase in forested area managed to enhance soil and water resources, biodiversity, landscape resilience.
- 100% increase in the use of forests for human health and wellbeing.
- 100% increase in the value of Māori standing forests with maximum carbon net returns defined by landowner values.
- Converting 30% of underutilised Māori land to standing forest plantations.

Three portfolios will achieve these impacts.

New Zealand's current standing permanent forests, scrub and wetlands provide non-market value ecosystem services estimated to be worth billions in perpetuity[3]. Ecosystem services on Rakiura/Stewart Island alone were found to be over $100 million in estimated value[4]. Standing native forests are highly valued and a pre-pandemic study found New Zealanders willing to pay approximately $100 per household per year to support indigenous tree planting on public land[5].

Today's permanent forests are a sponge holding an estimated 250 years fossil-fuel-sourced carbon[6]. What is our sponge of the future? New Zealand is operating outside what our natural resources can support, known as planetary boundaries. Co-designed research on the circular bioeconomy will enable the return to within these boundaries.

This impact area provides the knowledge, innovation and tools for establishing permanent forests to bring about the non-monetary balance in the circular bioeconomy.

Ecosystem services of new permanent forests (and landscapes) will enable carbon sequestration, nitrogen regulation (avoiding leaching), erosion control, natural pollination, flood regulation, waste treatment, water supply protection, recreation and species conservation and biodiversity.

This impact area will:

- Use environmental engineering design principles along with our forestry knowledge to enable the design and planting of indigenous forests that meets New Zealand's needs, whether it is a scrubland to mitigate industrial waste or a forest to provide eco-tourism.
- Consider expected climate change as we look to enable indigenous forest and mixed-species forest planting with economic efficiencies at a large scale. Scion's 75 years of knowledge on efficient forest-establishment is a foundation for this work.
- Use science, research, innovation and Te Ao Māori approaches for sustainable management of our unique flora and fauna to help restore the health of New Zealand's current indigenous forests. Ultimately providing New Zealand with healthy indigenous forests and enhanced social, cultural, economic and environmental benefits.

With rapidly changing climate comes rapidly changing risk, enhancing the need for the right tree, right place, right purpose for the expected climate. This need will be considered in all areas.

Establishing indigenous forests portfolio

Vision: Enabling New Zealanders to recloak the whenua by helping to establish indigenous forests so that these forests will be resilient and thrive, bringing health, wealth and wellbeing to communities, ecosystems and the environment.

The portfolio aims to make indigenous forest establishment as easy and economically viable as possible. To establish indigenous forests at all scales (from marae-based plantings to large scale afforestation) requires knowledge and tools from seed to canopy closure.

Indigenous plant production at scale programme

Grow healthy, resilient plants in the nursery in association with Te Tiriti partners. Future-proof sustainable plant growing through automation, sensing, technology and fundamental knowledge of plants. Co-develop breeding programmes to establish resilient and diverse indigenous forests. Grow the right trees for restoration, augmentation or large-scale planting. Develop tools, protocols and methods for all nursery sizes from family-owned business to large-scale plant producers.

Smart establishment of indigenous forests programme

Translate and stretch Scion's 75 years of exotic forestry research to establish large-scale indigenous and mixed species forests. Provide methods to overcome economic roadblocks to enable large-scale forest establishment. Develop and demonstrate best practice establishment across site types, considering the needs of the indigenous forests and society. Long-term planning of the forest under climate change through ecophysiology and the soil microbiome. Determine the natural flow of genetics between rohe and the role of eco-sourcing through both western science and mātauranga Māori approaches.

Establishment of complex indigenous forests programme

Successful characterisation and establishment of self-regenerating and complex permanent forests for multiple environment, economy, society and culture outcomes. Develop methods to accelerate ecological complexity and biodiversity of complex forests. Economic opportunities from harvesting young forests. Investigate, analyse and recommend simple policy to empower the planting of indigenous forests and methodologies for working together across world views.

Restoration, protection and mauri o Te Waonui a Tāne portfolio

Vision: Ko te Whakahaumanu, Ko te Whakamaru, Ko te Mauri Ora o Te Waonui a Tāne me Te Ao Tūroa – Restoration, protection o Te Waonui a Tāne for intergenerational prosperity and perpetuity.

Whakahaumanu me te whakamaru ngahere – Protect and restore indigenous forests programme

Research, science and technologies to protect our unique forests enabling improved decision-making and prioritisation when multiple risks are present and threatening indigenous forests. Deliver resistance, mitigation and adaptation models and tools that respond to biosecurity and health risks incurred by climate, wildfire, pests, weeds, diseases, social factors and other ecological stressors impacting on our indigenous forests.

Mai Papa ki Rangi, mai Rangi ki Papa, ko te mauri o Te Waonui a Tāne, ko te mauri o te taiao, ko te mauri o te tangata – Ecological wellbeing programme

In a new approach, this programme will use environmental science and cross-disciplinary methods to better understand and celebrate the complex nature of the biophysical and biocultural ecology of Te Waonui a Tāne. This pathway takes its leadership from Te Ao Māori worldviews, whakapapa, mātauranga Māori, Te Reo Māori, maramataka, mahi toi, rongoā Māori and kaitiakitanga, contributing to new science insights, expanding Aotearoa indigenous forests knowledge and data that remain largely unknown to science.

Designing forests - Mahi tahi whaihua portfolio

Vision: Designing forests to meet the needs and values of communities that restore and enhance New Zealand's natural capital, delivering sustainable and resilient ecosystem functions and equitable outcomes over generations and within a rapidly changing environment.

Carbon secure forests programme

Ensure our present and future stores of carbon in forest ecosystems are secure in a rapidly changing climate.

Develop new carbon models for indigenous, exotic and fusion forests. Create a new and innovative framework that characterises carbon in the whole forest ecosystem. Characterise the biophysical properties of soil carbon and breed plants for carbon storage in wood and roots. With our partners, this programme will explore the connections between environmental carbon, Māori ancestry, whakapapa and historic land use as a platform for future forest decision making and co-design. We aim to develop understanding of the processes that drives carbon pools in deep soils and understand the growth and retention of forest carbon.

Resilient landscapes programme

Significant areas of our rural landscapes are highly degraded and facing major challenges compounded by a changing climate. Design pathways to restore rural landscape function and resilience through targeted use of trees and forests. Delivery of ecosystem services to enhance the wellbeing of communities, regional economies and the environment.

Identify areas for targeted intervention at high-risk landscapes using climate change scenarios, land-use maps, landscape modelling and other tools. Co-design new landscape mosaics that secure bundles of forest benefits and ecosystem services using new forest systems. Develop a detailed understanding of microclimatic sites and a practical application of ecological silvicultural options from a whole-of-landscape ecology approach.

Community and mātauranga-Māori based solutions and environmental engineering principles to create community co-designed mosaics of rural land-use.

Urban forests programme

Urban forests are essential to support human health and wellbeing, enhance biodiversity, protect coastal margins and reduce air pollution. Using mātauranga-Māori approaches and environmental design principles that connect ecosystem services to create urban forest communities that better provide water quality, secure carbon storage, recreational, psychological and educational outcomes.

Complex forest systems programme

Our challenge is to design indigenous and fusion forests capable of delivering ecosystem services to different communities with different needs, in different landscapes and within a changing climate. These forests will be complex in form and function, providing long-term outcomes for communities.

In this enabling programme, we research the knowledge and design the tools to design complex forests. Given the urgency and need to design new systems plus the poor availability of field-trial data for these systems, we will integrate existing knowledge of indigenous forest ecology held by tangata whenua, with innovative approaches for complex system modelling, to enable rapid progress in forest design.

Partnerships to deliver impact

Meaningful long-term partnerships are required for our strategy to succeed in creating impact for New Zealand. Examples of impact are more forests being planted to protect land or sequester carbon, or more exports of high-value timber or energy from trees replacing oil.

Delivery of impact can only be achieved through robust partnerships across all players along the innovation pathway adapting science to achieve a business, social or environmental outcome.

Building powerful co-innovation partnerships with Māori

Māori and the Māori economy are important partners for Scion as we work together to deliver future benefits for Aotearoa New Zealand. We have invested in Māori capability across the organisation to embed these co-innovation partnerships.

We now have a dedicated Māori Research and Partnerships Team that is leading and supporting Māori research in partnership with Māori. We have invested in Māori culture training and development to ensure that our staff are much better equipped to be working with Māori.

We are now seeing great outcomes from this approach, where we are for the first time seeing genuinely Māori-led research, and the intersection of mātauranga Māori and our research science capability.

The partnership with our local mana whenua, Ngā Hapū e Toru, has seen two exciting projects progress that have significant mātauranga Māori components.

Innovating with industry

Scion's traditional industry stakeholders include the (mostly *Pinus radiata*) nurseries, forest growing companies and wood processing and manufacturing (timber and pulp and paper) companies. Interest is increasing from existing and new stakeholders, including Māori, in growing and using indigenous trees.

Most definitions of the forest industry focus on forest growing and wood manufacturing. Trees, however, can be made into a wide variety of materials suitable for general manufacturing such as bioplastics, biochemicals, biofuels and bioenergy.

Increasingly Scion's stakeholders include plastics manufacturers, fuel and energy companies, primary producers interested in sustainable packaging and other solutions and industry bodies that support them. Organisations we work with include Bioenergy Association of New Zealand, National Energy Research Institute, Business NZ, Venture Taranaki, NZ Automobile Association, Sustainable Business Network, Plastics NZ, Packaging NZ, WasteMINZ, the Sustainable Aviation Fuel (SAF) Consortium and more.

Some of the materials and innovations Scion works on may form the basis of industries that are nascent or do not exist in New Zealand, such as biochemicals. This presents a funding challenge as industries still to emerge cannot provide research and development funding for the science to underpin those economic development opportunities.

Commercialisation remains an important focus for Scion as we develop new industry partnerships across the forestry and wood processing value chain and creating opportunities for adding value to these partners.

To foster entrepreneurial thinking and lead to future innovator founders of new technologies, we will resume our internal accelerator programme 'Innovation Jumpstart' after COVID-19 disrupted last year's programme. 'Innovation Jumpstart' takes propositions from idea to pitch leveraging pre-seed accelerator funding support from the Ministry for Business, Innovation and Employment.

We are working more closely with Callaghan Innovation Technology Incubators to leverage their capability and investment to help commercialise complex technologies.

Government

In addition to funding science, the Government is a consumer and end-user of science, both to inform government policy development and for government operations. Our Strategy to 2030 continues to be highly relevant with significant opportunity for New Zealand in the context of climate change and sustainable development.

Scion's research around forest systems, ecosystems, biodiversity, water quality, carbon sequestration by trees, fossil fuel substitution (such as biofuels and bioplastics) and distributed manufacturing all provide useful evidence to inform the development of government climate change, biodiversity, environmental and economic policies.

Scion submits on a range of government policy consultations through the Ministry for the Environment, the Climate Change Commission, Department of Conservation, Ministry for Primary Industries and Te Uru Rākau – New Zealand Forest Service. We are encouraged that senior staff are increasingly invited to sit on ministerial and governmental

advisory groups. We will continue to seek a voice at such important forums where our expertise as a Crown researcher should be sought.

Key government operational responsibilities such as biosecurity (through Biosecurity NZ as part of the Ministry for Primary Industries) and rural fire prevention and fighting for Fire and Emergency New Zealand are also advanced and informed by Scion's research in these areas. This work provides significant public benefit for New Zealand as a whole.

Science system collaboration

Bringing together multiple perspectives through science collaborations yields better, more robust solutions and innovation. Scion actively collaborates with other Crown Research Institutes, New Zealand universities and research organisations and with international research organisations.

Key examples of these collaborations are:

- **Kauri dieback and myrtle rust** includes Scion, Plant and Food Research and Manaaki Whenua – Landcare Research collaborating with Māori and government to combat both diseases.
- **Bioprocessing Alliance** (joint with Callaghan Innovation, Plant and Food Research, AgResearch and a number of universities) works to advance innovation in the manufacturing of biological residues into new products.
- **Better Border Biosecurity (B3)** is a collaboration between Ministry for Primary Industries, Department of Conservation, Plant and Food Research, AgResearch, Scion and primary sector industry bodies using science to improve New Zealand's biosecurity system.
- **Specialty Wood Products Partnership (SWP)**, which includes industry, government and researchers, aims to develop a high-value wood products industry based on alternatives to radiata pine like Douglas-fir, eucalypts and cypresses.
- **Long-standing partnerships with universities**, such as Canterbury and Waikato Universities, where research teams collaborate over many years.
- **National Science Challenges** (Science for Technological Innovation; Our Land and Water; New Zealand's Biological Heritage; Resilience to Nature's Challenges; and Building Better Homes, Towns and Cities) to research a range of problems ranging from disease and pest management/eradication, microbiomes, urban infrastructure, 3D printing, robotics to biomechanics.
- **International collaborations** including with VITO Research in Belgium (on lignin, purification systems, 3D printing and circular bioeconomy), VTT Research Finland (on circular bioeconomy, hardwood materials, and packaging), Fraunhofer IGB in Germany (on bark biorefinery), the International Bioenergy Agency, US Forest Service and many more formal long collaborations and multi-year science programmes around the world.

Scion is also an active member of Science New Zealand, collaborating with the six other Crown Research Institutes on science research and joint projects to support the science system, such as the National Environmental Data system, science policy and general operational coordination.

Te Papa Tipu Innovation Park

Scion's campus – Te Papa Tipu – is an innovation park with more than 30 organisations and companies, including Te Uru Rākau – New Zealand Forest Service, Department of Conservation, NIWA, Timberlands, Oji Fibre Solutions and PF Olsen.

Scion's innovation building, Te Whare Nui o Tuteata, provides an anchor for Scion's leadership and growth to flourish by providing a hub for innovation between Scion and its partners (government, private sector and local community). Part of the building is available as a partnership and innovation space for our stakeholders.

The building strengthens the connection between Scion and the local tangata whenua and their ancestral land. The name Te Whare Nui o Tuteata was gifted by Ngā Hapū e Toru (comprising Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu) who hold mana over the Scion campus and innovation park, Te Papa Tipu. It is a tangible step in Scion's growing relationship with Māori and our support of Māori plans and activities that may call on us.

Supporting science and enabling impact

Critical to achieving the objectives of Scion's Strategy to 2030 is having an organisation that can efficiently conduct and deliver high-quality science and facilitate use of that science to create impact.

To make the shift to become an impact-focused organisation Scion completed and implemented an organisational-wide realignment over the past two years.

Our science matrix model

Scion moved to a matrix model (see Figure 4) a year ago to be more agile in use of our science capabilities across our three impact areas. The leadership structure that supports the matrix model has been embedded and is now producing the efficiencies and synergies that were intended.

Research programmes and projects that contribute to the research impact goals are homed under each of the 11 portfolios and are coordinated by Portfolio Leaders.

All our science capability resides in eight research groups reporting up through Research Group Leaders to the General Manager Te Ao Māori and Science Services. The Portfolio Leaders draw on this pool of science capability to resource the programmes and projects under the respective portfolios with project leaders and contributing scientists.

The General Manager Te Ao Māori and Science Services has responsibility for ensuring that Scion maintains a sustainable level of scientific capability across the research groups to adequately resource the work of the portfolios and to ensure that we partner and collaborate to avoid duplicating existing resources. Where resource might not currently exist or is over-utilised the General Manager Te Ao Māori and Science Services might contract in needed capability.

Over time, the make-up and mix of the research groups may change as the programmes and projects Scion is working on change. This will allow us to be more agile in responding to changing priorities and to more quickly take advantage of emerging opportunities.

The functional mix

Our organisational realignment included all functional roles to provide the right capability to more:

1. Efficiently support our science and scientists through project, operational and project-level finance management, bid support, modern and enabling IT and improved facilities and infrastructure;
2. More effectively enable impact through external stakeholder relationships with government (including to inform policy) and industry (including contract research and developing R&D partnerships), moving Scion technology through a

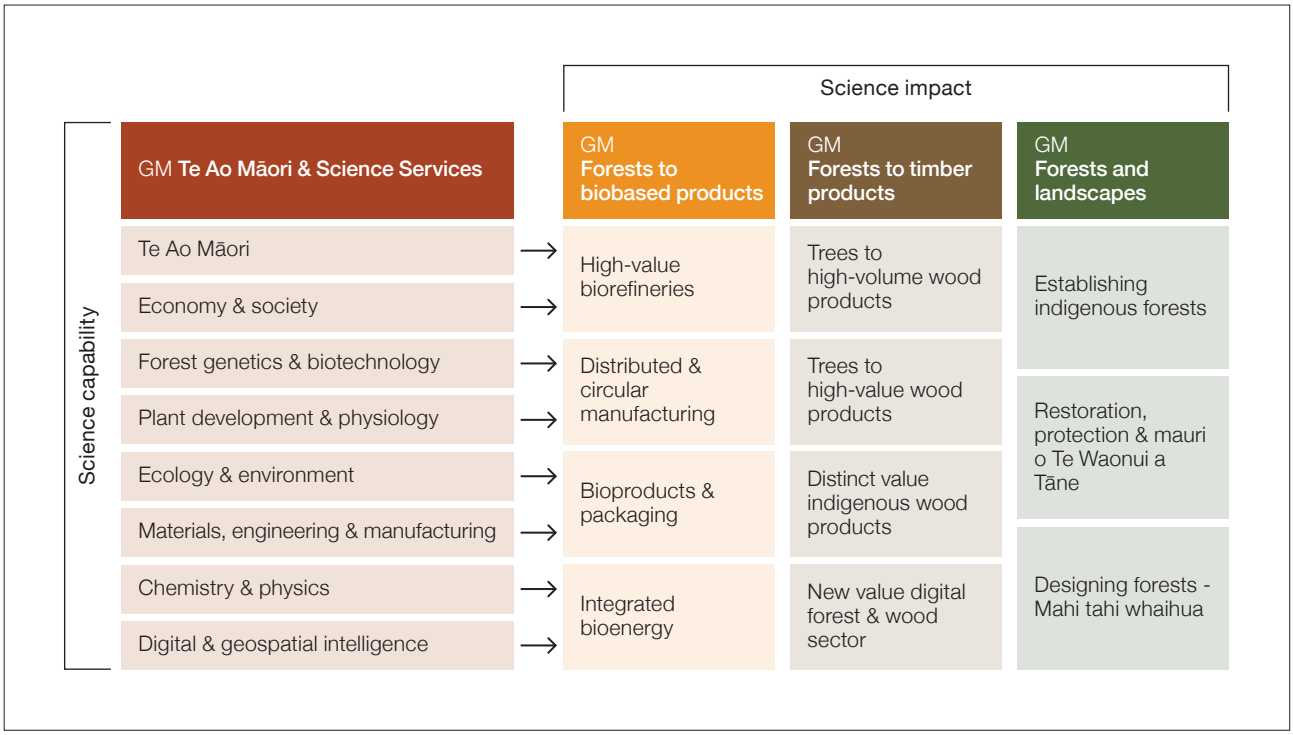

Figure 4: *Scion's science matrix model.*

commercialisation pipeline (supported by PSAF and investment funds), and external communications.

The new resulting functional structure came into effect in August 2021, and the operational roll out of changed and new roles and responsibilities is already showing gains and efficiencies that will increase once fully embedded.

Financial sustainability

We now have ministerial support for our strategy and the role that Scion should play in supporting many of the Government's objectives, particularly in the areas of emissions reduction, carbon sequestration, climate change response, bioenergy, biofuels, new plastics and regional economic development.

As pointed out in the science review, the work proposed in our strategy spans many government agencies and input from a variety of them is needed to explore funding options that we have put forward.

We are aware that the Government has signalled funding in areas such as climate emergency response, GHG emissions reduction, initiatives around sustainable aviation fuels, increase in the waste levy and the Plastics Innovation Fund to tackle New Zealand's immediate challenges and opportunities. The release, in May 2022, of New Zealand's first emissions reduction plan is exciting. *Te hau mārohi ki anamata; Towards a productive, sustainable and inclusive economy* mirrors much of our narrative and urges that bold action is needed to achieve net-zero emissions by 2050. Scion has critical research, science and innovation capability that is necessary to support many of the plan's recommended actions. We look forward to working intently with relevant agencies to see how our research capability can be put to use through all these initiatives to achieve the Government's goals for New Zealand.

We continue to work with the Ministry for Business, Innovation and Employment on a long-term funding solution for Scion. If we are to maintain financial resilience, then we do need to complete the funding solution work. We are currently facing rapidly increasing costs when most of our multi-year contracts have no indexation mechanisms.

Without long-term funding Scion will continue to be inhibited in how we deliver on our core purpose and our strategy.

We present our position as:

- With current funding we are making ends meet, but we are delivering limited impact and hampered by the need to chase contestable grants to retain our core capability.
- With a long-term funding solution, we can focus on maintaining and enhancing critical capability and make good progress with circular bioeconomy related R&D.
- With an additional capital injection from our owner (the Crown), we can replace our aged infrastructure and become transformative with circular bioeconomy focussed R&D.

Workforce relationships and development

Scion's greatest resource is its people. Ensuring we have the right people, doing the right things and enabling them to do their best work is critical to success. Staff wellbeing through the pandemic has been a major focus for Scion. We have actively supported our international staff around immigration issues by engaging licensed immigration consultants to hold seminars as well as reimbursing staff for unforeseen costs associated with their immigration. For the wider workforce, we have actively checked in on staff members who live alone during lockdown periods, incentivised vaccinations and provided clear communications on requirements at each change in alert levels or traffic lights.

As the country emerges from the peak of the pandemic, we look forward to re-engaging with staff as they physically return to the workplace and implementing initiatives that will support and engage our workforce.

Organisational realignment. We embarked on an organisational realignment two years ago to design a structure and network that supports delivery of Scion's strategic objectives. The realignment process for the science part of the business was concluded first and resulted in a new matrix structure. The corporate and functional activities were examined next.

In August 2021, Scion completed the structural realignment of its corporate and functional activities to better enable our new science operating matrix. This included the establishment of a Portfolio Management Office to provide clear linkages from Scion's desired business plan outcomes through to delivery of investments through projects and operations. Other related activities underway include a new projects and financials programme to provide a connected suite of technologies and processes to support our operations.

Workforce capacity and capability. Part of the organisation alignment and a feature of the matrix structure was to provide better line-of-sight to future capability demand driven from our impact areas, which will allow more accurate identification of capability requirements within our research group structure.

As the portfolio roadmaps, within each impact area, develop programmes of work and projects, we are gaining greater clarity on the specific capability and capacity required to deliver our strategy. To this end, and to ensure our workforce

capability is prioritised and available, significant work has gone into establishing an internal capability framework. Capability or capacity gaps can be identified early, and appropriate decisions made as to whether to develop internal staff, recruit or collaborate externally. Further work over the coming year to operationalise and enable these practices in the new structure will be carried out.

Career pathways. An exciting feature of the organisational realignment is the development of a technologist career path that focuses on applied science, with different metrics than the traditional h-index, to deliver impact for stakeholders.

Formalised career pathways will form an integral piece of Scion's talent framework in responding to new capability and capacity requirements. Scion will establish a competency-based development and remuneration structure that will not only develop individuals within their current role but prepare them for further career progression. We look forward to working with the PSA and wider workforce on establishing the framework and identifying the competencies required in each role.

Leadership and staff behaviour. Scion's commitment to leadership development was demonstrated over the past year with significant investment in a 12-month Active Leadership Programme (ALP) for all leaders within the new matrix structure including corporate and functional leaders. The programme has delivered succinct and practical material through online learning which is bolstered through collab groups and individual coaching where participants reflect on applying the learnings in the workplace. The coming year will see the programme being rolled out to the next tier of leaders. Further initiatives to come are a staff leadership forum to continue and broaden the learnings from the ALP as well as an emerging leaders programme aimed at those with the potential for future leadership but not yet in a formal leadership role.

We intend to revisit the current Scion Values to reflect the journey Scion has been on and the future ahead.

Māori engagement. Within our research structure, a Te Ao Māori capability team supports mātauranga throughout our research programmes, cultural capability and critical relationships with Māori. We envisage Māori cultural capability and relationship management to devolve across the entire organisation.

During the year, Scion, in partnership with mana whenua Ngā Hapū e Toru (Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu), Scion established a new role of Te Hunga Whakahaere Matua, to build on the existing partnership between the three hapū and Scion. In addition to the above-mentioned capability analysis and career path development, Scion has begun work on integrating mātauranga throughout its research role progression framework.

Safety and wellbeing of all workers. In addition to the work delivered as part of Scion's COVID-19 response, our Health & Safety Team progressed several initiatives stemming from the external review of our health and safety systems conducted last year. These initiatives included significant investment in our critical gas testing equipment and an external assessment across the guarding mechanisms on equipment. Also, our wellness teams hold monthly initiatives such as bike week, financial wellness and men's health.

In 2022/23, we will focus on better supporting our lab management teams to mitigate hazards, operationalising the recommendations identified in the guarding audit and a flexible working initiative that includes a 9-day fortnight trial aimed at increasing wellbeing and life balance among staff.

Facilities development

Creating the right environment for our work and staff remains important to Scion. This includes continuing to invest in leading edge science equipment and facilities and information technology systems.

Our Rotorua campus, Te Papa Tipu Innovation Park, is undergoing master planning that will transform the campus into a modern, high-tech research facility. The Campus Master Plan encourages industry and science collaboration and co-innovation, makes efficient use of space and provides an improved interface with the public. New facilities are being designed to attract staff and foster great, innovative science.

The campus transformation is being managed in stages with the first stage completed in 2020 with the construction of Te Whare Nui o Tuteata, our innovation hub. Designed using sustainable principles and showcasing timber technology Te Whare Nui o Tuteata is now the signature building on campus, encouraging collaboration and providing a welcoming gateway for industry and visitors alike. Te Whare Nui o Tuteata represents the heart of our campus with our people and facilities emanating from this centre.

This investment was followed by the implementation of new technology and expansion of our research nursery, which is scheduled for completion in 2022. The next stage has commenced which includes developing concept designs to upgrade and/or replace our aging facilities, labs and workshops with adaptable facilities that enable us to continue delivering innovative science in a safe and healthy environment.

Measuring our performance

Indicator name	Measure	Frequency	2020/2021 Target	2020/2021 Actual	2021/2022 Target	2022/2023 Target
End user collaboration	Revenue per FTE ($) from commercial sources (Note, the definition of commercial sources changes across these periods)	Quarterly	$53.067	$69,030	$65,114	$60,377
Research collaboration	Publications with collaborators	Quarterly	≥100	88	75	90
Technology and knowledge transfer excellence	Commercial reports per scientist FTE	Annually	>1.5	1.57	2.0	>2.0
Science quality	Mean citation score	Annually	3.3	4.27	3.3	3.5
Financial indicator	Revenue per FTE	Quarterly	$169,190	$185,824	$168,701	$175,208
Stakeholder engagement	Percentage of funding partners and other end users (number and %) that have a high level of confidence that Scion sets research priorities relative to the forest industry and biomaterials sector	Biennial	>85%	79%	>85%	>85%
	Percentage of funding partners and other end users (number and %) that have a high level of confidence in Scion's ability to assemble the most appropriate research team	Biennial	>85%	>94%	-	>90%
	Relevant end-users (%) who have adopted knowledge and/or technology from Scion	Biennial	>90%	>97%	-	>90%
Māori economic development	Partnerships (number (n) and value ($)) established with Māori entities to support economic development through the forest industry	Quarterly	n>10 >$1.5m	n=13 $1.3m	n>15 $2m	n>15 $2.5m
Accelerated commercialisation	Technologies in Scion's pipeline (number and co-investment ($)); projects that progress to the business case stage (case studies)	Quarterly	25 and $400,000 Cases ≥4	25 and $378,911 1	25 and $400,000 Cases ≥4	25 and $500,000 2 cases to validation stage
People and culture	Staff engagement	Annual	>75%	85%	>75%	>80%
	Staff retention – staff turnover	Annual	12%	12.5%	10%	12%
	Health and safety – serious harm events	Annual	0%	0%	0%	0%
	Staff diversity – % of permanent staff of Māori descent	Annual	11%	10%	11%	>12%
	Gender neutral – pay equity (Median – total compensation unexplainable differences below <5%)	Annual	<5%	<5%	<5%	<5%

Table 1: *Scion's performance monitoring scorecard indicators and measures.*

Our financials

Financial projections and performance

Scion's financial projections through to June 2025 are summarised in Table 2. Associated consolidated cashflow and balance sheet details are presented in Tables 3 and 4. Financial performance indicators are included in Table 5.

Scion is budgeting for a revenue growth for the year ending June 2023 and the outyears beyond this. This revenue growth is aligned to our Strategy to 2030 and is a combination of organic growth and long-term funding solutions in place to secure delivery. There is an element of risk in the outyears if we are unable to secure funding. This situation would result in a likely baselining of revenue similar to year ending June 2022 and ensuring the cost base is aligned accordingly.

For the financial years 2024 and 2025 we are factoring in projected Infrastructure Capital Investments. Scion will go through the business case process for these specific projects, which relate to aging research facilities, the nursery and campus facilities.

Projected Income Statement				
	30/06/2022 $000 Forecast	30/06/2023 $000 Budget	30/06/2024 $000 Projection	30/06/2025 $000 Projection
Revenue				
Total revenue	60,399	67,741	77,903	89,588
Adjusted for COVID-19 recovery grant	60,399	67,741	77,903	89,588
Total operating expenditure	55,589	62,593	72,644	81,928
EBITDA	4,810	5,148	5,259	7,660
Profit before tax	(1,006)	(986)	(2,428)	(1,849)
Group profit after tax	(728)	(710)	(1,748)	(1,331)

Table 2: *Projected income statement for the three years ended 30 June 2023 to 2025.*

Cash position, balance sheet structure and dividends

As at 30 June 2022, Scion is forecasting end of year cash balances of $9.8 million. Including planned investments (subject to business case and shareholder approval) this is projected to reduce to $6.7 million in June 2025.

Projected Consolidated Statement of Cashflows				
	30/06/2022 $000 Forecast	30/06/2023 $000 Budget	30/06/2024 $000 Projection	30/06/2025 $000 Projection
Net cashflows from operations	2,908	6,123	5,911	8,298
Net cashflows from investing activities	(7,716)	(14,000)	(20,096)	(29,220)
Net cashflows from financing activities	0	(156)	13,144	26,835
Net increase (decrease) in cash	**(4,808)**	**(8,033)**	**(1,041)**	**5,913**
Opening cash balance	14,643	9,835	1,802	762
Closing cash balance	**9,835**	**1,802**	**762**	**6,674**

Table 3: *Projected consolidated statements of cashflows for the three years ended 30 June 2023 to 2025.*

Projected Consolidated Balance Sheet				
	30/06/2022 $000 Forecast	30/06/2023 $000 Budget	30/06/2024 $000 Projection	30/06/2025 $000 Projection
Total assets	66,457	67,118	81,070	108,866
Projected closing shareholders' funds	52,323	51,613	57,864	75,533
Shareholders' funds to total assets	**0.79**	**0.77**	**0.71**	**0.69**

Table 4: *Projected balance sheet for the three years ended 30 June 2023 to 2025.*

Financial performance targets

	Forecast 2022	Budget 2023	Projection 2024	Projection 2025
Efficiency				
Operating margin	7.8%	7.5%	6.6%	8.4%
Operating margin per FTE	$13,565	$13,316	$12,594	$16,986
Risk				
Quick ratio	2.36:1	1.02:1	0.89:1	1.52:1
Profit volatility	21.9%	21.0%	20.7%	23.6%
Forecasting risk	3.4%	2.6%	1.5%	(2.3)%
Growth/investment				
Adjusted return on equity	(1.4)%	(1.4)%	(3.2)%	(2.0)%
Revenue growth	4.4%	12.2%	15.0%	15.0%
Capital renewal	1.3x	2.3x	2.7x	3.2x
FTE	355	387	418	451
Revenue per FTE	$170,330	$175,208	$186,564	$198,656

Table 5: *Financial performance targets for the three years ended 30 June 2023 to 2025.*

Appendix 1: Portfolio roadmaps to impact

High-value biorefineries portfolio

Vision: Making high-value chemicals and materials in New Zealand from sustainably sourced trees and other biomass.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Targeting solutions that impact several industrial value chains resulting in: • Unlocking future investment for new infrastructure such as biorefineries. • $20 billion sustainable GDP growth driven through existing and new companies. • 2500 new regional and rural jobs.		
			Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
High-value chemicals obtained from the oil industry are unsustainable New Zealand imports many high-value chemicals which affects our security of supply and represents a cost and access risk (opportunity cost to industry) and fewer imports reduce our carbon footprint The value of New Zealand's abundant biomass is not currently being fully realised or capitalised There is an opportunity to build new high-tech high-value sectors based on the entire value-chain derived from biorefineries, including their construction There is an opportunity for government strategy to provide clear incentives or direction to implement capital intensive research which is currently limiting industry response and investment into biorefineries Māori have the opportunity to	**Indigenous biomass-based biorefineries** Working with Māori to identify chemicals and products from indigenous biomasses to enhance the Māori economy. Supporting Māori landowners to advance their rights and interests in the taonga growing on their lands through science discovery and mission-led research	Te Ao Māori based options for Māori owned and operated high-value biorefineries with appropriate safeguards for IP and data protection	A Māori biorefinery is investigated and established	A Māori brand/value chain is established	Māori are world leaders in New Zealand's indigenous biobased refineries adding $5 billion to New Zealand's economy
	Pine and other exotic forestry-based biorefineries Using New Zealand's existing and future commercial forestry as feedstock for biorefineries. Working with existing forestry and related companies to envision what forested trees and their value-chains could become	Implementation of biorefinery approaches to the deconstruction of wood Engagement with the pulp and paper industry with options to add further high-value products	A short rotation forestry feedstock trial is established with industry At lab scale a 'lignin first' biorefinery has been shown to be viable 10% of forest residues are transported out of the forest for use in biorefineries	One pulp & paper mill has upgraded to produce chemicals for high-value industries A pilot plant scale 'lignin first' biorefinery has been tested at biopilot plant scale 50% of forest residues are transported out of the forest for use in biorefineries	Sufficient biomass is available to support a large scale biorefinery industry At least two industrial 'lignin first' biorefineries have been constructed 80% of forest residues are transported out of the forest for use in biorefineries
	Alternative sustainable biomass-based biorefineries Working with industries across the value chain to maximise value from	New technologies for the conversation of biomass into feedstock for high-value industries Novel bio-derived bioactive compounds	At least one biorefinery producing chemicals for the cosmeceutical industry	At least one biorefinery producing chemicals for the nutraceutical industry	At least one biorefinery producing either fine chemicals or pharmaceutical intermediates

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
participate in an emerging sector under their own terms Due to New Zealand's abundant biomass, the country has the opportunity to be a net exporter of a range of high-value chemicals and materials	current and future biomass sources This area will work with a broad range of companies and partner research providers to explore and deploy leading-edge technologies	New linkages with other research providers			
Cross cutting research outputs to 2030 and impacts	Science reported in the media and peer reviewed journals Benefits and opportunities of biorefineries communicated with iwi, industry and investors Resource databases for high-value (bio) chemical production		Develop an investment case for biorefineries based on Scion and other world leading technologies	Identify biomasses and locations that meet environmental and economic criteria	Generate $20 billion sustainable GDP growth; 2500 regional high-value jobs

Bioproducts and packaging portfolio

Vision: Enabling onshore manufacturing of bioproducts and packaging from New Zealand's natural resources for global markets.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Targeting solutions that impact several industrial value chains resulting in: • $20 billion sustainable GDP growth driven through existing and new companies. • 2500 new regional and rural jobs. • Substituting fossil energy and materials with sustainable alternatives.		
			Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
Education and change: Lack of consumer and value chain understanding hinders change and uptake necessary to support a circular bioeconomy Iwi engagement: Low engagement with Māori makes it hard to interweave tikanga (knowledge and values) for Māori benefit	**Bioplastics made in New Zealand** Enable onshore manufacture of bioplastics from bioresources and methane/CO_2	Expertise to enable onshore large-scale production of existing bioplastics New technology for direct conversion of methane and CO_2 into bioplastics Development of novel high-performance bioplastics from sustainable resources	Commercial onshore production of compostable/ recyclable bioplastics has begun Sustainable value chain for manufacturing developed Commercially relevant feedstocks and opportunities are identified and evaluated	Commercial onshore prototyping of new higher performance bioplastics begins Negative carbon footprint for bioplastic and polymer production Scion recognised as a global leader for biomass utilisation through biotechnology	High performance, high-value engineering grade bioplastic/ biopolymers in commercial production in New Zealand Export of high value bioplastics/ biopolymers
Product: Sustainable products currently not suitable for all use cases Feedstock: Large geographic distribution, seasonality, low volume, cost and variability means it can be hard to secure a reliable biomass source Economics: Market forces associated with oil-based or imported alternatives makes it challenging to develop a competitive local market Manufacturing: Lack of onshore manufacturing (plastics and products) and recycling infrastructure Legislation: Regulations for	**Compostable, reusable and recyclable packaging** Enable the transition to sustainable packaging for New Zealand companies, and support export of New Zealand goods Digitisation of the packaging value/ supply chain	Improved compostable packaging materials for domestic and export markets New high-performance renewable and recyclable fibre-based packaging options Expertise to support New Zealand's transition to compostable and recyclable packaging New conductive carbon-based material Printable green electronics New biobased sensors/electronics enabling authenticity/ traceability	75% of New Zealand products are packaged in recyclable (or with recycled content) or compostable packaging Consumers are selecting products that are better, more affordable, and support the circular economy Development of new prototype biobased packaging and electronics	New Zealand has a circular economy for packaging Recycling is feasible and the norm Re-pulpable recycled fibre solutions with barrier properties are on the market Commercial uptake and technology transfer of novel protype packaging solutions	Scion is regarded as leading advisor on circular bioeconomy Commercial onshore production of biobased electronics

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
plastics and packaging are not currently incentivising the transition to sustainable packaging options Waste: Need to reduce waste to landfill to reduce both methane emissions and mitigate environmental impact	**Distinct products from indigenous fibres** Māori-led design and manufacture of products using indigenous fibre	Foster the revitalisation of Māori traditions using biofibres New products from Māori resources and traditional knowledge	Establishment of a national Māori industry fibres association	An indigenous fibre supply chain and value chain investment is complete A premium cultural brand supporting the Māori economy and tikanga is established	Industry built upon utilisation of indigenous fibres established
	Sustainable composite products Development of existing and new sustainable fibre, polymer and composite products manufactured in New Zealand	New biocomposites for uptake by New Zealand companies Expertise to enable onshore large-scale manufacture of biocomposites Optimised biomass for application – fibre forests, alternative fibres, or renewable polymer feedstocks	Commercial uptake of a new bioproduct for production (Ligate/Woodforce) Multiple novel fibre-polymer composite prototype products	On-shore manufacture of new biocomposites by upgrading or retrofitting existing New Zealand mills Impact of new bioproducts exceeds $100 million pa to the New Zealand economy	Displacement of petrochemical derived composites with innovative fibre products that satisfy internal consumer demands and external emerging markets

Distributed and circular manufacturing portfolio

Vision: Kick-starting a distributed, circular bioeconomy that brings economic, social and environmental benefit to our regions by using the resources of today and tomorrow.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Targeting solutions that impact several industrial value chains resulting in: • $20 billion sustainable GDP growth driven through existing and new companies. • 2500 new regional and rural jobs. Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
Lack of high-value, future-proof jobs in New Zealand's regions Biomass resources (wood and non-wood) that drive a bioeconomy are geographically and seasonally spread-out and under-utilised Some biobased material options are not financially competitive with oil-based alternatives There is a lack of Te Ao Māori in New Zealand's bioeconomy vision and its systems' and value definition Variable definitions of a national-scale circular bioeconomy and uncertainty on how it aligns globally New Zealand manufacturing needs to advance to a resilient, high tech, high value sector that enables New Zealand's circular bioeconomy Lack of chemical industry, advanced biorefinery and bioproduct markets to support a New Zealand circular bioeconomy	**Distributed biomass conversion** We will develop technology that turns biomass waste into products at its origin to use resources that we have; displace non renewables and start a distributed bioeconomy in New Zealand	Regional-scale distributed mobile processing-decision tool developed Modular plant converting lignocellulosic to biochemicals developed Case studies of feasible distributed/ mobile biomass conversion completed Iwi/hapu-led holistic, distributed biomass conversion models developed	Stakeholders are investigating implementation of regional, modular biomass-to-chemical refining options Distributed manufacturing co-development begins with and implementation by Māori partners Distributed manufacturing clusters start to drive regional, pan-sectoral bioeconomy implementation	Modularised biomass conversion enables value from biomass in the regions Increased New Zealand biomass resources are used for bioeconomy products with reduced carbon footprint Increased demand for New Zealand-made bioproducts or refining/conversion technologies	Bioeconomy integrated forest industry sector delivers high-value employment and increased wellbeing to regional communities
	Eco-industrial regions We will design our future primary industry land-use and distributed symbiosis 'value' chains to start the transition to a bioeconomy	Sustainability Indicator Framework for New Zealand symbiosis networks developed Roadmap on New Zealand's path to a distributed, bioeconomy symbiosis network published Regional-scale future land-use decision tool and symbiosis model developed Business models and parameters for symbiosis networks and systems with Te Ao Māori at its heart developed and published	New Zealand policy drives to circular bioeconomy implementation and uptake Primary and secondary industries are integrating networked-symbiosis system in strategies Te Ao Māori-led value chain and techno-economic models enable regional bioeconomy opportunities Distributed manufacturing clusters start to drive regional, pan-sectoral bioeconomy implementation	Networked eco-industrial symbiosis cluster operating – New Zealand biorefinery – increasing regional high-value employment Embedding new technology modules increases New Zealand's wood processing and manufacturing sector's resilience and profit	A distributed and networked New Zealand bioeconomy gives effect to Māori and Pākehā aspirations and ensures intergenerational wellbeing for all

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
	Modular and circular manufacturing We will bring more of New Zealand manufacturing into the forest-based, circular bioeconomy to make it an integral part of a regenerative future for New Zealand	Future regional, modular and distributed forestry manufacturing value chains defined Case studies of modular biomaterial manufacturing systems completed Small-scale, modular forestry product (re)processing technologies developed Models for Māori-led modular and circular manufacturing framework developed Modularised, dynamic, distributed manufacturing technology for New Zealand bioproducts implemented	Increased domestic (and international) demand for bioeconomy technology and materials Increased awareness and demand in New Zealand for modular and mobile, small-scale bioresource processing and recovery technology Regional communities participate in Māori-led symbiosis initiatives Increased circular bioeconomy and technology knowledge in New Zealand's primary industry and manufacturing sectors Distributed manufacturing clusters start to drive regional, pan-sectoral bioeconomy implementation	New Zealand companies produce and export New Zealand-designed and made modular technology and service solutions for the global bioeconomy New Zealand manufacturing industry demonstrated improved efficiency and effectiveness using modular and distributed technology approaches	New Zealand's manufacturing sector is positioned as a resilient, global technology and service leader for the New Zealand and global circular bioeconomy ensuring long-term sustainable GDP growth
Cross-cutting impacts			Further investment/ support in small-scale, modular technology R&D unlocked	Te Ao Māori led regional bioeconomy clusters drive and guide the New Zealand primary and manufacturing sectors Regional thought and action leadership powers a primary industry and (bio) manufacturing sector evolution	Increased sustainable GDP through new eco-industrial regions and symbiosis clusters that make better use of our current and future resources Transform the forestry sector to high-tech, high-value products that replace petrochemical materials and delivers emissions reduction A distributed and networked New Zealand bioeconomy gives effect to Māori and Pākehā aspirations and ensures intergenerational wellbeing for all

Integrated bioenergy portfolio

Vision: Positioning bioenergy as part of the transition away from fossil fuels.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Targeting solutions that impact several industrial value chains resulting in: • Substituting fossil energy and materials with sustainable alternatives. • 10 million tonne reduction in CO_2 equivalents. Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
Over 91% of New Zealand's CO_2 emissions are from energy use (transport and heat) which needs to be reduced to achieve net zero emissions by 2050 The value of petroleum imports were $11.2 billion in 2018 which represents an economic opportunity Reliance on energy from geopolitically unstable sources is a risk to our security of supply Our export products have high carbon footprints The regulatory framework for bioenergy in New Zealand is evolving rapidly so compliance requirements are unclear Rapidly changing requirements in sectors and international bodies are driving change in bioenergy legislation We need to ensure there is enough biomass feedstocks to support bioenergy production in the longer term We need to ensure a 'just' transition in regional New Zealand	**Transport biofuels** Responding to emerging New Zealand legislation and international commitments on climate change by replacing fossil fuels	New technology for marine biofuel production developed Identified the socio-economic benefits of bioenergy Pathways to implementation identified	Full feasibility study and feedstock plan is developed for sustainable aviation fuel plant in New Zealand Investment case for marine biofuels is developed	Commercial scale sustainable aviation fuel plant is operational Marine biofuel plant piloted in New Zealand by venture, and business case defined	Commercial scale (100 million litres pa) marine biofuel plant is operational GHG emissions from transport sector are reduced, making a significant contribution to Paris commitment
	Process heat bioenergy Responding to emerging New Zealand legislation to replace coal and natural gas with bioenergy options	New high energy density, waterproof coal replacement from wood New technology for distributed production of biohydrogen from wastes (with CO_2 capture and utilisation)	Industry scale trial of coal replacement solid fuel demonstrated Ecogas facility in Reporoa is fully operational	Drop-in solid biofuels production in New Zealand is underway and up to 20% of existing coal burners have switched to bioenergy Biohydrogen substitution of natural gas in gas pipelines has started	No coal, significantly less gas being burnt in New Zealand for process heat GHG emissions from process heat sector reduced, making significant contribution to Paris commitment
	Support new bioenergy focused value chains Is there enough biomass? Now and into the future, and ensuring we use biomass in the "best" way	State of the art modelling tools, e.g. energy systems Feedstock plans for new bioenergy production plants, including aviation and marine biofuel production in New Zealand Advanced precision planting/nutrition/processing	A short rotation forestry feedstock trial established with industry Wood energy heat plant demonstration at Scion is operational New biofuel bioenergy policy, legislation has passed and standards enable licence to operate in New Zealand	Energy dedicated production forests established by forest owners One Māori bioenergy company established and operating Commercialisation of new technologies for liquid and solid biofuels started	Sufficient biomass available to support large scale bioenergy industry

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
economies to future energy production and markets					
Cross-cutting research outputs to 2030 and impacts		Best use of biomass for bioenergy established Established relationships (including Māori) embedded in project outputs White papers, reports, manuscripts, and communication articles	New biofuel/ bioenergy policy, legislation and standards enables licence to operate in New Zealand	One Māori bioenergy company established and operating Commercialisation of new technologies for liquid and solid biofuels started	Carbon footprint of New Zealand export goods reduced to level acceptable in markets Energy independence and security position improved through the use of New Zealand energy resources Regional economies are improved with new jobs, feedstock production, and conversion plants Integrated bioenergy makes a significant contribution to the New Zealand circular bioeconomy

Trees to high-volume wood products portfolio

Vision: Supporting the exotic forest sector in New Zealand to deliver highly productive and sustainable forests that produce quality high-volume wood products.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Via the forest, manufacturing and construction industries we aim to: • Increase GDP by $10 billion through low emission, forest diversity, timber products and sustainable and healthy communities. • Reduce CO_2 emissions by 1 million tonnes from the adoption of circular principles. Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
The forestry industry is dependent on a limited number of exotic species, markets and products with no clear contingency plan or tools to cope with a disruption to the value chain either through productivity or market disturbances	**De-risking the forestry sector** **Managing value chain system risk** We will de-risk current, future and alternative value chains through the implementation of risk mitigation and diversification practices	Developed, evaluated and assessed more than two viable contingency species for current *Pinus radiata* cultivars Developed biosecurity surveillance and diagnostic tools to allow industry to prevent and manage new pest and disease incursions Identified new export opportunities and economic models to address loss of primary market access	Contingency species are adopted as a viable option to diversify the forestry estate Industry implementation of integrated biosecurity, pest and disease management models Prototypes of advanced tools and techniques used to control disease and manage biosecurity are developed	Realisation of new commodity value chain opportunities Confidence to re-plant *Pinus radiata* for log and feedstock supply	Trees can be planted in the right setting with confidence that they have the best chance of surviving and remaining productive and profitable Diversified value chains are embedded within the forestry industry Preparedness, ability, and capacity to manage all types of biosecurity threats are in place
Current risks and future threats are increasing with climate change impacting on certainty of our ability to meet supply of high-volume logs	**Protecting the future forestry sector** **Climate adaptive forest management** We will increase resilience to biotic and abiotic stress in trees, forests and landscapes while maintaining productivity	Develop epidemiological models and remote disease monitoring platforms Developed predictive and adaptive management models and frameworks that account for climate change risk to support decision-making Developed new climate adaptive biotechnologies and genetic technologies to protect pine	Prototypes of advanced tools and techniques used to control disease and manage biosecurity are developed	Radiata pine growth is maintained across production clines A shorter rotation of *Pinus radiata* is realised Critical forest management decisions are supported by fit-for-purpose tools Resilient forest management is normalised within the industry and identified as best practice	By 2050, improved diversity, resilience, and productivity of plantation forestry in New Zealand delivers a $5 billion pa increase in GDP through greater forest diversity and timber products Trees can be planted in the right setting with confidence that they have the best chance of surviving and remaining productive and profitable Forests are managed in an integrated way and at an appropriate landscape scale

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
The negative perceptions of radiata pine forestry are compromising the sector's ability to contribute and benefit from ecosystem services, integrated land use, climate change mitigation and the circular bioeconomy	**Transforming the forestry sector** **Sustainable forest management** We will evaluate emerging environmentally sustainable and socially responsible forest management models against their ability to meet public, government and investor scrutiny	Develop forestry management frameworks to minimise environmental impacts and maximise site productivity Develop economic and social ecosystem services benefit look-up tables Develop a rubric for guidance and assessment to build public engagement and social licence	A Māori Forestry Strategy and Implementation Plan is enacted Forests are managed to minimise environmental impacts and maximise site productivity Forests are designed and managed for optimised production and profit	Māori are increasingly at the value-end of the supply chain leading to increased contribution to the Māori economy Planted forests are valued for their ecosystem service	Non-commercial benefits of forestry ecosystem services are realised Public have embraced radiata pine forestry to address climate change challenges Forests are managed in an integrated way and at an appropriate landscape scale. Trees can be planted in the right setting with confidence that they have the best chance of surviving and remaining productive and profitable
Much of our exotic forestry is *Pinus radiata* however its inherent characteristics and current management limits the ability to meet the demands of the wood processing sector which requires greater volume, wood quality and log uniformity	**Improving resilience in the forestry sector** **Managing resilient forests for productivity and wood quality in the face of climate change** We will adapt radiata pine production systems to improve wood quality and productivity to reduce uncertainty in log, fibre, and feedstock supply		Forests are designed and managed for optimised production and profit There is improved wood quality and yields across all sites Large scale planting of improved *Pinus radiata* cultivars is underway	Investment to increase onshore timber processing capacity Consistent supply of high-grade high-volume *Pinus radiata* logs More onshore processing from supply of high-quality *Pinus radiata* logs	New Zealand has a diverse and productive forest estate More wood, fewer trees Trees can be planted in the right setting with confidence that they have the best chance of surviving and remaining productive and profitable

Trees to high-value wood products

Vision: Delivering low-carbon built environments, regenerative communities and intergenerational wellbeing in New Zealand through trees to high-value wood products.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Via the forest, manufacturing and construction industries we aim to: • Increase GDP by $10 billion through low emission, forest diversity, timber products and sustainable and healthy communities. • Reduce CO_2 emissions by 1 million tonnes from the adoption of circular principles. • Have two New Zealand communities adopt circular living concepts.		
			Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
Exotic alternative species are not yet planted at scale and are not clustered in viable wood processing catchments The value of alternative forests and landscape management, regenerating wood while delivering wider benefits, is unknown and unrecognised Potential of Māori-owned forests to sustain long-term Māori housing supply is not yet realised The value of circular manufacturing and low-carbon manufacturing is not captured Alternative tree species, innovative wood products and technologies are struggling to gain market share (and investment) while high-value wood is imported to fulfil internal market demand Design and construction sector stakeholders, consumers and regulators are not confident in the quality and	**Shaping future forestry, processing and built environments** Shaping our future diverse exotic forests, manufacturing and built environments to maximise the holistic values they can provide to us, and to the next generations	Regenerative-productive forest landscapes and processing models are defined supporting productive forests transition to mixed species, continuous cover, selective harvesting and integrated land-use Innovative wood processing, manufacturing and construction approaches are investigated to transition the wood products and building sectors towards circular, high-efficiency and low-impact manufacturing Forests-to-Papakāinga systems and supply chain approaches are co-developed supporting Māori living in healthy homes built by Māori from trees grown and processed on Māori land Circular built environment and communities' models, systems-thinking and roadmap are defined. Supporting regenerative planning and local developments	An increase in alternative species forest areas and catchments and a diversification of forest models Government and industry invest in ongoing R&D on alternative species, forestry and processing Regenerative benefits of productive forests are measured and accounted by industry Industry and Scion establish a long-term sector database infrastructure Local councils are implementing circular, regenerative urban/community principles	Farmers implement productive agroforestry models on their land Forest growers, landowners and wood processors capture new value streams from regenerative forestry and alternative species A circular bio-economy model is successfully applied to Māori housing. Māori are increasingly living in healthy homes grown from and located on Māori land providing intergenerational health and housing security Wood manufacturers and construction stakeholders implement circular manufacturing processes	A New Zealand forestry model for new productive forests has transitioned to mixed species, selective harvesting and integrated land use Wood manufacturers and construction deliver full circularity. Products are fit for markets Large-scale developers implement circular regenerative principles on building and/or neighbourhood developments

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
performance of high-value wood products The benefits of transition to a wood-based circular and regenerative built environment and communities are little known The holistic value of an integrated New Zealand forestry-wood products value system is largely unknown. This limits the opportunity to capture higher value for the sector The wider regulatory system needs to enforce quality control and best-practice towards goals and incentivising value-added products and solutions	**Quality, performance and innovations** Delivering prosperity to our sector and communities by ensuring that our diverse exotic trees, their wood products and systems are of high quality and deliver performance and low impact over their life cycle Ensuring ongoing innovation pathways and adaption of Māori technical ingenuity and practice	Durability pathways are developing integrating specialty species natural durability, tree genetic enhancements, wood thermo-chemical modifications together with building physics design and construction principles Wood and wood products are modified, engineered and processed to deliver fit for in-use performance supporting new market opportunities for high-value exotic species, timber, wood processing, products and construction systems Novel high-tech wood products for new and speciality applications are developed and prototyped Fundamental wood science knowledge is enhanced Scion's strategic infrastructure of scientific knowledge, data and physical facilities are maintained and upgraded for the benefit of Scion and New Zealand	Genetic and breeding stakeholders deploy trials of diverse tree species Wood processing and manufacturing industry partners are commercialising new high-value wood products and innovations Local council building authorities accept alternative solutions based on building physics and timber design guidelines Building Code and ASNZ Standards include a variety of performing products and species	Regulation enables industry implementation of wood-performance-based genomic selection methods and market deployment Wood processing and manufacturing industry process high-value products from alternative species at increasing scale and capacity Large housing developers transition to wood-based construction medium density housing	The forest and wood product sectors are fulfilling the increasing internal demand for specialist timber through a variety of products and species Export markets increase demand for New Zealand brand high-value wood products and innovations Wood is the market's material of choice for low-carbon and healthy buildings
	Removing barriers and enabling higher values through partnerships Mapping the holistic value flows across the forest-wood community value	Forest-wood-community circular values-system are mapped linking the forests, the products and the people Forest-wood-community circular	Regenerative forest and products labelling inform consumers choice Industry adapts plans and procedures based on holistic value stream	Policy makers adapt plans and procedures based on holistic value stream modelling Local and central government provide regulation and	The value of diverse exotic forests and wood products is harnessed by the sector stakeholders and celebrated and preferred by our society

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
	system, identifying interdependencies and opportunities to deliver higher-value through circular regenerative approaches Partnering for change, to remove barriers and create the right context – industrial, market, regulatory, educational, economic and socio-cultural – for transitioning to a wood-based, low-carbon, circular and regenerative future	values-system interdependencies and socio-economic and environmental values flows are defined and modelled New sector partnerships for change are developed, supporting cross-industries initiative to enable higher-values across the forest-wood-community-value system New policy and decision making are supported by robust science outcomes and data at all stages, supporting transitions to circular biobased forestry, wood processing, timber construction and low-carbon built environments Te Tiriti and Te Ao Māori pathway approaches are co-developed or adopted specific to supporting new opportunities for Māori to develop healthy and sustainable homes from trees grown, owned and processed by Māori on whenua Māori Co-creation, participatory action, and co-innovation are developed or adopted to enable education, awareness and community engagement towards transition to the wood-based circular bioeconomy	modelling A NZ Timber Design Centre supports sector, regulators and end-users providing knowledge and education The industry sector accounts for temporary carbon storage in construction wood products	incentivise wood construction The forestry, wood processing and timber design and construction associations are confederated	New Zealand is recognised as an international leader/ hub for carbon-positive wood architecture, built environment

Distinct value indigenous wood products portfolio

Vision: Mō te oranga o ngā uri whakatupu a Tāne Mahuta – for the wellbeing, sustenance and regeneration of the future generations depending on Tāne Mahuta.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Via the forest, manufacturing and construction industries we aim to: • Increase GDP by $10 billion through low emission, forest diversity, timber products and sustainable and healthy communities. • Reduce CO_2 emissions by 1 million tonnes from the adoption of circular principles. **Impacts delivered with our partners**		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
Historic over-exploitation and conservation lobbying of our indigenous wood forests has fuelled anti-harvest sentiment, low social licence, and is limiting freedom to operate The tools of policy, regulation and incentives have been roadblocks for Māori and private landowners. The risk management and sustainability of these forests are not prioritised The Treaty of Waitangi promised undisturbed possession of the forests to the chiefs of the time, but they were annexed by legislation and regulations – UNDRIP, Wai262, recommendations support indigenous licence as critical to wood trading, genetic improvement and breeding Indigenous forests represent 0.05% of New Zealand's national annual forestry harvest. R&D spend on indigenous wood products is less than 1% The price per cubic	**New, scalable indigenous forest-to-wood product paradigms** Values-based modelling and communicating for a new distinct value taonga product create the building blocks for Māori-led and private landowner value chains at scale Harvestable and distinct indigenous forest - special nature, culture-full, tikanga-led, regenerative mauri-centred, place-based and whole-systems	Facilitate the development of a national indigenous wood strategy by 2023 Social licence study communications plan and campaign National resource stocktake informs several scaled provenance forest with digital fingerprints Modelling a system for multi-management regimes (with and without other land uses) and enabling bio-origin tree breeding capabilities Two optimised indigenous wood supply chains operating at a regional/national scale	People are investing in new indigenous forest farms in rural communities and are welcoming new business to the regions Māori and private landowners are propagating seedlings sharing seed systems knowledge Trees are being planted at scale on under-utilised land Indigenous permanent production systems are highly valued	People embrace trees as living enablers, and we are exceeding New Zealand's planting goals We see diversified forests and landscapes. We operate in diversified sectors and benefit flows back into these forests and landscapes Ngāhere Māori value chains are leading the sector and fortifying the cultural identity of indigenous forests	>15% of production forestry stocks are fast-growing indigenous species Existing and new indigenous wood forest systems are future proofed with the latest technology, methods and new tools Other productive sectors have been integrated and are being driven by values and system flows A national indigenous forestry strategy prioritises intergenerational forestry outcomes for New Zealand
	Reinforcing distributive intergenerational economics Developing a framework for forest-to-wood product to appropriately value and support the people that depend on distinct value indigenous forests and products	A theoretical economics and distributions framework for long-term stocks and flows Modelling and testing the intergenerational economics theory - applying to land-use and adjusting to yield long-term wellbeing, 'whole systems' and mitigation of risk	Intergenerational economics theory legitimises Māori and whole systems perspectives through the production, finance, investment and property sectors Government has simplified welfare and environmental spending because people are treating their low carbon	Indigenous-forest-to wood-product sector is where people want to work in and do business with New Zealanders are starting to enjoy newfound freedom to plan, save and invest using natural capital and wellbeing-centred tax credits and incentives	Resilient communities are built not by income but by increased levels of understanding, social cohesion and reciprocity The world is working within planetary boundaries as global intergenerational priorities expand We have the dreams

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
metre is more than pine and local diversity mitigates risk – we need to rethink The quantity and quality of indigenous wood resource on Māori and private land is not well understood, and we lack improved (resilient, productive) indigenous stocks		Demonstrating the theory on multi-use ngahere farms	assets and investments differently		of the next generation in our new forests
	Launch a wood with meaning indigenous wood products futures lab Facilitate an independent distinct value in-market product incubator to grow community, domestic and export markets for interior appearance, high value furniture, exterior/hardwood, whakairo/cultural and indigenous value chain applications	Distinct value tikanga and value transmitted through bio-origins products Resilient distinct value markets and value chains characterised	Designers and architects are driving distinct value indigenous product lines Highly praised appearance and exterior wood applications are being used on marae and other heritage buildings Values-based industries are defining the way of the future	An intergenerational wood products movement is driving a sense of pride through communities Architectural and design awards are being won in distinct value categories Consumers feel a high sense of contribution to New Zealand through indigenous wood products. Tohunga Whakairo are driving values and information about wood products	A consumer's life is enhanced, and society is improving because of wood values All New Zealanders value and utilise indigenous forests as Māori once did Led by multi-use ngahere products, forestry champions the meaning behind distinct value New Zealand primary exports
Cross cutting research outputs and impacts	Established best practice and published papers, reports, manuscripts, and articles		Values based industries are defining the way of the future		Led by multi-use ngahere products forestry champions the meaning behind distinct value New Zealand primary exports

New value digital forest and wood sector portfolio

Vision: Transforming our forest and wood product ecosystem in New Zealand through digitisation and automation enabling new players, platforms and jobs.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Via the forest, manufacturing and construction industries we aim to: • Increase GDP by $10 billion through low emission, forest diversity, timber products and sustainable and healthy communities. • Reduce CO_2 emissions by 1 million tonnes from the adoption of circular principles. Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
Current and future markets are uncertain as demand and supply fluctuates and inventory flows are hard to visualise in a disconnected productive forest and wood processing system	**Supply chain connectivity** We will enable a smart connected supply chain for the forestry and wood products sector by enabling visibility of wood flows to market, predictive modelling and traceability	Developed an advanced forestry inventory model at national scale Developed a model of the current supply chain Developed predictive models for new supply/value chains	Regional wood flow variation and side stream potential is realised A connected view of information flow in the New Zealand forestry supply chain allows industry to identify automation opportunities	A dynamic wood flow model at national scale allows full visibility of the forest inventory for government Data traceability through forestry supply chain drives automation and protection for industry	Measurement, monitoring and evaluation of productive forest at scale drives sustainable practice New entrants into the forestry and biobased products sector have a baseline to assess supply chain and market A national view of forest inventory unlocks planning and modelling at scale and offers greater protection for our natural capital
Simulation and modelling of change agents such as climate change, biotic, abiotic and economic risks as it contributes to productivity is not easily accessible or available	**Intelligent forestry systems** We will bring together data and intelligent analysis to visualise New Zealand's national productive estate and simulate change under current and future conditions using deep learning delivering digital forest experiences through mixed realities	Developed national scale, spatial, change simulation model under different conditions Developed 3D models using synthetic data generation and 3D generative techniques Developed decision support models at individual tree level and next generation productivity models	Foresters have the ability to predict and forecast productivity and risk at scale spatially Forestry has an agreed data collaboration approach to drive sector innovation	A national scale risk modelling platform for forest growers drives decision support Real time data from national scale sensor informs new real time risk and productivity models	A national 'digital twin' of productive estate to simulate growth, assess risk and productivity A public/private national scale productive forest risk, inventory and health decision support platform
Precision forestry and manufacturing methods and interoperability are well underway but have not been	**Precision forestry at scale** Using advanced tissue culture methods, matching	Developed an advanced single tree phenotyping platform Developed precision embryo selection	Data sharing across industry partners drives greater collective knowledge Technology has	Individual tree characterisation methods transferred to industry enable precision management,	An automated health assessment platform delivers more precise forest inventories alongside improved silviculture using

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
operationalised as knowledge has yet to be scaled up and scaled out	best genotypes to the site environment through phenotyping and managing lifecycle through precision management we will transform the way forestry industry selects, plants, manages trees	protocol using machine learning/ adapted fluidics systems Advanced single tree characterisation methods End-to-end precision tree management model including wood quality post-harvest	enhanced selection of best genetics to aid growth	inventory and estate valuation services Cultural identity of Māori forests are fortified through cultural phenotyping. This drives right tree, right place, right purpose on Māori land	individual tree methods
The scale and remote nature of forestry breeds greater health and safety risks which leads to labour and skills shortages and a need for new ways of working through digitisation and automation	**Future-proofing forestry** Digital-led forestry and wood processing transformation to support the existing workforce and attract new people into highly skilled, safer jobs, that lift productivity, job satisfaction and environmental outcomes	Innovating towards future silviculture and harvesting systems Digital nursery demonstration scale at Scion Modelling risks and benefits of mechanised/ automated technologies Informed technology policy/regulation	Three automated log sort yards in operation drive efficiency Experiential education upskill supports existing workforce and attracts new people into jobs	Forestry futures lab showcase jobs, tech, skills for forestry and wood processing	75% of forestry silviculture and harvesting now mechanised or automated for enhanced productivity Greater precision, mechanisation/ automation increases forest carbon value by $1.35 billion and net present value of timber by $479 million

Establishing indigenous forests portfolio

Vision: Enabling New Zealanders to recloak the whenua by helping to establish indigenous forests so that these forests will be resilient and thrive, bringing health, wealth and wellbeing to communities, ecosystems and the environment.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Via permanent standing forests we aim to achieve: • 100% increase in afforestation of highly erodible red zone land. • Converting 30% of underutilised Māori land to standing forest plantations. • 80% increase in forested area managed to enhance soil and water resources, biodiversity, landscape resilience.		
			Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
Propagation methods for indigenous tree species are needed that are cheaper, more reliable and sustainable. These methods must consider Treaty obligations We need to plant at scale to establish a large area of healthy and resilient indigenous plants to meet government goals The public and farming communities may not welcome large-scale plantings Guidelines, tools and methods are required to grow and site indigenous forests now and for future generations	**Indigenous plant production at scale** Cultural protocols, frameworks and tikanga Māori-led and kaupapa research Seed orchard and breeding methodologies for indigenous trees Seed, plants and nurseries at scale Nurseries at all scales – large, medium and small Co-developed breeding Case studies, tools, methods, workshops, capacity and capability building	Healthy, cost-effective and sustainable plant production methods at scale improved and developed Co-developed seed orchard and breeding methodologies for indigenous trees Māori nursery protocols, frameworks and tikanga developed	Propagation protocols and plant quality metrics for indigenous forest plants are adopted Māori-nursery collective is established Solutions mitigating the limitation of seed supply are developed Strategic partnerships are established between Scion and Te Uru Rākau, Māori, Whenua Oho, DOC, Manaaki Whenua, NZPPI, Tānes Tree Trust and Pāmu	A productive financially viable and thriving indigenous forest nursery industry is established Māori-led indigenous forest initiative is launched Co-developed active forest breeding programmes with sovereignty solutions are implemented	Indigenous nurseries are producing high-quality forest plants in a way that is more sustainable and circular Large-scale propagation of indigenous forest plants results in the Government's goal of planting 300,000 ha by 2050 being on track
Multi-species multi-age forests have a whole new complexity where we need new adaptive and active ways to support all future uses and climate outcomes Under-storey or pre-canopy value chains are limited, and their potential is under-realised Policy and legislation that facilitates the widespread planting	**Smart establishment of indigenous forests** Seed orchard and breeding methodologies for indigenous trees Māori-led and kaupapa research Mapping biogeographical zones with climate change Active stewardship	Create site species matching tools for indigenous species with and without climate change New forest establishment and management regimes developed for different sites, scales and purposes Frameworks are developed for informed ecosourcing	Demonstration forests are planted on Māori, Pāmu and other land. Māori-led forest methodologies and frameworks for propagation are identified and described Indigenous forest plantings are successful, and more land is being planted	Siting of new indigenous forests across different eco-zones with and without climate change is being actively adopted by landowners	Co-developed appropriate active forest management systems are being implemented by forest industry and landowners A national seed ecosourcing system (regulations and best practice) is established Large-scale propagation of indigenous forest plants results in the Government's goal

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
of indigenous forests is needed Māori rights and interests have not been adequately enabled and the potential is yet to be realised	Sensible eco-sourcing Case studies, tools, workshops, capacity and capability building				of planting 300,000 ha by 2050 being on track
	Establishment of complex indigenous forests Testing and piloting new types of complex planted forest Active and adaptive forest management Complex forest modelling Inter-cropping value chains and taonga species	Active and adaptive forest stewardship championed as a living method of ecosystem management Inter-cropping and kaupapa-led under-storey taonga species identified for multiple uses and described	New permanent forest systems have been designed and demonstration forests are planned for establishment Strategic partnerships established between Scion and Māori, DOC, Pāmu and Te Uru Rākau	New designed permanent forest systems have been designed and demonstration forests are being established	Scion and Te Uru Rākau are working with partners to establish new complex forests across New Zealand
Cross-cutting research outputs to 2030 and impacts		Partnerships and relationships White papers, reports, manuscripts and communication articles; tools, workshops, capacity and capability	Strategic partnerships are established between Scion and Te Uru Rākau, Māori, Whenua Oho, DOC, Manaaki Whenua, NZPPI, Tānes Tree Trust and Pāmu	Partnerships between landowners and with Te Uru Rākau are in place	People's lives are enriched through their connection with nature Improved human health Resilient rural communities with attractive career opportunities

Restoration, protection and mauri o Te Waonui a Tāne portfolio

Vision: Ko te Whakahaumanu, Ko te Whakamaru, Ko te Mauri Ora o Te Waonui a Tāne me Te Ao Tūroa - Restoration, protection o Te Waonui a Tāne for intergenerational prosperity and perpetuity.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Via permanent standing forests we aim to achieve: • 80% increase in forested area managed to enhance soil and water resources, biodiversity, landscape resilience. • 100% increase in the use of forests for human health and wellbeing. • 100% increase in the value of Māori standing forests with maximum carbon net returns defined by landowner values.		
			Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
Single-factor focused solutions do not address the complexity and holistic nature of the biophysical systems and biocultural relationships with Te Waonui a Tāne Associated research, science and innovation is often led by dominant worldviews and does not access the opportunities of indigenous knowledge systems	**Ecological wellbeing** Kia Ora Te Waonui a Tāne	Together with Māori partners, develop a set of projects that value Te Ao Māori worldviews, enriching Aotearoa ngahere knowledge depth and data through methods largely unexplored by science Māori centred research that enables capacity, capability and leadership in ngahere ecosystem science, innovation, priorities and initiatives	Kaitiakitanga approaches to environmental science, regeneration and adaptation Enabling Māori centred and co-developed research projects has led to improved ngahere health	Contributed traditional ecological knowledge has resulted in meaningful data and implementation strategies, practices and protocols resulting in resilient ngahere biodiversity and ecosystems	An ecosystem approach to ngahere health and diversity Te Ao Māori ecosystem concepts are understood as complementary and have created many opportunities for environmental and human wellbeing outcomes, locally, nationally and internationally
New Zealand's unique indigenous forest ecosystems are under ongoing increasing stress from multiple factors (abiotic/biotic threats, e.g. climate, pests, insects, pathogens, land use, human impacts) An absence of a Te Tiriti approach has resulted in missed opportunities for new and novel solutions to improving forest ngahere health	**Protect and restore indigenous forests** Whakamaru ngahere	Methods, protocols and tools to effectively quantify and prioritise existing and new pests and pathogens that pose a threat to our ngahere Predicting extreme fire; integrated fire experiments; preparedness for wildfire; safeguarding indigenous ngahere; smart firefighting; reigniting Māori relationships with fire Economic and socio-cultural ngahere landscape and species research to better inform local and national organisations and agency's strategies and policies	Reduced likelihood of new pest establishment through increased sharing of knowledge and network collaborations Activating innovative and meaningful participatory approaches to connect with Māori and community through involvement in ngahere research	Reduced impact of established pests through partnerships and delivery of advice, actions and resources for community, tangata whenua, local and central government RS&I Flammability knowledge and dataset baselines with multi-factor risk modelling for New Zealand landscapes and conditions Data sets of contributing risk factors (climate, wildfire, pests, pathogens, weeds) are in a central risk database enabling agencies to build (past), present and	Strategic collaborative approaches, new technologies, partnerships and clear direction for mobilising 'Ko tatou – This is Us' to effectively protect against the impacts of abiotic and biotic threats to New Zealand ngahere World leading predictive extreme wildfire knowledge for spread, rural urban interface and new mitigation options enabled though policy Māori, community and industry research co-development through trusted relationships

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
		Climate change and bioprotection research, framework, strategies and approaches for local, regional and national inclusion Tools and technology available to support New Zealand make informed climate and biosecurity (aggregated) risk decisions		future combined risk, climate and carbon scenarios	for improved mobilisation and implementation Government, tangata whenua and private landowners are making informed decisions for the ngahere around intervention and resourcing with aggregated risks from climate, fire, pests and pathogens modelling Carbon stores are protected

Designing forests - Mahi tahi whaihua portfolio

Vision: Designing forests to meet the needs and values of communities that restore and enhance New Zealand's natural capital, delivering sustainable and resilient ecosystem functions and equitable outcomes over generations.

Critical issues	Programmes	Research outputs to 2030	**Contributes to:** Via permanent standing forests we aim to achieve: • 100% increase in afforestation of highly erodible red zone land. • 8 million tonnes increase in sequestered above and below ground carbon storage in new forests. • 80% increase in forested area managed to enhance soil and water resources, biodiversity, landscape resilience. • 100% increase in the use of forests for human health and wellbeing.		
			Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
New Zealand's economic base, including the primary sector and tourism, is directly reliant on a healthy productive environment. Exploitation beyond what the natural resources can sustainably support undermines the systems that depend on it Climate change biodiversity loss, soil and water quality, changes to pests, diseases, increased fire and other threats are interconnected yet typically addressed in isolation. Holistic response and systems-level change are needed Carbon stored in forests, particularly forest soils is at risk of loss due to climate change. Any shift in forest carbon fundamentally alters system ecology and function, changing our soil and water quality, biodiversity and net productivity The rural sector is often operating as fragmented, vulnerable, individual components, leading to unsatisfactory outcomes for	**Complex forests systems** Recognising multiple, rapid changes impacting forests, changing needs and expectations of forests and enabling solutions	Enabled decision making based on amalgam of information, spanning empirical data to cultural value-based systems Natural capital valuation tool that can enable holistic planning and decision making when considering types and placement of trees and forests in New Zealand Entirely new areas of ecological understanding of complex forest behaviour and function that is needed to protect forest multifunctionality and resilience in changing conditions (spanning pests, diseases to climate shifts)	Growth and ecosystem service data layers are established for a range of exotic and indigenous plants. These publicly available layers assist in informed planting decisions Long-term trials are established to understand how the ecology of complex forest systems function in changing climate. These trials serve an outreach and demonstration purpose	A natural capital framework is in place to enable equitable and long-term decision making on land use options Complex forests are increasingly being established for their resilience to pests and climate change These complex forests have bespoke portfolios of ecosystems functions These forests avoid the perverse outcomes of planting for a single function, e.g. carbon storage	Forest systems across New Zealand are regenerating natural capital across the physical, social, human, financial and cultural domains, providing a safe, prosperous, equitable future for all Complexity of species and management enables New Zealand's forest systems to be resilient to abiotic and biotic threats while sustainably delivering a mixed portfolio of ecosystem functions and meeting the specific needs of each community
	Carbon secure forests Simultaneously meet New Zealand's climate change obligations and protect, sequester and retain carbon	Carbon budgets and sequestration rate predictions for diverse range of tree species and forest types under varying climate scenarios Capacity for holistic carbon accounting, capturing carbon's full value in supporting natural capital Innovative designs of climate smart forest	Quantify carbon budgets for exemplar production and indigenous forests, including root soil and subsoil components. This information informs and updates New Zealand's ETS carbon accounting schemes Release a new framework that reconceptualises	Sensitivity of forest carbon balance to ecosystem change is mapped under different climate scenarios; Risks to ecosystem functions understood, quantified to enable mitigation planning Novel methods for forest soil carbon stabilisation are established and forests are planted to	New Zealand forests remain a carbon sink, enabling New Zealand to meet zero carbon ambitions

Critical issues	Programmes	Research outputs to 2030	Impacts delivered with our partners		
			Short term (1-5 years)	Medium term (~ 10 years)	Long term (~ 20 years)
communities, environments, and the sectors themselves Urban centres are critical zones where sea-level rise, heat waves, coastal pollution, waste and storm water discharge, most strongly impact people, infrastructure and coastal margins		systems that protect forest carbon stocks for generations	carbon in terms of its role in delivering ecosystem functions and supporting natural capital	store carbon in perpetuity	
	Resilient landscapes Integration of trees into natural and managed landscapes for a diverse range of purposes	Design options operating across spatial scales that can integrate trees and forests into farm systems and landscapes for specific needs, e.g. water quality, soil stabilisation, or biodiversity Tools and approaches available to protect iconic landscapes, sensitive catchments and other valuable whenua from degradation	Key barriers to integration of trees onto farms and landscapes identified and communicated to all stakeholders. Strategies to overcome these barriers co-developed New tools and knowledge deployed that are enabling purposeful integration of trees into natural and managed landscapes to meet range of purposes	Complex forests are in place providing diversity of income and jobs, stabilising hill slopes, keeping topsoil in place, and protecting watersheds Landscape values and functions are restored and preserved Specific community needs for trees and forests are met, e.g. soil stabilisation on erodible land	Landscapes and farms have been transitioned from vulnerable individual components into connected, complex and resilient systems
	Urban ecosystems Trees as green infrastructure, enabling healthy and connected communities in urban environments	Informed community and council/ regulatory decision making and policy for urban forestry to protect infrastructure, properties and communities from sea level change, storm events, winds and other adverse events Enabled modelling of trees in urban environments for scenario projection, engagement and education allowing for placing of the right trees for the right purpose	A National Urban Forestry Strategy is released highlighting risks and opportunities for trees in urban centres and providing guiding principles for design of urban forests around community needs Education packages for schools and other learning centres are in place	Increase in canopy cover in major urban centres results in enhanced community health and wellbeing, lower insurance claims for storm events, greater biodiversity outcomes and significantly improved water quality Communities are digitally connected to their urban forest, engaging them in tree health, urban resilience and shared outcomes	Design of trees into urban ecosystems provides a multitude of benefits to infrastructure and communities, particularly for climate change resilience, biosecurity and biodiversity, water quality and reducing inequality

Appendix 2: Other matters required by the CRI Act 1992

Information to be reported to shareholders

Scion will provide information that meets the requirements of the:

- Crown Research Institutes Act 1992 (the Act);
- Companies Act 1993;
- Financial Reporting Act 1993;
- Crown Entities Act 2004; and
- New Zealand Institute of Chartered Accountants (NZICA) with regards to Generally Accepted Accounting Practice (GAAP).

The following information is made available to enable our shareholders to make an informed assessment of Scion's performance:

- A Statement of Corporate Intent (SCI) which sets out Scion's strategy for delivering against its core purpose and the company's financial and non-financial performance targets. The draft SCI is due not later than one month before the start of the financial year (31 May).
- An Annual Report containing sufficient information to allow an informed assessment to be made against the performance targets in the SCI. This report includes comments on our core business and how we communicate our science, financial statements (including audit report), and a report from the Directors to the shareholders. The Annual Report is to be provided within three months of the financial year ended 30 June. A public Annual General Meeting is to be held no later than six months after balance date and not later than 15 months after the previous AGM.
- A Half-Yearly Report containing unaudited financial statements (including comparatives of the same period in the previous year) and major highlights during the period. The Half-Yearly Report is due within two months of the first half of each financial year ended 31 December.
- A Quarterly Report containing information such as unaudited financial statements (including current quarter and year-to-date budgets and a forecast for the financial year ended 30 June). The Quarterly Report also includes financial performance measures and progress towards meeting non-financial performance targets. The Quarterly Report is currently requested within one month of each financial quarter ended 30 September, 31 December, 31 March, and 30 June.
- Any other information relating to the affairs of the company, as reasonably required by shareholders, under section 20 of the Act and section 45B of the Public Finance Act 1989.

Accounting policies

Scion adopts generally accepted accounting practice in New Zealand as prescribed by the External Reporting Board.

The accounting policies for the measurement and reporting of financial performance, movements in equity, financial position, and cash flows are detailed in Scion's Annual Reports available at www.scionresearch.com

Dividend policy

In determining the amount of ongoing dividend (if any) recommended to be distributed to the shareholders, consideration will be given to:

- providing for capital investment requirements and consideration as to whether there is a need for capital injection from shareholders;
- Scion's working capital requirements;
- the ongoing financial viability of Scion, including the ability to repay debt;
- the need to comply with Bank Covenants;
- the obligations of the directors under the Companies Act 1993 and other statutory requirements;
- resilience against fluctuations in the demand for Scion's services;
- the need to ensure the maintenance of scientific capability through the provision of scientific technology, equipment and science capability building.

Any dividend would be paid within three months of the financial year-end.

Activities where shareholder compensation would be required

The Board would look to seek compensation from the shareholders in the following circumstances:

- Where the shareholders instruct Scion to undertake activities or assume obligations that would result in a reduction of the company's profit or net realisable value.
- Where the Board may consider undertaking strategic investments for the wider benefit of the New Zealand public, involving financial outlays beyond those incorporated within the company's Statement of Corporate Intent or financing capabilities.

  No request for compensation is currently being sought from the shareholders. At this time no such investment has been identified, nor have any financial projections for such investment been included in Scion's 2022-2025 Statement of Corporate Intent.

Other matters specifically requested by the shareholder

There are no other matters that have been specifically requested by the shareholders.

Significant transactions policy

As required by section 13(1)(d) of the Crown Research Institutes Act 1992, neither Scion nor its subsidiaries will acquire:

- shares that give it substantial influence in or over a company; or
- an interest in any partnership, joint venture, or other association of persons, or an interest in a company other than in its shares; or
- settle, or be or appoint a trustee of, a trust except after written notice to the shareholding Ministers.

The Board will obtain prior written consent from shareholding Ministers for any transaction or series of transactions involving a full or partial acquisition, disposal or modification of property (buildings, land, and capital equipment) and other assets with a value equivalent to or greater than $10m.

The Board will obtain prior written consent for any transaction or series of transactions with a value equivalent to or greater than $5m involving:

- the acquisition or disposal, in full or in part, of shares or interests in a subsidiary, external company or business unit
- transactions that affect a company's ownership of a subsidiary or a subsidiary's ownership of another entity (provided that transactions which include "drag-along" clauses that compel Scion to sell interests at a future date at the direction of the investors shall be valued at the time of the investment transaction)
- other transactions that fall outside the scope of the definition of the company's core business or that may have a material effect on the company's science capabilities.

The Board will advise shareholding Ministers in writing before entering any transaction related to property and commercialisation activities below this threshold in accordance with notice requirements agreed between the Ministers and Scion from time to time.

Commercial value of the shareholders' investment

Section 16(3) of the Act requires the Scion Group to furnish an estimate of the current commercial value of the Crown's investment. The Scion Board is satisfied that the projected net asset position (or shareholders' funds) as at 30 June 2022 is a fair and reasonable indication of the commercial value of the Group. The net asset position as shown in accordance with the company's accounting policies for 30 June 2021 was $53 million.

Appendix 3: References

[1] A Finnish forest products manufacturer

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Yao, R. T., & Velarde, S. J. (2014). *Ecosystem services in the Ōhiwa catchment* (A commissioned report submitted by Scion to the Bay of Plenty Regional Council.) https://www.boprc.govt.nz/media/395767/ecosystem-services-in-the-ohiwa-catchment.pdf

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[5] Yao, R., & Kaval, P. (2010). Valuing biodiversity enhancement in New Zealand. *International Journal of Ecological Economics and Statistics*, 16(10), 26-42.

[6] Collins, C. (1996). *Forests and the carbon cycle: Emerging opportunties for native forest protection and afforestation in New Zealand.* Conservation Advisory Science Notes No. 132. Department of Conservation. Wellington.

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