

# GNS SCIENCE TE PŪ AO



## OUR STATEMENT OF CORPORATE INTENT

JULY 2021 – JUNE 2026

**OUR PEOPLE  
OUR SCIENCE  
OUR OUTCOMES**

*Ō tātou tāngata  
Tō tātou pūtaiao  
Ō tātou putanga*

**MAI I TE RANGI, KI TE NUKU O TE WHENUA,  
KA PUTA TE IRA TANGATA I TE PO,  
I TE WHAIAO, I TE AO MARAMA.**


**NAU MAI, HAERE MAI KI TE PŪ AO**

*From the sky and the land came people,  
from the night, to the old world, to the world of light.*

*Welcome to GNS Science*

 Servicing DWARFS seismometer station above the  
South Westland Alpine Fault

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# INTRODUCTION FROM THE CHAIR AND CEO

**We are pleased to introduce the GNS Science Statement of Corporate Intent for 2021-2026. It reaffirms GNS Science's strategic direction and our commitment to achieving a Cleaner, Safer, More Prosperous New Zealand. It also sets the framework for the key activities GNS Science will undertake in the 2021/22 year.**

The COVID-19 pandemic has changed the priorities and needs of communities across Aotearoa New Zealand and around the world. It shone a spotlight on the importance of science and technology – in undertaking research, delivering analysis and offering solutions. After weathering the immediate impacts of the pandemic, GNS Science is now focused on supporting long-term economic recovery for Aotearoa New Zealand. These issues, along with the need to build a vibrant and sustainable future for GNS Science, are central to our strategic direction in the next five years.

## **WHAKAARI/WHITE ISLAND**

Over the coming year, we will continue to respond to the charges laid against GNS Science as a result of the investigation into the Whakaari/White Island eruption. This process is having a significant impact on the organisation and requires a substantial commitment of time and resources.

We are trying to find ways to avoid or minimise the adverse impact on research teams involved, both by providing additional resources or delaying the delivery times of research work and by supporting people personally through a turbulent time. Alongside this, we continue to review and improve our processes and approaches as part of our commitment to continuous improvement.

## **THE SCIENCE ROADMAP AND THEME PLANS**

In the GNS Science Strategic Review, completed in 2019, we sought to align our strategic direction with Government priorities and the needs of our stakeholders, industry partners and iwi/Māori interests. The next step in this process is the development of our Science Roadmap. This document will describe our future science direction and focus to 2030 and ensure our outcomes-focused Science Themes are driving the delivery of impactful and relevant science for the country.

The Roadmap will be completed in the coming year and will guide our organisational priorities in future years. We know Aotearoa New Zealand needs to be at the edge of innovation and technology to succeed in the future, and we intend to make a significant and enduring contribution through relevant, agile and adaptable science, and innovative thought leadership. Each of our four Science Themes – Natural Hazards and Risks, Environment and Climate, Energy Futures and Land and Marine Geoscience – will complete a Theme Plan to facilitate implementation of the Roadmap.

Staying strategically aligned with Government direction and priorities remains key to our purpose, and GNS Science is well positioned to support government initiatives. For example, progress within our energy futures theme, which includes being chosen as the new Advanced Energy Technology SSIF Platform host and our research into new materials and green hydrogen production, is a key enabler in the move to a zero carbon economy.

## **OUR PEOPLE, OUR CAPABILITY**

Alongside the implementation of the Science Roadmap, we will continue to invest in people and infrastructure to maintain capability and capacity in key areas for Aotearoa New Zealand.

In order to enable innovative and integrative research and support new ways of working, updating our infrastructure will continue to be a priority in the years ahead. In the coming year, GNS Science is committed to completing our Property Strategy and progressing its implementation. Our current buildings are old and are no longer fit for purpose. Contemporary facilities will ensure the delivery of great science, minimise health and safety risks to our staff, and bring people together to enable connection, collaboration, and innovation. We will work closely with others in the science system to ensure the best outcomes – for GNS Science and Aotearoa New Zealand.

## **GEONET AT 20: WHERE TO FROM HERE?**

The GeoNet programme will celebrate its 20-year anniversary in July 2021, and the programme will mark this milestone with a year of special events. GeoNet's achievements over two decades are too many to list: it was established to deliver the core elements of a modern geological hazards monitoring system, but has evolved into a system which monitors a range of parameters related to earthquakes, tsunami, volcanoes and geothermal, and landslides.

The GeoNet investment has delivered significant benefits to New Zealand. Its world class datasets underpin extensive research which has advanced our understanding of earthquakes, tsunami, volcanoes and landslides. It is used by scientists both in New Zealand and overseas, contributing to a safer and more resilient world.

In the 2021/22 year, we will be updating the GeoNet contracts to reflect the scope and complexity of GeoNet operations. A strategic review of the GeoNet programme will also be completed, which will guide the programme into the future.

# HE KUPU WHAKATAKI MAI I TE TIAMANA ME TE TUMUAKI

## WORKING TOGETHER FOR THE FUTURE

Collaboration and interdisciplinary research partnerships are key in enabling us to deliver on our Science Themes. We will continue to collaborate whenever possible with Crown Research Institutes (CRI) and other partners, both nationally and internationally – seeking new relationships and deepening existing ones. In particular, we are building on the increased collaboration amongst the CRIs evident during the response to the COVID-19 pandemic, and as a result of the *Te Pae Kahurangi* review report.

Our relationships and partnerships with Māori are also essential as we continue to incorporate mātauranga Māori into relevant research programmes and build internal and external capability. Over the coming year we will develop and implement a Vision Mātauranga training programme, which will include staff workshops and a review of our Ahunuku (Māori scholarship) programme.

We will also be working with other CRIs to agree a consistent approach to working with Māori/iwi to strengthen the capability, skills and networks between Māori and the Research, Science and Innovation system.

The strategies and initiatives set out in this Statement of Corporate Intent position us to deliver on our aspiration for a cleaner, safer and more prosperous Aotearoa New Zealand for current and future generations.



## VISION MĀTAURANGA

is at the core of GNS Science's  
strategic framework

Dr Nicola Crauford  
Chair

Ian Simpson  
Chief Executive



# OUR PURPOSE

To undertake research that drives innovation and economic growth in Aotearoa New Zealand's geologically-based energy and minerals industries, that develops industrial and environmental applications of nuclear science, that increases Aotearoa New Zealand's resilience to natural hazards and that enhances understanding of geological and earth-system processes.

(Statement of Core Purpose)



# TŌ TĀTOU TUMANAKO

## Our Vision

### **A Cleaner, Safer, More Prosperous Aotearoa New Zealand.**

We do this by:

- understanding freshwater, energy and mineral resources to enable their wise custodianship and building of intergenerational wealth and wellbeing
- reducing the physical, economic and societal impacts of geological hazards, including through 'early warning' systems, improved hazard awareness and preparedness, enhanced geohazards monitoring, and enabling more resilient communities and buildings
- understanding past climates to improve global models that predict the future impacts of a changing climate, including critical tipping points
- developing and applying novel technologies such as nano-scale devices and isotope measurements to create new value for industry.

## About us

### **GNS Science, Te Pū Ao, is one of seven Crown-owned research institutes. As the national Institute for Geological and Nuclear Sciences, we are focused on delivering benefits for Aotearoa New Zealand from natural processes occurring in the Earth's crust.**

With around 470 staff at five sites across Aotearoa New Zealand, GNS Science draws on a heritage of over 150 years of excellence in Earth sciences. We undertake a wide range of activities from basic research through to applied science, technology development and knowledge translation.

Our work is highly collaborative, with deep local and global partnerships across the full spectrum of our research. This partnering approach enhances our contribution to world-leading science and enables us to adapt it for Aotearoa New Zealand's benefit, to deliver highly-relevant, tailored research, science and technology to central and local government, industry and iwi/Māori.

As host of the *Resilience to Nature's Challenges* National Science Challenge and as a lead contributor to its research programmes, GNS Science champions the value of cross-system and interdisciplinary research collaborations. To deliver meaningful solutions to those who most need our science, we form teams across institutions and research disciplines, reflective of the growing diversity of Aotearoa New Zealand society.

GNS Science will continue to build enduring and sustainable partnerships with tangata whenua. These partnerships are critical and enable the impact and benefits we aspire to achieve for all New Zealanders. We will continue to work with our partners to identify opportunities for co-designed programmes that respond to the unique and distinctive contribution that iwi can make to research outcomes. We will do this by developing a clear and consistent approach to our leadership, research strategy and staff training.

Our Māori Engagement Strategy was the first step in identifying how we will create strong and enduring relationships through the promotion of genuine and transparent engagement. We will now build on this by developing a strong strategic direction which will complement and support the broader GNS Science strategic direction. We will also explore opportunities to incorporate mātauranga Māori into targeted research programmes of relevance. And finally, we will build internal and external capability by developing a training programme and build on the scholarship programme, Ahunuku.

GNS Science will be taking a proactive leadership role to ensure that our partnerships with iwi/Māori contribute to bold and aspirational outcomes for Aotearoa New Zealand. Iwi/Māori have a growing interest in how our science and research can build resilience and develop new commercial and economic opportunities for their people. Through our continued commitment to partnership we will co-design opportunities that contribute to the wellbeing and prosperity of Aotearoa New Zealand. We aspire to create opportunities for iwi to lead significant research programmes and grow capability and capacity to contribute to long term intergenerational change. We continue to gain a deeper understanding of mātauranga Māori and how it contributes to our work, but there is much to do. We are on a journey with our iwi partners and are committed to bold leadership and delivery of mutually beneficial outcomes.

# OUR CHANGING ENVIRONMENT

**The world in which we operate is changing and the rate of change is accelerating. The level of societal interest in building resilience in the face of change is also increasing. By connecting with a wide range of collaborators, end-users and partners both locally and internationally, GNS Science aims to ensure our science keeps pace with major societal, scientific and technological changes, so we deliver excellent, relevant science that benefits Aotearoa New Zealand now and into the future.**

## COVID-19 IMPACTS

Science has been at the heart of Aotearoa New Zealand's response to the COVID-19 pandemic. The centrality of scientific evidence to government decision-making has also highlighted the importance of our national Crown Research Institutes in national emergency preparedness, response and recovery.

Like most sectors, science has been significantly affected by the impacts of COVID-19. Firstly, science is a global endeavour, particularly for the large-scale, complex Earth Systems that are core to the research GNS Science undertakes. GNS is highly interconnected with international science institutions, particularly for our geological hazards, climate change, alternative energy, Antarctic and Southern Oceans research. Restricted international travel has, by necessity, taken our knowledge exchanges with international collaborators 'online' whenever possible.

GNS Science is highly dependent on international recruitment for our expertise, including our earlier-career staff. The expected gradual opening up of international travel over the coming year will allow us to increase our capability and diversity and address the current staff shortages. We will also continue our focus on retaining and developing our existing capability, and in collaboration with CRIs, universities and wānanga, we will continue to work through how we can attract and develop more 'home-grown' expertise and ensure that science remains a valued and accessible career for our increasingly diverse society, including for Māori through our outreach programmes in schools and Ahunuku Māori Scholarship Programme.

Across all CRIs, the pandemic has highlighted a common purpose and set of challenges. We will continue to build on the growing collaboration and commitment to

pan-CRI approaches – already, the CRIs are working together to identify how best we might contribute to a sustainable, resilient and future-facing economic recovery centred on Kiwi innovation and ingenuity.

## RISK, RESILIENCE AND WELLBEING

New Zealanders live in a high-risk zone with an active plate boundary running directly beneath our feet. This produces geological hazard events that can have a significant impact on the country's economy and social wellbeing. GNS Science plays an important role in cross-system research to better understand and manage our exposure to natural hazards, with a focus on geological hazards but also including climate change impacts.

The awareness of New Zealanders about the impact of major geological hazard events has heightened in recent years with the Canterbury and Kaikōura earthquake sequences and Whakaari eruption. GNS Science has a national leadership role for research on the causes and consequences of geological hazards and managing the risk they pose for society. We have extensive scientific knowledge in Earth processes, and globally and nationally recognised expertise in hazard and risk modelling, forecasting socio-economic impacts of events, and system modelling of consequences and resilience options. We apply our social science capability to increase community resilience, improve risk communication and develop tools for hazard preparedness.

The National Geohazards Monitoring Centre, hosted by GNS Science, is playing a vital role in providing around-the-clock monitoring of major geological hazards to help keep New Zealanders safe. We are also supporting the development of early-warning systems, such as the DART buoy Tsunami warning system which was used following the March 2021 Kermadec earthquakes and tsunami.



# TŌ TĀTOU TAIAO HURIHURI

Our research aims to generate critical scientific knowledge for the benefit of Aotearoa New Zealand, providing scientific support to decision makers at national, regional, business, community and individual levels.

## CHANGING EXPECTATIONS OF SCIENCE

The role of science in society is changing, with new technologies and 'citizen science' bringing science closer to the everyday lives of New Zealanders. This brings opportunities for our communities to engage with science and understand its value in helping create the future. It also brings growing expectations of communication, participation and transparency in science.

Increasingly, science is being asked to deliver 'whole solutions' to complex issues. To address this, GNS Science is focusing on developing more strategic and effective interdisciplinary research and research collaborations that cross institutional boundaries. Increasingly, major stakeholders are participating more deeply in the research design and delivery, ensuring our research is useful, useable and used.

The draft *Research, Science and Innovation (RSI) Strategy* sets out the Government's objectives for RSI in Aotearoa New Zealand and its role in delivering a productive, sustainable and inclusive future. The strategy signals future drivers for science in Aotearoa New Zealand. At its heart are three principles to effect change: excellence, impact and connections.

The *Te Pae Kahurangi* CRI review report was released in 2020 and provided a useful analysis of the range of issues in the science system. The review's recommendations aim to build on our collective strengths and address some of the challenges all CRIs face. GNS Science recognises that collaboration and interdisciplinary research partnerships are key in enabling us to deliver on our Science Themes, and we work hard to ensure such collaboration is part of our culture. We seek to collaborate with CRIs and other partners whenever possible for mutual benefit and to improve the outcomes for New Zealand. We have been working closely with other CRIs to consider the outcomes from the review and how they might be implemented effectively across the system.

GNS Science is already responding to these and other drivers of change in the science and innovation system, and will continue to build on our strengths to deliver independent science advice and commentary that meets the needs of policy-makers, decision-makers and the public. Following our major Strategic Review, completed in 2019, which refocused our science direction to capitalise on our core strengths and use our capability more effectively to respond to current and emerging stakeholder needs, we are now finalising our Science Roadmap and research Theme Plans to ensure our future focus is well placed within the national and international research ecosystem and able to deliver on the wide-ranging needs of our stakeholders.

This Science Roadmap complements our Māori Engagement Strategy, which focuses on increasing our engagement and our commitment to co-development in our science programmes, developing effective science partnerships with iwi/Māori, and integrating mātauranga Māori concepts into our Science Themes to support iwi/Māori aspirations.



# OUR DIRECTION

**Over the period of this Statement of Corporate Intent, we will continue to build on our legacy of excellent science, focusing on national and sector priorities for a Cleaner, Safer, More Prosperous Aotearoa New Zealand.**

GNS Science undertook a major Strategic Review over 2018 and 2019, which refocused our direction to capitalise on our core strengths and use our capability more effectively to respond to current and emerging stakeholder needs. We also refreshed our enabling corporate functions to improve support for our science programmes. Following the review, our strategic direction is now better aligned to the priorities of Aotearoa New Zealand stakeholders in central and local government, major industry partners and iwi/Māori interests. Investing purposefully to ensure we are a strategy-led organisation is a key element of our approach.

Our outcomes-focused Science Themes are driving greater interdisciplinary research and helping broaden our research expertise beyond the physical sciences. Dedicated investment in Data Science, Vision Mātauranga and Social Science supports the development of these increasingly important capabilities. Ongoing leadership, learning and development and culture programmes are strengthening our organisation and will diversify our workforce over time, to meet future needs and aspirations.

Our Science Roadmap (discussed above), when completed, will describe our future science direction and focus to 2030, ensuring our outcomes-focused Science Themes are driving the delivery of impactful and relevant science for the country.

# TŌ TĀTOU AHUNGA

## GNS SCIENCE STRATEGIC FRAMEWORK

The GNS Science Strategic Framework highlights our research direction and enables clear line-of-sight throughout the organisation. It shows how our Science Themes, ways of working, plans and performance are aligned to deliver benefits for Aotearoa New Zealand. Vision Mātauranga permeates all our activities, as we work in partnership with Māori on their science needs.

### NATURAL HAZARDS AND RISKS



- Managing risk to the four capitals
- Enabled and informed public, community and business
- Effective early warnings and forecasts
- Improved response decision-making and recovery planning
- Improved risk governance

### ENERGY FUTURES



- Improved understanding of geothermal systems
- Improved sustainable use of geothermal energy
- New and improved technologies for producing and storing green hydrogen
- New and improved technologies for energy efficiency and storage

### ENVIRONMENT AND CLIMATE



- Our groundwater systems
- Antarctica in a 2°C world
- Ecosystem response to a warming world
- Revealing the drivers of our climate
- Carbon cycle dynamics
- Our rising tide

### LAND AND MARINE GEOSCIENCE



- Improved resilience to natural hazards
- Adapting to changing climate
- Managing natural resources sustainably
- Wider use of collections and databases
- Vision Mātauranga



## WHY

### A Cleaner, Safer, More Prosperous Aotearoa New Zealand

Our science enables a more sustainable environment and better quality of life for New Zealanders.

## WHAT

Unlocking the environmental, social, cultural and economic benefits through our work across four Science Themes:

- Natural Hazards and Risks
- Environment and Climate
- Energy Futures
- Land and Marine Geoscience

## HOW

Our four Strategic Pillars:

- Investing with Purpose
- Deep Partnering
- Decision Maker
- Growing Awareness

## WHO

Our whole organisation working together.

We connect and collaborate with stakeholders, government and industry to deliver fit-for-purpose science.

We partner with iwi/Māori to explore the science and innovation potential of Māori knowledge, resources and people to benefit all New Zealanders.

# OUR SCIENCE

## Excellent science, where it matters most

We have made clear, strategic choices about the areas of research we will prioritise and invest in over the next five years, to progress towards a Cleaner, Safer, More Prosperous Aotearoa New Zealand.

### SCIENCE ROADMAP


During the 2020/21 year, GNS Science has been working on a draft Science Roadmap that describes our future focus and will enable us to continue our contribution to national and international collaborative science initiatives to enhance capability and science value. Our Theme Plans support


the delivery of our Science Roadmap and have been designed to ensure we play our part in delivering impactful and relevant science for the country. Through our four Science Themes, we will build on the strong foundations of our world-renowned expertise to contribute international thought-leadership and deliver practical solutions of high relevance to our major stakeholder sectors and end users. We are also investing in multi- and inter-disciplinary methods, such as Data Science and Social Science, to provide linkages and threads across our Science Themes and enable us to provide data-driven, outcome-oriented science for the benefit of all New Zealanders.

### STRATEGIC SCIENCE INVESTMENT FUND

GNS Science's Strategic Science Investment Fund (SSIF) investment is an important element in the delivery of our Science Roadmap. Each Science Theme is underpinned by SSIF programmes that provide long term strategic research to support end-to-end science delivery along the value chain (Appendix 1).

In the coming year, we will be increasing our focus on building critical research capabilities and capacity for the future through strategic training and development.



 Tongariro annual sampling trip

# TŌ TĀTOU PŪTAIAO

In addition to the SSIF Programme funding, the SSIF Infrastructure Fund provides support for:

- The eight Nationally Significant Collections and Databases GNS Science is custodian of. We manage these collections and databases and enhance their ongoing value to Aotearoa New Zealand (see Appendix 3).
- Enhanced Geohazards Monitoring, which allows GNS Science to provide more timely and accurate advice on geohazard events to responsible agencies. This allows those agencies to issue faster, more effective warnings to improve public safety and protect lives and property.

## MEASURING OUR SCIENCE PERFORMANCE

Our Science Theme priorities were identified using an outcome-oriented approach and following stakeholder engagement. The global and national drivers, focus and impacts of the four Science Themes are described in more detail in the following sections, along with the measures that will demonstrate the impacts of our work over the next five years. The overall performance of GNS Science is monitored against the set of GNS Science Key Performance Indicators (KPIs) shown in Appendix 2.

## EXTERNAL ADVICE

Our Strategic Scientific and User Advisory Panel last met in March 2021. It has an important role in evaluating our science excellence and delivery for and with stakeholders. Reporting directly to our Board, the Panel meets annually to review our performance, future research directions and capability needs to ensure our research is both excellent and relevant, and that we are taking advantage of key developments in international science and technology.

# NATURAL HAZARDS AND RISKS



## Research priority areas:

- Managing risk to the four capitals
- Enabled and informed public, community and business
- Effective early warnings and forecasts
- Improved response decision-making and recovery planning
- Improved risk governance

## THE CHALLENGE

High rates of natural hazards and significant consequences are to be expected in a nation straddling a plate boundary in the middle of the Southern Ocean. At the same time, the impacts of hazard events are intensifying through population growth and ageing, continued urbanisation, and business vulnerabilities of fast-moving consumer goods and just-in-time supply chains. Risk is increasing and Aotearoa New Zealand's ability to manage future impacts from natural hazards is being tested.

## GNS SCIENCE'S ROLE

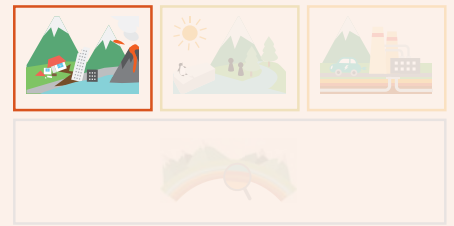
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Through GeoNet we are building on two decades of operations and are looking for new opportunities to deliver even greater benefit to Aotearoa New Zealand, our Pacific neighbours and beyond. As an integral component of GeoNet, the National Geohazards Monitoring Centre *Te Puna Mōrearea i te Rū* provides 24/7 active monitoring of Aotearoa New Zealand's geological hazards.



Slope stability testing, Saint Gerard's Monastery, Wellington

# NGĀ MATEPĀ ME NGĀ TŪRARU Ā TAIAO



## WORKING TOGETHER

GNS Science is working across the resilience and science systems as a major coordinator of key research providers and data suppliers in the university, CRI, central and local government and private sectors. Our work involves collaboration with a wide range of users, through engagement with communities, iwi/Māori, industry bodies, government agencies and the hazard management sector, and communication through multiple channels to ensure stakeholders understand and manage the risks in their areas/roles.

The Natural Hazards and Risks theme, which works closely with the *Resilience to Nature's Challenges* National Science Challenge, also works with Centres of Research Excellence and other major collaborative programmes, to ensure that GNS Science's work complements and adds value to the work of others across the Aotearoa New Zealand science and innovation system. Our aim is to facilitate an integrated view of 'who is doing what,' leading to a coherent scientific evidence base for hazard risk management.

## RESILIENCE TO NATURE'S CHALLENGES NATIONAL SCIENCE CHALLENGE

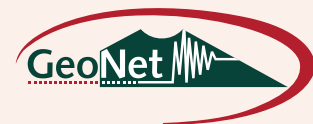
GNS Science hosts *Resilience to Nature's Challenges*, one of 11 National Science Challenges. The mission of the Challenge is to accelerate Aotearoa New Zealand's natural hazard resilience.

Phase 2 of the Challenge commenced in July 2019 and is focused around two major themes that align with the **National Disaster Resilience Strategy**.

The Multi-hazard Risk Model comprises exciting new research to advance our understanding of natural hazard processes (such as earthquakes and tsunamis, volcanoes, coastal hazards, high impact weather, and wildfires).

The Resilience in Practice Model comprises mātauranga Māori, social science, and engineering research, to develop policies, tools and methods to ensure new resilience knowledge becomes part of daily decision-making in Aotearoa New Zealand.

As in Phase 1, the Challenge has brought together multi-disciplinary research teams from CRIs, universities and research organisations across the country, together with research-users working collaboratively to ensure research outputs are useful and used.

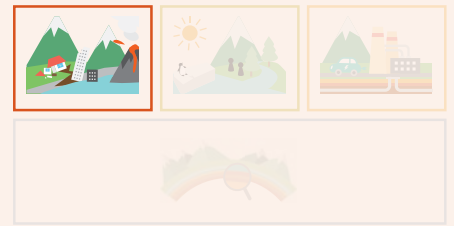


July 2021 marks

# 20

years of the GeoNet geological hazards monitoring system in New Zealand.

# NATURAL HAZARDS AND RISKS



## BUILDING THE KNOWLEDGE BASE

GNS Science takes a deliberate approach to building the national knowledge base through custodianship of a number of nationally significant databases (Appendix 3). The National Earthquake Information Database, NZ Volcano Database, Regional Geological Map Archive and Data File, and the NZ Fossil Record File, as well as generation of primary data relating to earthquakes, tsunami, volcanoes and landslides are particularly relevant to the Natural Hazards and Risks theme. Through GeoNet and research across GNS Science, this growing knowledge base is used to characterise the processes that manifest as geological hazards and ensure world-class risk management advice to maintain New Zealanders' wellbeing and livelihoods in the face of natural hazard challenges. We are increasingly looking to apply data science methods to improve our ability to forecast geological events and their spatial impacts.

## RESEARCH DIRECTION

Our research aims to generate important scientific knowledge for the benefit of Aotearoa New Zealand and drive its uptake and use to improve resilience to natural hazards at national, regional, business, community and individual levels.

Our outcome-oriented research spans the full value chain of information, from underpinning knowledge to better understand Aotearoa New Zealand's natural hazards, through to risk management options to help communities mitigate their destructive effects and advise on policy and regulation.

## NATURAL HAZARDS AND RISKS IMPACTS AND PRIORITIES 2021-26

### 1. Managing Risk to the Four Capitals (Natural, Human, Social, Financial/Physical)

- Understanding the Earth processes that generate natural hazards, their magnitude, frequency and spatial reach.
- Developing national hazard and risk models for earthquakes, volcanoes, tsunami and landslides.
- Understanding the fragility of the built environment to geological hazards.
- Calculating risk to lives, livelihoods, business, and infrastructure from natural hazard events.
- Integrating natural hazard risks and their secondary impacts (e.g. landslides, floods, fire and liquefaction) with weather risks and the stresses associated with climate change.

### 2. Enabled and Informed Public, Community and Business

- Understanding how people think about hazard and risk, and the vulnerabilities of different groups in society including cultural context and values.
- Developing effective communication and visualisation methods of the threats and impacts of future events.
- Understanding the capacity in communities, and the public and private sectors to manage risk and adopt adaptive pathways to risk mitigation.

### 3. Effective Early Warnings and Forecasts

- Visualisation of event scenarios, effective evacuation planning and event forecasts.
- Understanding behavioural responses to warnings and forecasts.
- Using new technologies to improve event forecasts.

### 4. Improved Response Decision-Making and Recovery Planning

- Improved GeoNet and wider hazard event science advice.
- Improved policy and planning scenarios and exercises with stakeholders for recovery including build-back-better options.

### 5. Improved Risk Governance

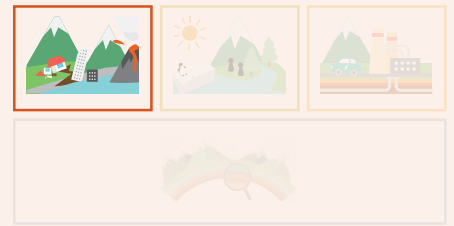
- Reviewing building, planning, and resource management codes, guidance, standards, legislation and policy to assess alignment of risk management controls.
- Developing socio-economic risk models to inform resilience investments.
- Exploring evidence-based decision-making processes and decision support tools to inform an "all-risks" approach to risk governance arrangements.



The ROPOS remotely controlled underwater vehicle on board the *RV Tangaroa*



# NGĀ MATEPĀ ME NGĀ TŪRARU Ā TAIAO



## RESEARCH OUTPUTS 2021/22

### Progress towards measures of success is delivered through the following research outputs in the coming year:

1. Improved understanding of earthquake rupture processes, ground motions, frequency and magnitude characteristics, spatial and temporal distributions and interactions, and the underlying tectonic processes operating in New Zealand to inform the refresh of the National Seismic Hazard Model.
2. Deliver improved laboratory and field-based models of submarine landslides, rainfall triggering thresholds for New Zealand debris flows and site-specific conditions and performance of fill slope urban areas under earthquake and rainfall.
3. Continue to develop and refine conceptual and numerical models of New Zealand volcanoes, which along with field data, will inform hazard maps and decision support tools for life safety and asset management decision-making.
4. Socialise an update of the National Tsunami Hazard Model (NTHM) among the stakeholder community, and plan for a major revision of the NTHM by 2024.
5. Continue RiskScape 2.0 product development, improve multi-hazard and probabilistic capabilities and investigate interoperability capability of the platform with other domestic and global risk tools.
6. Deepen understanding of interdependencies between critical infrastructures which may result in compounding hazard impacts, using Wellington and Hawke's Bay as case studies.
7. Develop and test a protocol to assess iwi management plans for their natural hazard and risk provisions.
8. Support the translation of science into accessible forms to enable community understanding, risk management and resilience through the development of visual tools and information products.
9. Deliver improved monitoring capability in line with the outcomes specified in the Enhanced Geohazards Monitoring Contract.
10. Landslide forecast models will be incorporated into National Geohazards Monitoring Centre (NGMC) advice to stakeholders, allowing the near-real time forecasting of landslide occurrence and severity in future earthquakes.
11. Refine and secure enduring governance, contracting and funding arrangements for the GeoNet programme. This includes stakeholder agreement to the GeoNet product and service catalogue and service level measurement.

## MEASURES OF SUCCESS

**By June 2023**, new and improved decision support tools (through the National Seismic Hazard Model and HRM End-to-end Flagship project) to determine balanced risk management.

**By June 2023**, methods for collecting baseline information to enable measurement of community resilience will be assessed.

**By June 2024**, research will address how people, communities and business think about hazard and risk, and from this, effective methods for uptake and appropriate actions responding to warnings and forecasts of natural hazard events will be developed.

**By June 2025**, our assessments of the effectiveness of building, planning and resource management codes, guidance, standards, legislation, policy, land use, business continuity, and integrated planning and advocacy for revisions where appropriate, will have improved risk governance arrangements in Aotearoa New Zealand.

**By June 2025**, seamless integration of new research into science advice products for both long-term risk reduction and short-term dynamic risk assessments.

**By June 2026**, values, attitudes and behaviours of individuals, communities and businesses, in responding to hazard risk information and warnings, are understood and factored into decision-making.

# ENVIRONMENT AND CLIMATE



## Research priority areas:


- Our groundwater systems
- Antarctica in a 2°C world
- Ecosystem response to a warming world
- Revealing the drivers of our climate
- Carbon cycle dynamics
- Our rising tide

## THE CHALLENGE

Groundwater availability and quality is fundamental to life in Aotearoa New Zealand. We have extensive aquifers – 40% of our people depend on groundwater for drinking water, and 80% of the annual river flow comes from groundwater. This natural resource is critical in sustaining aquatic ecosystems and cultural values, such as mahinga kai. While its value is clear, we do not fully understand the extent of our groundwater system or the processes that affect water quality and availability, like the impact of land use practices, the relationship between groundwater and surface waters, and interaction with geothermal water. We need to map, quantify, and monitor our systems to better manage risks as our population grows and demand for groundwater increases. We need to improve our ability to model our groundwater systems to better predict their response to changing land use and climate.

Climate change is a global reality. Temperatures are on track to reach 1.5°C warmer than pre-industrial temperatures between 2030 and 2052. Warming is likely to continue to increase through the 21st century, unless large emissions reductions are achieved. We need to improve our ability to predict how our climate may change and identify tipping points and thresholds in the system so that we can reduce or avoid climate surprises. We need to find ways to measure and account for our greenhouse gases while developing mechanisms to reduce our emissions. We need to adapt to unavoidable change as our oceans warm, pressure on freshwater resources increases, sea level rise affects coastal communities and infrastructure, and extreme weather events become more common and intensify.



 The Lakes380 programme's highest altitude lake sampled to date at 1,812 metres above sea level, Lake Alta in The Remarkables, Queenstown

## TE TAIAO ME TE ĀHUARANGI

### GNS SCIENCE'S ROLE

We are establishing a more comprehensive understanding of freshwater systems to provide new insights and improve policy, management and restoration approaches. New technologies and science methods enable us to better document Aotearoa New Zealand's groundwater resource and evaluate its vulnerabilities. Using a values-based approach, we will make sure that our research is fit-for-purpose for those who need it.

Our Earth system scientists uncover geological data to extend our environmental knowledge well beyond the short but detailed datasets collected from instruments over recent decades. Earth's long-term environmental archives allow us to examine how our marine and terrestrial ecosystems, coastal environments, and Antarctica's ice sheets, responded during previous intervals of time when average surface temperatures were like those we will experience in the coming decades. This insight improves our ability to anticipate and adapt to future change.

We have world-leading expertise in analysing and monitoring carbon budgets for our major Aotearoa New Zealand cities, to better inform decisions on emissions mitigation approaches. Our proven capability in air particulate matter research enables us to monitor air quality and guide local government in better understanding and managing air contaminants and their sources.

As sea levels rise, we must understand the effects on our coastlines and the communities living there. By studying the response of our coastal systems to previous episodes of warmer-than-present climate and major environmental change we anticipate how coastal ecosystems will change in the future. Our work on ice sheets allows us to reduce uncertainty regarding the rate and magnitude of sea level change.

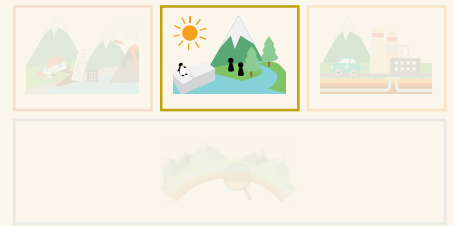
By measuring and modelling coastal land movement we can provide location specific sea level projections for planning and adaptation to rising or falling seas.

### WORKING TOGETHER

GNS Science is part of the National Groundwater Research Alliance, a platform which brings together all Aotearoa New Zealand's research providers. Working alongside Regional Council partners and the Ministry for the Environment, the Alliance provides a coordinated and strategic approach to identify and resolve groundwater research priorities and enable sustainable management of Aotearoa New Zealand's precious water resources.

As part of a wider system of environmental and climate change research, we are committed to deepening collaborations with selected research teams nationally and internationally to achieve better outcomes. In part, this will be achieved through cooperative research enabled by various large-scale research initiatives like the National Science Challenges (e.g. *Our Land and Water*, *Deep South*), the Antarctic Science Platform, and joint initiatives with other environmental CRIs, such as the National Environmental Data Service.

Working in more connected ways will enable our research contributions in groundwater, air quality and climate change to complement efforts by others. Together, we will develop and refine more accurate environmental and climate models and forecasts, more effectively communicate expected future impacts, and provide tailored guidance, models and tools to mitigate the risks to and from our changing natural world.



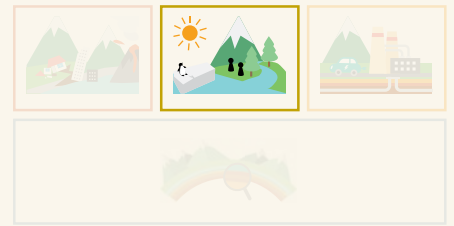
# 1.5°C

The Earth is on track to be 1.5°C warmer than pre-industrial temperatures between 2030 and 2052

### BUILDING THE KNOWLEDGE BASE

We will continue to develop and enhance our Nationally Significant and other environmental science databases and collections (e.g. Geothermal and Groundwater databases, Aotearoa New Zealand Fossil Record File database, and the National Paleontological Collection). This will increase access to, and use of, information on Aotearoa New Zealand's natural resources and biological heritage to more accurately understand and manage our groundwater, restore our natural environment, and identify potential pressures on our ecological systems as climate warms and sea levels rise.

# ENVIRONMENT AND CLIMATE



## RESEARCH DIRECTION

Our research focuses on groundwater resources, sea level rise, climate change impacts on ecosystems, and the carbon cycle. Working with our major partners, we have designed our programmes to meet their current and future needs.



Mt Erebus, Antarctica

Training camp with views of Mt Erebus

## ENVIRONMENT AND CLIMATE IMPACTS AND PRIORITIES 2021-26

### 1. Our Groundwater Systems

- Measuring, mapping and modelling groundwater systems.
- Recognising the social, environmental and cultural value of Aotearoa New Zealand's groundwater.

### 2. Antarctica in a 2°C World

- Developing and improving understanding of how ice shelves, ice sheets and sea ice will change as temperatures increase and how this will impact the Southern Ocean and New Zealand.

### 3. Ecosystem Response to a Warming World

- Enhancing tools and models to increase understanding of the effect of previous episodes of climate change on plankton in our oceans and native terrestrial flora.
- Characterising the state of our lake systems prior to the influence of human activity and analysing the signals of environmental change in these systems.

### 4. Revealing the Drivers of Our Climate

- Generating highly resolved records of past climate from sediment layers and ice cores to identify and examine patterns not currently captured in short-term datasets (e.g. thermometers and satellites).
- Identifying thresholds and tipping points in the climate system to improve our ability to model and project future climate.

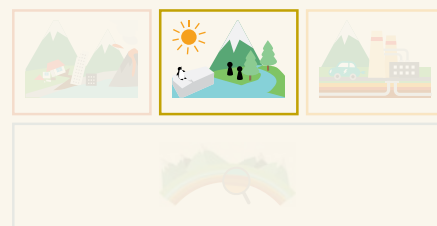
### 5. Carbon Cycle Dynamics

- Improving New Zealand's national and regional carbon budgets, so that Aotearoa New Zealand can meet its global commitments.
- Examining carbon uptake and/or release in the Southern Ocean and land-based ecosystems.

### 6. Our Rising Tide

- Understanding the causes, rate, and magnitude of past, present, and future sea level change and its impact on Aotearoa New Zealand and the South Pacific.
- Connecting our ice sheet research with global sea level datasets and coastal vertical land movement to improve regional projections of sea level.
- Incorporating sea level research results into groundwater, coastal hazard and risk models to guide climate change adaptation policy and planning.

# TE TAIAO ME TE ĀHUARANGI



## RESEARCH OUTPUTS 2021/22

**Progress towards measures of success is delivered through the following research outputs in the coming year:**

1. National Groundwater Recharge Model resolution has been enhanced using state of the art data science techniques (e.g. Google Earth Engine).
2. At least four staff members have been trained to use DELFT3D modelling tools. These staff will work on projects that aim to examine sedimentary processes under changing environmental conditions in a variety of coastal settings in Aotearoa.
3. National scale sample collection from over 300 lakes from Aotearoa is completed and associated environmental histories of lake health are developed for 50% of the sites.
4. New international partnership for drilling at the grounding zone of the West Antarctic Ice Sheet is established.
5. Automated microscopy is implemented and improved to help mitigate loss of key skill sets due to staff retirement and to enhance efficiency in paleoecological data acquisition.
6. A new groundwater model for South Dunedin is developed and has been used to assess changes in inundation probability due to sea level rise.
7. The first estimate of Auckland's full carbon budget is provided.
8. Co-designed field-based activities to enhance iwi involvement in Geosciences are completed and lead to a new iwi-led research partnership that aims to investigate climate change impacts on local communities in Northland.

## MEASURES OF SUCCESS

**By June 2022**, 30% of our (~150) coastal aquifers have been mapped, measured, and modelled.

**By June 2023**, the carbon budgets across our four major urban centres are accurately monitored.

**By June 2023**, improved climate projections are integrated into national climate change policy and at least one Regional Plan.

**By June 2024**, a revised ocean model is being used to simulate future changes in primary productivity in the oceans around New Zealand.

**By June 2025**, estimates of sea level rise commitments from Antarctic ice sheet melt are integrated into at least one long- term environmental management plan.

**By June 2026**, Aotearoa New Zealand's systems-based coastal research capacity has been enhanced and includes Māori researchers.

# ENERGY FUTURES



## Research priority areas:

- Improved understanding of geothermal systems
- Improved sustainable use of geothermal energy
- New and improved technologies for producing and storing green hydrogen
- New and improved technologies for energy efficiency and storage

## THE CHALLENGE

Energy powers our economy and underpins the wellbeing of our communities. Energy generation and how energy is used are inextricably linked to environmental impacts, including greenhouse gas emissions. Like other countries, Aotearoa New Zealand is grappling with how it can meet increasing demands for energy, without causing irreversible changes to our environment. There is growing demand for low-carbon energy supply and more equitable access to energy resources.

Aotearoa New Zealand has committed to a path with net-zero carbon emissions by 2050. Currently energy use based on hydrocarbon products makes up 60% of the Aotearoa New Zealand energy supply and is a significant contributor to Aotearoa New Zealand's greenhouse gas emissions. Science can play a critical part in identifying and developing innovative solutions to reduce the emissions of CO<sub>2</sub> to the atmosphere from energy production and use.

## GNS SCIENCE'S ROLE

As 'the Energy CRI' and the host of the new Advanced Energy Technology SSIF Platform, GNS Science plays a major role in enabling Aotearoa New Zealand's transition to a low-carbon energy future. The solutions that result from our research will reduce our national carbon footprint, while enhancing Aotearoa New Zealand's energy security and economic competitiveness.

We invest in diverse research to grow Aotearoa New Zealand's renewable energy supply, develop new materials for producing and storing hydrogen, and reduce energy-related emissions.

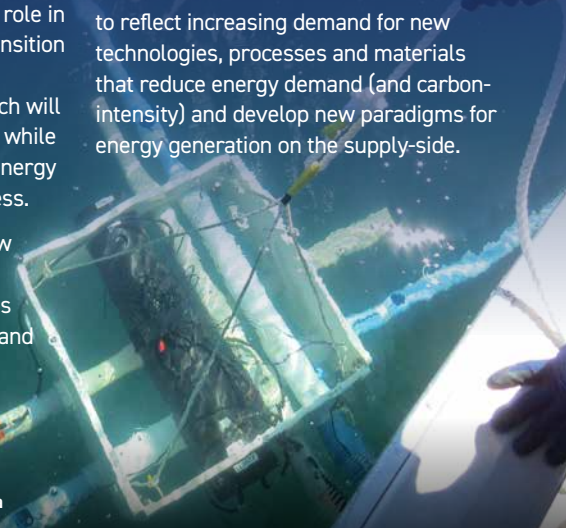
Our expertise in understanding the geological framework of the country and characterising geothermal systems is essential to assess the feasibility of future energy potential from deeper geothermal resources, and also to maximise opportunities for business, iwi/Māori and the community from using geothermal heat. In order to inform decision-making at all levels, we communicate evidence-based advice to our stakeholders about future energy resources and current resource availability, as well as the implications of resource use, including social and cultural impacts.

As Aotearoa New Zealand increases the use of intermittent energy sources such as wind and solar in our energy mix the need for energy storage will become more important. Our research into materials will capture the benefits of advances in global R&D to develop regional opportunities to produce and export green hydrogen and will provide Aotearoa New Zealand with options for the distributed storage of energy.

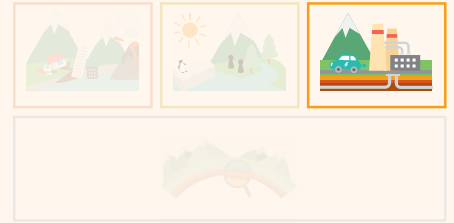
Efficient use of renewable energy is another area where our science contributes to the way Aotearoa New Zealand reduces its carbon emissions. We focus our research in new materials to reflect increasing demand for new technologies, processes and materials that reduce energy demand (and carbon-intensity) and develop new paradigms for energy generation on the supply-side.



Marine magnetotelluric survey, Lake Tarawera



# PŪNGAO MŌ ANAMATA



## WORKING TOGETHER

In line with Government goals to grow private-sector-led R&D activity, over the next three years we will foster external partnerships which will focus our research where there is high industry demand. This will assist Aotearoa New Zealand industry and homes to transition to low-carbon emissions. We expect our research in this area to be central to GNS Science's work that will enable the creation of new, high-value industries in Aotearoa New Zealand and also develop new value streams for export.

Through our thought leadership and robust science, we are well placed to ensure that Aotearoa New Zealand understands the opportunities and risks relating to a changing energy mix into the future. We will play an important role in bringing a science voice to national conversations alongside central and local government, industry, iwi/Māori and community interests.

## BUILDING THE KNOWLEDGE BASE

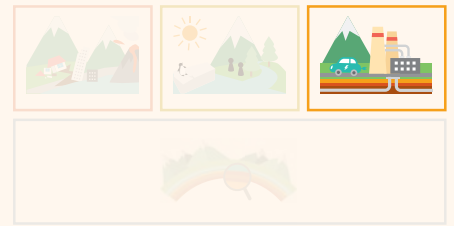
By drawing on more than 60 years of government exploration of, and research on, Aotearoa New Zealand's geologically based energy resources, our research increases understanding of the processes that contribute to the transport of fluids and heat to the geothermal areas of the central North Island. This work involves geological and geochemical analyses, geophysical imaging, data analysis and computational reservoir modelling.

This work will also build on new data for the Taupo Volcanic Zone collected in the Land and Marine Geoscience programmes. These data will advance the conceptual understanding of the transport processes that lead to the formation of the geothermal systems that are found at the surface.

We will develop new knowledge related to the production, storage and utilisation of green hydrogen as a zero-emissions energy carrier. In addition to our research on functional materials that can improve the efficiency of hydrogen production, we will undertake social and techno-economic studies related to incorporating hydrogen as a new fuel into Aotearoa New Zealand's energy system. The information from these studies will offer insights for developing policies to support a just transition to a green energy future.



Green hydrogen is a zero-emissions fuel created using renewable energy instead of fossil fuels



## RESEARCH DIRECTION

Our research aims to increase opportunities to use renewable resources and efficiency gains to reduce carbon emissions from energy use and to grow energy resource security. This will be achieved through increased use of geothermal energy for electricity generation, direct use of geothermal energy, improvements in hydrogen production, the development of enabling technology to increase the use of renewable energy and the identification of new energy sources that contribute to a low-emissions energy future.



GNS Science National Isotope Centre

Using the ion-implantation system to manipulate the chemical and electronic structure of materials for energy conversion processes

## ENERGY FUTURES IMPACTS AND PRIORITIES 2021-26

### 1. Improved Understanding of Geothermal Systems

Understanding near-surface geothermal resources

- Acquire geoscience data on low enthalpy, near-surface geothermal systems through field surveys including geology, geophysics and geochemistry.
- Developing numerical models that can be used to delineate resources, assess sustainability and encourage direct use of Aotearoa New Zealand's geothermal resource.

Knowledge of high-enthalpy geothermal resources

- Enhancing understanding of hydrothermal systems and their heat sources from depth to surface in the Taupo Volcanic Zone.
- Developing a comprehensive 3D model of the Taupo Volcanic Zone, with an emphasis on geology, geochemistry, and hydrodynamics of the heat sources and associated hydrothermal properties.

Superhot Geothermal Fluids

- Combine many disciplines to develop new methods for characterising the deep superhot resource in the Taupo Volcanic Zone.
- Enhance understanding of the transfer from source to surface of heat and gases.

### 2. Improved Sustainable use of Geothermal Energy

Reducing Risks Associated with Geothermal Developments

- Developing new methods for integrating and analysing datasets and models to reduce uncertainty and risk for geothermal developments.

Improved Reservoir Modelling

- Improve methods for predicting the future state of geothermal systems and the surrounding environment in response to extraction of fluid and energy.

### 3. New and Improved Technologies for Producing and Storing Green Hydrogen

Improved Electrolyser Efficiency

- Developing novel materials to improve the efficiency of green hydrogen production from electrolysis by focusing on the synergistic use of physical and chemical techniques to modify the surface properties of materials.

New Technologies for Producing Green Ammonia

- Design new catalysts that maintain lower overpotentials for the electrochemical synthesis of ammonia as a means of storing green hydrogen.

### 4. New and Improved Technologies for Energy Efficiency and Storage:

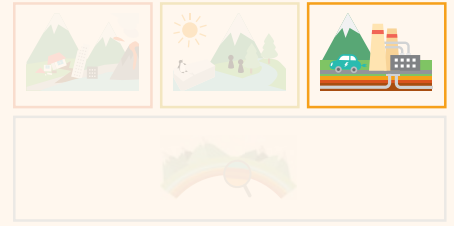
New Materials and Devices

- A new rapid prototyping capability is created for energy materials discovery and novel energy device development to enable research and industry R&D for improved energy efficiency and renewable energy utilisation.

Circular Battery Use

- Develop approaches to lithium ion battery reuse and recycling appropriate to the Aotearoa New Zealand context.





## RESEARCH OUTPUTS 2021/22

**Progress towards measures of success is delivered through the following research outputs in the coming year:**

1. New insights on the factors that influence the source and location of Aotearoa New Zealand's geothermal systems are obtained from integrating findings from geochemistry, geology geophysics and modelling.
2. New understandings of the consequences of different model representations of the energy source of a geothermal system are obtained.
3. An assessment of environmental impacts is undertaken to support the resource consenting of a geothermal power company.
4. GNS Science will organise and contribute to a workshop focused on implementing direct heat infrastructure in Taupo that will demonstrate the value of geothermal energy to the Taupo public, government and developers.
5. An electrocatalytic testing facility is developed for researchers and industries to test materials for hydrogen production.
6. Integrated capability will be developed in the field of thermal materials and engineering that will enable research and industry consultancy to improve energy efficiency and renewable energy utilisation.

## MEASURES OF SUCCESS

**By June 2022**, a new resource assessment model is being used to increase renewable electricity generation from geothermal energy.

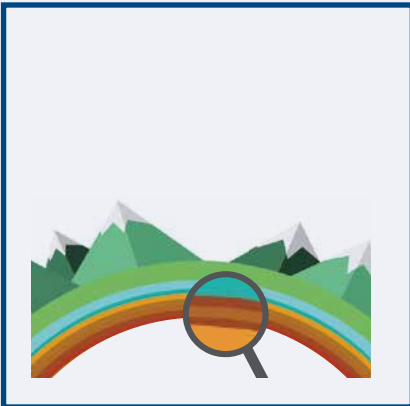
**By June 2023**, new geoscience data and modelling of low enthalpy geothermal systems are being used to unlock greater direct use of geothermal energy.

**By June 2024**, R&D created by GNS Science is taken up and used by at least one primary industry or manufacturing company.

**By June 2025**, new geothermal tracers and reservoir models will be available to determine the reservoir temperatures between reinjection and production wells.

**By June 2026**, our R&D on green hydrogen production will have been used for a demonstration project by a hydrogen production company in Aotearoa New Zealand.

# LAND AND MARINE GEOSCIENCE



## Research priority areas:

- Improved resilience to natural hazards
- Adapting to changing climate
- Managing natural resources sustainably
- Wider use of collections and databases
- Vision Mātauranga

## THE CHALLENGE

Te Riu-a-Māui / Zealandia is Earth's eighth continent. It forms the surface landscape and continental shelf areas under and beyond Aotearoa New Zealand's jurisdiction – extending over nearly 5 million square kilometres. Aotearoa New Zealand has continental scale challenges, opportunities and stewardship responsibilities for this large area of the South Pacific. Science research has a crucial role in determining how successfully Aotearoa New Zealand manages understanding global-scale environmental change, variability and impacts, improving predictive capability for hazards and disasters, identifying new sustainable resources, and developing transformational new technologies to make new discoveries.

## GNS SCIENCE'S ROLE

Fundamental geoscientific research undertaken by GNS Science plays an essential part in providing an accurate and up-to-date framework for Aotearoa New Zealand's natural geological and biological environment. It also adds to iwi/Māori knowledge of culturally, environmentally and economically significant solid earth materials and processes.

Deeper knowledge of fundamental Earth deformation and plate boundary structure and processes is critical for research on the causes and impacts of geological hazards such as earthquakes, landslides and volcanoes. As we develop greater understanding of the planet's dynamic processes we will be able to strengthen our resilience to risk.

In a low-carbon future, there will be continuing demand for a sustainable, secure supply of energy and critical elements. GNS Science's work provides accurate appraisal of Aotearoa New Zealand's on-land and offshore resource potential to enable sustainable custodianship of the continent's natural resources.



📍 Surveying the lake bed of Lake Roto Kawanu to record near fault fractures associated with the Wellington Fault, Zealandia Ecosanctuary, Wellington

# PŪTAIAO ARONUKU Ā-WHENUA, Ā-MOANA



## WORKING TOGETHER

GNS Science nationally coordinates geoscience research initiatives, collaborating with Aotearoa New Zealand government agencies, universities, CRIs, iwi/Māori, and other providers, and leads international initiatives of benefit to Aotearoa New Zealand. Our participation in major international collaborative consortia, for example, the International Ocean Discovery Program (IODP) and the International Continental Scientific Drilling Program (ICDP), enables us to grow capability, leverage co-funding and brings to Aotearoa New Zealand significant new knowledge and critical thinking, as well as additional scientific infrastructure and equipment.

Land and Marine Geoscience provides the data and underpinning research needed for accelerating innovation in our other Science Themes: it provides a wider context for tectonic and volcanic hazards, delivers an improved framework for energy, supports management of natural resources, and delivers a richer perspective on current and future environmental change.

## BUILDING THE KNOWLEDGE BASE

Discoverable and accessible data, information, and collections will underpin a wide variety of research applications, models and real-world impacts in GNS Science, and more broadly across the Aotearoa New Zealand science system. An informed government, industry, iwi, and society with Earth Sciences data and information will enable better decisions.

As the national geological sciences agency in Aotearoa New Zealand, we hold more than 150 years of knowledge about the continent of Te Riu-a-Māui / Zealandia and exercise scientific custodianship of national datasets. Our Nationally Significant Collections and Databases are precious taonga that underpin Te Riu-a-Māui / Zealandia's heritage and history. We are committed to facilitating use of the data we hold and communicating our knowledge across Aotearoa New Zealand society.



# 94%

of the Zealandia continent is submerged

# LAND AND MARINE GEOSCIENCE



## RESEARCH DIRECTION

We are investing in an extensive research programme to address fundamental questions about the composition and architecture of the continent Te Riu-a-Māui / Zealandia and understand the geological processes that have shaped it. Our foundation programme aims to close critical knowledge gaps that relate to societal challenges including undertaking research on the physical processes that control geohazards, characterising natural resources and appreciating the consequences of past environmental change.

## LAND AND MARINE GEOSCIENCE IMPACTS AND PRIORITIES 2021-26

### 1. Improved Resilience to Natural Hazards

- Understand Te Riu-a-Māui / Zealandia's geological evolution, structure and plate boundary processes to improve resilience to natural hazards.

### 2. Adapting to changing climate

- Understand how the tectonic and climatic evolution of Te Riu-a-Māui / Zealandia has affected marine and terrestrial biological and physical systems to aid research on the impacts of future climate changes.

### 3. Managing Natural Resources Sustainably

- Understand how critical elements and materials, geothermal heat and other natural resources are distributed through Te Riu-a-Māui / Zealandia and how they can help enable a low carbon future for New Zealanders.

### 4. Wider use of Collections and Databases

- Ensure our geological collections, data and knowledge are known, accessible and useful to stakeholders for public good research, science education and outreach, as well as co-development of commercial opportunities.

### 5. Vision Mātauranga

- Integrate mātauranga Māori into New Zealanders' perception of the evolution and unique character of Te Riu-a-Māui / Zealandia, and its geological and biological heritage.



Acquiring photogrammetry data of the Waiou Stream outcrop in Taranaki

# PŪTAIAO ARONUKU Ā-WHENUA, Ā-MOANA



## RESEARCH OUTPUTS 2021/22

**Progress towards measures of success is delivered through the following research outputs in the coming year:**

1. Refine our knowledge of the underlying processes associated with plate boundary hazards to improve resilience to earthquakes, tsunamis, volcanic eruptions and landslides.
2. Develop models that show how heat and magma are generated in the Taupo Volcanic Zone to improve understanding of how renewable geothermal energy can be utilised.
3. Quantify how critical elements and materials are distributed in the subsurface through building new workflows for resource assessment.
4. Refine our understanding of surface processes in coastal and urban environments through integrated geological, geochemical, and geophysical investigations to inform predictive modelling of sedimentation and erosion.
5. Refine the age control of past climate events to improve understanding of the rates and scale of climate impacts.
6. Ensure GNS Science's high-value geoscience databases are increasingly interconnected and interoperable, resulting in a significant upsurge in their use in data science applications.
7. Work closely with international scientific organisations, especially IODP and ICDP, to enhance understanding of global-scale environmental change, variability and impacts and improve predictive capability for hazards and disasters.
8. Communicate our research, its potential outcomes and impacts in clear, accessible and engaging ways to key stakeholders.

## MEASURES OF SUCCESS

**By June 2022**, greatly improved characterisation of potential for Hikurangi subduction earthquakes and their likely impacts is provided for natural hazard risk assessment.

**By June 2023**, underpinning paleo-environmental information from the South West Pacific, Antarctica, and Aotearoa New Zealand is available for use in climate assessments and policies.

**By June 2024**, tectonic, geological and geophysical information is utilised for marine and land use planning and decision-making.

**By June 2025**, our important geological hazard databases meet FAIR Data Principles, as appropriate, and are routinely used by government, industry and Māori for risk mitigation strategies and practice.

# VISION MĀTAURANGA



**GNS Science is committed to developing enduring and mutually beneficial partnerships with iwi and Māori. Ensuring our internal processes are aligned with the aspirations of our partners will promote meaningful and beneficial outcomes for Aotearoa New Zealand. Our commitment to exploring the innovation potential of Vision Mātauranga is reflected in our GNS Science Strategic Framework placing it at the core of our organisation. This ensures that Vision Mātauranga contributes to all of our relevant areas of work in a proactive and genuine way, leading to positive social, environmental, economic and cultural outcomes for Aotearoa New Zealand.**

## PARTNERING FOR SUCCESS

### EMBEDDING VISION MĀTAURANGA IN OUR WORK

Building the capacity and capability of GNS Science to effectively implement Vision Mātauranga is a critical component of our success. We will do this by:

- Promoting and providing learning opportunities for young Māori in the science system, including through our Ahunuku internship scheme and scholarships for Masters and PhD students.
- Building on our existing partnerships with iwi and Māori entities to increase our understanding of their research and science aspirations.
- Developing a Strategy that includes shared outcomes that will guide our future work and will inform all our relevant work programmes early and meaningfully.
- Collaborating with CRIs, universities and other relevant agencies to deliver meaningful Vision Mātauranga outcomes.
- Building on existing Vision Mātauranga capability development by running staff workshops and supporting internal workforce development initiatives and bid strategies.
- Contribute to iwi research capability development through secondments, kura whenua, field work and iwi-led research planning and development.

Through our partnerships and targeted, focused application of Vision Mātauranga we will deliver on the strategic aspirations of both GNS Science and our partners. GNS Science is committed to exploring the contribution that mātauranga Māori can make to the research and science we undertake. We will do this by connecting key research and theme leaders with relevant iwi practitioners to explore how mātauranga Māori can contribute to research outcomes for broad community benefit. Integrating a Te Ao Māori perspective into relevant research is a critical component of facilitating the development of internal capability.

As we continue to build meaningful partnerships with iwi/Māori, we will increase our reputation and visibility within Māori communities. This will assist us in attracting emerging talent that builds our capability to contribute to innovative research outcomes in the future.

### KEY INITIATIVES FOR 2021/22:

- Develop a Māori Strategic Plan to provide critical guidance and direction regarding priority areas of future work.
- Develop and implement a Vision Mātauranga training programme which will include staff workshops and a review of Ahunuku – the Māori scholarship programme. This will assist with the continued development of our capability and capacity to support Vision Mātauranga implementation.
- Work with other CRIs to agree a consistent approach to working with iwi/Māori to strengthen the capability, skills and networks between Māori and the Research, Science and Innovation system.
- Build strategic priorities from iwi partners into our operational activities.

## Innovative, multi-disciplinary approaches

**By using multi- and inter-disciplinary methods, we are extending the impact of our science, gaining new insights and deepening the value and usability of our science for society.**

### SOCIAL SCIENCE

To maintain social, environmental, economic and cultural wellbeing in Aotearoa New Zealand's geological landscapes, we have to understand the interplay between geological resources and processes, and the people who live on and with them. Through a better appreciation of how society functions, including governance and policy frameworks, we expect there will be a greater uptake of the physical science that GNS Science invests in, to ensure our research results are useful, usable and used.

We apply our social science expertise to mitigate risks and build resilience to natural hazards by understanding how to influence individuals, communities, and organisations, including Māori resilience frameworks. Embedding social science approaches across our Science Themes allows us to better understand public perceptions and values, identify barriers to adopting new practices and technologies, and ensure effective public discussion on critical issues.

We are actively exploring opportunities for social science to elevate the impact of our science by embedding and integrating social science methods across our Science Themes.

#### KEY INITIATIVE FOR 2021/22:

- Social science is increasingly embedded in our Science Themes through internal engagement and strategic planning.

### DATA SCIENCE

Leading-edge techniques and expertise in data science (including Deep Learning, Decision Support Models, Data Lens, and trust in Artificial Intelligence) can be applied across our Science Themes to make the most of our information and insights. These are applied to all our databases (many of which are nationally significant), GeoNet and satellite data to address science problems with artificial intelligence and machine learning methods.

We are investing in data science, firstly to build capability and capacity in relevant disciplines, and secondly to integrate data-science approaches across the Science Themes. This enables us to extract more value from GNS Science's significant data resources, for the benefit of the wider science community, and to deliver greatest value and impact for Aotearoa New Zealand.

#### KEY INITIATIVES FOR 2021/22:

- Broaden the uptake of data science approaches through an internal funding round supported by the Capability Development Fund.
- Update GNS Science's data management plan to include new data streams and developments in National Data Services across the CRIs.

## How we work – Pehea Tā Tātou Mahi

**Our four Strategic Pillars signal how we want to work to achieve continued growth and success for GNS Science and to deliver greater value and impact. They serve as focus areas for shaping our culture, guiding our decision-making and priorities as well as assessing the effectiveness of our organisation.**

### INVESTING FOR AND WITH PURPOSE

**We focus our work on meeting Aotearoa New Zealand's needs**

We will gear our activities to making a difference for Aotearoa New Zealand and be transparent and accountable with our investments. We will be more purposeful in how we invest our science capabilities and our funding will be strategy-led. We are actively managing our non-contestable funding from the Strategic Science Investment Fund (SSIF) to make the most of our strengths and as a springboard for other revenue opportunities. We will be clear about our priorities to increase the impact of everything we do, across the scientific world, for the benefit of New Zealand.

### DECISION-MAKER

**We use our knowledge to influence stakeholder decisions**

We will improve our connections with a wide range of stakeholders in government, business and communities to proactively become part of the decision-making agenda. We want to be at the table to contribute meaningfully in the conversations about Aotearoa New Zealand's future. We will have more confidence to get involved with key stakeholders to influence their decisions – talking to the right people, in the right way, at the right time, and empowering our teams to make decisions and proactively explore opportunities with our stakeholders. It's about situational awareness to know when, with whom and how we might have influence and then going for it.



**Me āta whakangao,  
me whakangao hoki  
mō te whāinga**

Investing for and with Purpose

**Ko tā tātou e arotahi nei, kia mahi hei  
whakatutuki i ngā hiahia o Aotearoa**

We focus our work on meeting  
New Zealand's needs



**He Kaiwhakatau**

Decision maker

**Ka whakamahia tā tātou mōhiotanga hei  
whakaaweawe i ngā whakatau  
a tō tātou hunga whaipānga**

We use our knowledge to influence stakeholder decisions



## DEEP PARTNERING

### We partner for long-term success

This means building significant relationships that can be identified as long-term – where there's value in engaging, building trust and working together for mutual long-term benefit, making conscious decisions to collaborate rather than compete in a contestable funding environment. We will build on our great relationships with other Crown Research Institutes, universities, local and central government, industry and business, iwi/Māori, and international science organisations enabling us to work together in making Aotearoa New Zealand a Cleaner, Safer and More Prosperous place to live, and develop ongoing projects with our commercial clients to respond to their changing needs.



**Kia whai hoa rangapū  
tūturu nei**  
Deep Partnering

**Ka whai hoa rangapū tātou  
mō te momoho pūmau**

We partner for long-term success

## AWARENESS

### We are recognised for the great work we do

We want to raise awareness of who we are and what we do so we can engage New Zealanders in the significance of our work. This will be done with a compelling shared narrative that puts us firmly in the science space where we are uniquely placed and strong. As we demonstrate the benefits of our work and build trust with our partners and communities, they will recognise the value that we add and advocate for us. This means our people will be active in places where we can have influence. Internally we are creating and fostering pride in the breadth and depth of what we do, and what others say about us, so we can celebrate together.



**Te Aroā**  
Awareness

**Ka para te huarahi kia whakamihia tātou  
mō ngā mahi pai e oti ana tātou**

We build recognition for the great work we do

# OUR ORGANISATION

## Strategic Priorities


**Major areas of focus for GNS Science during the 2020/21 year were our response to the impacts of the COVID-19 pandemic, and the investigations into the Whakaari eruption and resulting charges laid against GNS Science. This work will continue into the 2021/22 year.**

Our work will be guided by both the *Te Pae Kahurangi* review of CRIs and recommendations from GNS Science's Strategic Scientific and User Advisory Panel (SSUAP). Implementing recommendations from these reviews will assist in ensuring our science continues to have a focus on excellence and relevance, and that we are well attuned to national and international trends and opportunities.

We remain committed to deepening our relationships and collaboration with other research entities, both nationally and internationally. In particular, building on the increased collaboration amongst the Crown Research Institutes evident during the response to the COVID-19 pandemic, and as a result of the *Te Pae Kahurangi* review report.

### KEY INITIATIVES FOR 2021/22:

- Remain agile in our response to the COVID-19 pandemic, in order to safeguard staff wellbeing, retain organisational capability and ensure that we are financially sustainable.
- In conjunction with other CRIs, continue our collaborative work to implement outcomes from the *Te Pae Kahurangi* review report effectively across the system.
- Respond to the demands of various investigations into the Whakaari eruption, including responding to the charges laid against GNS Science by WorkSafe NZ.
- Implement a GNS Science Carbon Management Plan, which provides clear targets to assist us in meeting the Government's net carbon zero directive.



Taking magnetotelluric (MT) measurements in the Raukumara ranges along the Hikurangi margin

# TŌ TĀTOU ROOPŪ WHAKAHAERE

## Valuing Our People

**GNS Science is progressing its change journey and taking key steps to ensure it delivers on its promises to establish itself as a science employer of choice, meet our strategic goals and deliver value to Aotearoa New Zealand.**

Our investment and focus in the areas of leadership development, strategic workforce planning, recognising and rewarding high performance, building capability and diversity, and focusing on Health and Safety ensures our workforce is aligned to our strategy.

### THE VALUE OF DIVERSITY

We are committed to creating an inclusive work environment that will contribute to our productivity and impact as well as strengthen the relationships between science and society.

There is still more work to do to encourage greater representation of Māori staff and capacity to support Vision Mātauranga and our engagement with iwi/Māori, and working collaboratively with them. Our standing and connections into science globally remain vital as does our need to attract high quality talent in Aotearoa New Zealand and internationally.

Our focus has continued to build capability with a new Diversity and Inclusion (D&I) Policy, unconscious bias training, and the establishment of a D&I committee. There are improvements in both overall staff perceptions of diversity and inclusion and the workforce participation rate across all levels of GNS Science evidenced by the index movement of +9% in the last staff engagement survey. Managers have a growing awareness of diversity and inclusion matters – and the importance of ensuring a range of perspectives.

The now well-established Early Career Network (ECN) has a commitment to enhance connectivity supporting our early-career people. The ECN programme has been designed to provide development opportunities that provide mentoring and inspiration.

### CAPABILITY PLANNING AND DEVELOPMENT

As we continue our investment in the development of our people, key areas of focus are leadership development and strategic workforce planning.

The recently developed Leadership Strategy and Programme is focused on the delivery of the change required at all levels of the organisation. In our approach we place significant investment in ensuring our leadership development is integrated with 'real work' and aligns expectations, promotes innovation, supports organisational processes and forums, and targets development opportunities.

At GNS Science leadership development goes beyond personal development – it is about leveraging the impact of our science, and overall organisational development.

To develop the workforce GNS Science will need in the future we are equipping our leaders to build the capability of their current teams. Leaders are also providing input into the development of the Science Roadmap which will determine and drive the capabilities we will need.

### CULTURE AND ENGAGEMENT

We are maintaining our focus on our people leading the culture change by embedding our expectations in 'the way we do things here', embracing our values, championing cross-team collaboration, and encouraging

new ways of thinking to shape the organisational culture that is right for GNS Science and the people who work here.

We will continue to measure our progress on this journey through staff surveys and targeted actions to develop the culture that will best support the achievement of our strategy. Key areas of focus to enhance our capability, make us easier to work with and develop our culture are captured in our People and Culture Strategy and Implementation plan which has a focus on:

- Strategic workforce planning – to ensure we have the right capability to meet the needs of the future including initiatives that build a diverse and inclusive workforce
- Leadership development – growing leaders at all levels of the organisation, and providing the opportunity for all staff to gain a solid foundation and establish a shared leadership language across GNS Science
- Reward and recognition programmes which recognise high performing talent and value the diversity of our people and their contribution to our success.

### KEY INITIATIVES FOR 2021/22:

- Continue implementation of our People and Culture Strategy, with a key focus on strategic workforce planning, lifting leadership capability and shaping the diversity of our workforce.
- Roll out the Career and Capability Framework with a focus on refining the Performance Development Framework to ensure alignment with behavioural descriptors of our values, required competencies and refine the criteria and process for the promotion framework.
- Implementation of the Remuneration, Reward and Recognition Strategy.

## Health and Safety

**Providing and supporting a safe and productive work environment is central to our beliefs. Our people have responded well to the changing pandemic environment with managers putting an increased focus on mental wellbeing and the importance of a safe and supportive work environment.**

We have increased capability within the Health and Safety team to support our focus on improving the management of critical risks, systems, structure, documentation and processes.

Good progress is being made, and the results of the Health and Safety component of our Staff Survey are encouraging - GNS Science was 19% above the WorkSafe benchmark in relation to health and safety behaviours, and 10% above the benchmark in relation to attitude. The survey results have provided good data to help steer our efforts going forward.

Overall, we are committed to ensuring our staff have the capability, as well as the behaviours, that will ensure they look after each other and get home safe every day.

### KEY INITIATIVES FOR 2021/22:

- In consultation with staff, review our critical risk management framework and implement the actions identified in the Critical Risk Review conducted in November 2020.
- Continue to engage with and educate staff on the principles of risk management and a risk-based approach to Health and Safety.
- Improve GNS Science contractor management procedures across our procurement process, including how we collaborate with our contracted partners.
- Build on our wellbeing initiatives and develop procedures to manage psychosocial hazards and risks.

## Connectivity and Innovation

**We continue to embed new programmes to deliver meaningful value with and for our major stakeholders. This includes implementing our Stakeholder Engagement programme and engaging our major partners and end-users earlier in the research process.**

GNS Science relies on international research collaborations and partnerships to deliver high-quality research outcomes through the leveraging of international capability and large-scale facilities. We maintain this through strategic agreements with other national geoscience and isotope science agencies in Australia, Japan, Germany, Italy and the USA. We also hold strategic national memberships that enable national access to collaborative resources, including the International Ocean Discovery Program (IODP) and the International Continental Scientific Drilling Program (ICDP).

The Innovation Hub within GNS Science will continue to provide internal mechanisms and incentives to support higher-risk innovation and co-design approaches to develop new research directions. This includes hosting innovation workshops, allocating capability development funds to encourage co-design approaches to new research directions and allowing higher-risk initiatives to be tested. While the Innovation Hub activity is mostly virtual, we are working towards developing innovation spaces to support ideation and the development of an innovation community of practice across GNS Science.

We continue to advance our approach to commercialisation and intellectual property (IP) management, recognising that both 'open science' and industry-led innovation are needed to grow new industries and value-streams for New Zealand.

Given the significant impact of COVID-19 on some of our major stakeholders, including the ways in which we can engage with our international stakeholders and partners, we will continue to focus on:

- Broadening delivery of our Stakeholder Engagement programme
- Continuing to develop and roll out new engagement approaches
- Exploring new digital methods to deliver value to our international customers
- Progressing our collaborative research agreements with major international partners
- Continuing to engage in key international forums, and building our leadership in major international collaborations, including International Ocean Discovery Program (IODP) and International Continental Scientific Drilling Program (ICDP).

### KEY INITIATIVES FOR 2021/22:

- Continue to broaden and deepen external stakeholder engagement approaches to reflect stakeholder needs.
- Continue to allocate capability development funds to help drive our innovation practices.



UAV (drone) investigations for groundwater recharge modelling

## Information Services and Technology

**GNS Science is investing in its Information and Communication Technologies (ICT) infrastructure to ensure that we are well-positioned to take advantage of the growing opportunities across the Aotearoa New Zealand science and innovation system for high-performance computing and associated data science opportunities.**

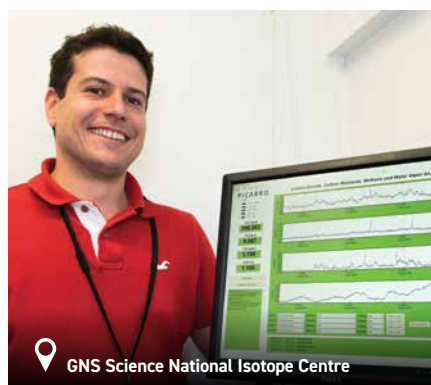
Key elements of our Information Services and Technology strategy are:

- **Collaboration and knowledge dissemination** – continuing to improve information management, providing better tools and practices, with a focus on dataset availability and management, will enable our people to work from any external organisation or scientific disciplines to deliver shared goals
- **Organisational intelligence and efficiency** – providing better contract, project, financial and performance management information across our organisation. This involves improved information flow management tools and practices through an Enterprise Resource Planning (ERP) system
- **ICT Infrastructure modernisation** – continuing our programme of consolidation and redesign of our ICT Infrastructure to better provide resiliency, immediacy, scalability and cost savings
- **Continued development of our people** to improve data literacy, the application of data science across the organisation, and high-performance computing.

Over the last year, GNS Science has been working collaboratively with the Institute of Environmental Science and Research (ESR) to identify a common replacement for our enterprise systems, which will address issues with our core capabilities of Financial Management, Human Resources Management, and Contract and Project Management. An effective and integrated system will result in significant efficiency gains and enable the delivery of timely information and transparency for managers and decision makers. The system will be implemented in the coming year.

### KEY INITIATIVES FOR 2021/22:

- Implement the recommended solution for an ERP system for GNS Science.
- Complete the refresh of the www.gns.cri.nz website purpose, platform and content.
- Support and implement the changes from the New Zealand Research Information System (NZRIS) project as required.



GNS Science National Isotope Centre  
Checking carbon dioxide readings on the Picarro Greenhouse Gas analyser, a cavity ringdown spectrometer

## Financial Services

**Financial Services support GNS Science in achieving financial sustainability through the delivery of a range of accounting and financial services, including leadership of the financial strategy and goals of the organisation, financial and management information reporting, development of the budget and business plans transactional processing, and providing information and advice to project leaders and managers throughout GNS Science that support strong decision-making.**

Like many organisations, GNS Science has been through a period of significant disruption to business-as-usual and ongoing financial uncertainties due to the COVID-19 pandemic. This has required focused financial leadership, including improved financial monitoring, reporting and advice.

### KEY INITIATIVES FOR 2021/22:

- Complete the implementation for a long-term replacement of the finance system as part of the ERP initiative (noted under Information Technology).
- Continue improvements to financial modelling and forecasting and build these into the new finance system.

## Property

**Over the 2020/21 year, GNS Science has been working towards completion of our Property Strategy that will provide the high-level framework for coordinated planning across our national portfolio of research laboratories, workshops, office accommodation and public interface property.**

It integrates the operation, maintenance, improvement, adaption, construction and disposal of buildings and infrastructure, and is set within the context of the people, places, processes and technologies required to create a built environment that underpins the delivery of our science. Our objective of developing a strategic asset plan will support our Property Strategy.

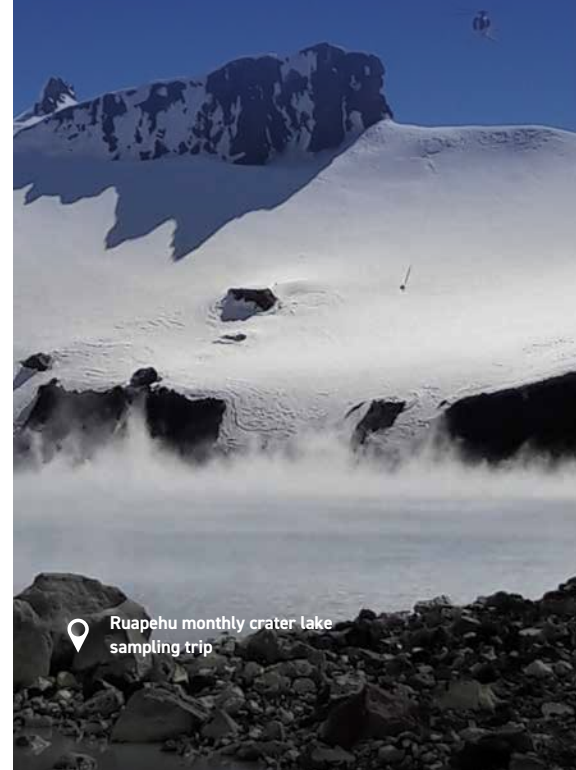
GNS Science requires contemporary facilities to enable the delivery of great science, to minimise health and safety risks to our staff and support their wellness, to create connection both internally and externally, and to bring our people together under a 'one GNS' vision, where our facilities enable connection, collaboration, and innovation. In the coming year, we will be primarily focused on engaging with relevant partners, including mana whenua, others in the science system and government, on our proposed property development to ensure we deliver the best possible facilities and environments for our people, and to facilitate collaboration and innovation wherever possible.


### KEY INITIATIVES FOR 2021/22:

- Engagement with partners, key stakeholders and government on the proposed Property Strategy.
- Progress master planning and design for a new volcanology and visitor centre in Wairakei.
- Develop a strategic asset management plan and implement a digital facilities asset management tool to optimise maintenance renewal and improvement decisions, which aligns with the Property Strategy.
- Development of business and investment plans for new facilities as required.

### PHOTOGRAPH ACKNOWLEDGEMENTS

|  |                       |
|--|-----------------------|
| Karen Britten  | Cover, P7, 36         |
| Calum Chamberlain,<br>Victoria University of<br>Wellington | Inside front<br>cover |
| Colin McDiarmid  | P3                    |
| Emily Warren-Smith   | P4                    |
| Nick Macdonald   | P10                   |
| Margaret Low   | P12, 35               |
| Jess Hillman   | P14                   |
| Susie Woods,<br>Cawthron Institute                         | P16                   |
| Jenny Black  | P18                   |
| Brad Scott   | P20                   |
| Nick Kirkman   | P22                   |
| Paul Viskovic  | P24                   |
| Suzanne Bull   | P26                   |
| Mark Lawrence  | P29                   |
| Grant Caldwell   | P32                   |
| Frederika Mourot   | P34                   |



 Ruapehu monthly crater lake sampling trip

# FINANCIAL PROJECTIONS

## The Financial Projections for GNS Science over the next three years reflect the continued organisational advances arising from the Strategic Review.

These are resulting in a strengthening financial performance, which is particularly pleasing given the challenges of the COVID-19 pandemic in the past year. GNS Science's revenue is projected to increase by 7.3% during 2021/22 compared to 2020/21 (excluding the one-time COVID relief grant of \$4.2m). This is reflective of the success achieved with new research grants over the past 12 months, and solid progress in relation to New Zealand commercial work. However, the international commercial market continues to be difficult, and is likely to remain so until the economic and travel impacts of the COVID-19 pandemic diminish. As a consequence, the financial projections reflect a conservative view on international revenue in the short term, with the outyears eventually recovering to similar levels experienced prior to COVID-19.

It is anticipated that base operating costs will remain constrained during the next few years, with base expenditure levels consistent with 2021. This will provide the financial capacity to support new strategic initiatives necessary for GNS Science to continue its growth and improved performance. As an example, projections include operating investment of \$4.2m over the next 24 months to replace and improve current enterprise systems and tools (including HR and Finance systems).

The projections also include \$8.4m capital investment per annum to enable further development of fit-for-purpose assets over time. The capital programme is essential to continue the investment in science equipment and infrastructure. There is sufficient actual and forecasted cash flows to meet business needs over the SCI period, dependent on the increase of activity levels in commercial revenue.

## SHAREHOLDER CONSENT FOR SIGNIFICANT TRANSACTIONS

The Board will obtain prior written consent for any transaction or series of transactions involving 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 \$10 million or 20% of the Company's total assets (prior to the transaction), whichever is the lesser.

The Board will obtain the prior written consent of Shareholding Ministers for any transaction or series of transactions with a value equivalent to or greater than \$5.0 million or 30.0% of the Company's total assets (prior to the transaction):

- the acquisition, disposal, or modification in a joint venture, partnership, or other similar association;
- the acquisition or disposal in full or in part of shares or interests in external companies, subsidiaries, and business units;
- transactions that affect the Company's ownership of a subsidiary or a subsidiary's ownership of another equity;
- other transactions that fall outside the scope of the definition of the Company's core business or may have a material effect on the company's science capabilities.

The Board will advise the Shareholding Ministers in writing (in the Quarterly Report) before entering into any transaction below this threshold related to property or to a specific commercialisation venture which involves change in intellectual property ownership or control.

## Ratio of Shareholders' Funds to Total Assets

The target ratio of 'shareholders' funds to total assets' is as follows:

|               |              |
|---------------|--------------|
| 2021 Forecast | 2022 Budget  |
| 58.4%         | 58.4%        |
| 2023 Outlook  | 2024 Outlook |
| 55.8%         | 54.0%        |

Shareholders' funds are defined as the sum of the 'share capital' and 'equity reserves' (otherwise called 'total equity'). Total assets are defined as the sum of the net book value of 'current' and 'non-current assets'. This is 'as disclosed' in the company's balance sheet as per the Annual Report, prepared in accordance with the accounting policies adopted by the Board.

## COMMERCIAL VALUE

Section 16(3) of the CRI Act requires the Company to furnish an estimate of the current commercial value of the Crown's investment.

The Board is satisfied that the net asset position (or shareholders' funds) as at 30 June 2020 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 2020 was \$35.0 million.

## DIVIDEND POLICY

The GNS Science dividend policy states that the Company may elect to return surplus cash to shareholders in the form of a dividend when no sound investment opportunities exist (including reinvestment, commercialisation, capital expenditure, and the retention of important capabilities).

GNS Science is investing in people, systems and science infrastructure to enable delivery of its research strategies over the longer term. Therefore, no dividend is proposed in the short to medium term.

## 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 GNS Science 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 GNS Science's Statement of Corporate Intent 2021–26.

## GROUP RATIOS AND STATISTICS

| Year ending 30 June   | Forecast<br>2020/21 | Outlook<br>2021/22 | Outlook<br>2022/23 | Outlook<br>2023/24 |
|---|---------------------|--------------------|--------------------|--------------------|
| <b>Revenue</b>  |                     |                    |                    |                    |
| Total revenue (\$000s)  | 107,798             | 111,106            | 117,916            | 123,764            |
| Revenue growth  | 13.0%               | 3%                 | 6%                 | 5%                 |
| <b>Operating results (\$000s)</b>                                     |                     |                    |                    |                    |
| Operating expenditure (excluding depreciation)                        | 96,342              | 104,423            | 110,555            | 114,493            |
| Earnings before interest, tax, depreciation and amortisation (EBITDA) | 11,456              | 6,683              | 7,361              | 9,271              |
| Earnings before interest and tax (EBIT)                               | 5,990               | 813                | 1,198              | 2,800              |
| Net profit/(loss) before tax  | 6,113               | 963                | 1,348              | 2,950              |
| Net profit/(loss) after tax   | 4,401               | 694                | 971                | 2,124              |
| EBITDA per FTE  | 25                  | 15                 | 15                 | 18                 |
| Total assets  | 67,514              | 68,703             | 73,614             | 80,020             |
| Total equity  | 39,396              | 40,090             | 41,061             | 43,185             |
| Capital expenditure   | 4,600               | 8,400              | 7,500              | 7,500              |
| <b>Liquidity</b>  |                     |                    |                    |                    |
| Quick ratio   | 2.9                 | 2.2                | 1.7                | 1.5                |
| Interest coverage   | n/a                 | n/a                | n/a                | n/a                |
| <b>Profitability</b>  |                     |                    |                    |                    |
| Return on equity  | 12.6%               | 1.8%               | 2.4%               | 5.2%               |
| Operating margin  | 10.6%               | 6.0%               | 6.2%               | 7.5%               |
| <b>Operation risk</b>   |                     |                    |                    |                    |
| Profit volatility   | 40.9%               | 38.9%              | 34.7%              | 31.6%              |
| Forecasting risk  | 10.2%               |                    |                    |                    |
| <b>Growth/Investment</b>  |                     |                    |                    |                    |
| Capital renewal   | 0.8                 | 1.4                | 1.2                | 1.2                |
| <b>Financial strength</b>   |                     |                    |                    |                    |
| Equity ratio  | 58.4%               | 58.4%              | 55.8%              | 54.0%              |



# ACCOUNTING POLICIES

## Reporting entity and activities

The Institute of Geological and Nuclear Sciences Limited is established under the Crown Research Institutes Act 1992 and the Companies Act 1993. Its subsidiary companies are established under the Companies Act 1993. The financial statements have been prepared in accordance with the Crown Research Institutes Act 1992, the Public Finance Act 1989, the Companies Act 1993, the Crown Entities Act 2004 and the Financial Reporting Act 2013.

Consolidated financial statements for the group comprising the Institute of Geological and Nuclear Sciences Limited (the Company) and its subsidiaries are presented, and the effects of intra-group transactions are fully eliminated in the consolidated financial statements. Subsidiaries are those entities controlled by the Company.

Control is achieved where the Company has the power to govern the financial and operating policies of an entity to obtain benefits from its activities.

The subsidiaries of the Company are:

- Isoscan Limited
- Isoscan Food Limited
- Geological Surveys (New Zealand) Limited
- Geological Risk Limited
- GNS Science International Limited.

The principal activities of the Group are to undertake geoscience and isotope science research, development and commercial projects, predominantly in New Zealand.

## Revenue

### STRATEGIC SCIENCE INVESTMENT FUND

The Company is party to a Strategic Science Investment Fund (SSIF) agreement with the Crown to perform research activities. Revenue under this contract is treated as a Government Grant under NZ IAS 20.

### REVENUE FROM OTHER RESEARCH AND COMMERCIAL CONTRACTS

Revenue from other research and commercial contracts are accounted as revenue from contracts with customers under NZ IFRS 15.

Revenue earned from the supply of goods and services is measured at the fair value of consideration received and is recognised when the significant risks and rewards of ownership of the goods have been transferred to the buyer.

Revenue from services is recognised based on the percentage of work completed. Any amounts received in relation to work not yet commenced are recorded as revenue in advance.

### FUNDING OF THE GEONET PROGRAMME'S ASSETS AND OPERATING COSTS

It is expected that assets owned by the Earthquake Commission (EQC) will be transferred to the Company within the 2021-22 Financial Year.

Funding received from EQC related to future asset purchases and operating costs will be treated as a Government Grant under NZ IAS 20.

## Property, plant and equipment

Property, plant and equipment are stated at cost less accumulated depreciation and impairment. Cost includes expenditure that is directly attributable to the acquisition of the item. Assets are depreciated on a straight-line basis at rates calculated to allocate the assets' cost over the estimated remaining useful lives. Freehold land is not depreciated.

The estimated useful lives, residual values and depreciation methods are reviewed annually, with the effect of any changes in estimate accounted for on a prospective basis. The gain or loss arising on the disposal or retirement of an item of property, plant and equipment is recognised in profit or loss.

### HERITAGE ASSETS - COLLECTIONS, LIBRARY AND DATABASES

The Company owns various collections, library resources and databases that are an integral part of the research work undertaken by the Company. These collections are highly specialised and there is no reliable basis for establishing a valuation. The two major collections are:

- The National Paleontological Collection
- The National Petrology Reference Collection
- The Historical Geological Map Archive.

## Intangible assets

Software, patents and capitalised development costs have a finite life and are included at cost less accumulated amortisation and impairment. Amortisation is charged on a straight-line basis at rates calculated to allocate the assets' cost over their estimated remaining useful lives.

The estimated useful life and amortisation method are reviewed annually, with the effect of any changes in estimate being accounted for on a prospective basis. The following useful lives are used in the calculation of amortisation:

- Software 4–8 years
- Patents 4–17 years
- Capitalised development costs 4–8 years.

## Deferred tax

Deferred tax is accounted for using the comprehensive balance sheet liability method in respect of temporary differences arising from differences between the carrying amount of assets and liabilities in the financial statements and the corresponding tax base of those items. In principle, deferred tax liabilities are recognised for all taxable temporary differences. Deferred tax assets are recognised to the extent that it is probable that sufficient taxable amounts will be available against which deductible temporary differences or unused tax losses and tax offsets can be utilised. The carrying amount of deferred tax assets is reviewed and reduced to the extent that it is no longer probable that sufficient taxable profits will be available to allow all or part of the assets to be recovered. Deferred tax assets and liabilities are measured at the tax rates that are expected to apply in the period in which the liability is settled or the asset realised.

Under Section OB1(2)(d) of the Income Tax Act (2007), the Company is not required to maintain an imputation credit account.

Following changes to tax depreciation rules in 2020, the Company now recognizes a deferred tax asset in respect of its buildings.

## Employee entitlements

Liabilities for wages and salaries, annual leave, long service leave and retirement leave are recognised when it is probable that settlement will be required, and they are capable of being reliably measured. Employee benefits to be settled within twelve months are reported at the amount expected to be paid and are classified as current liabilities. Employee benefits not expected to be settled within twelve months are reported at the present value of the estimated future cash outflows.

Provisions for long service leave and retirement leave depend on a number of assumptions such as the expected employment period of employees, salary levels and the timing of employees taking leave. When measuring employee benefit liabilities risk-free discount rates provided by The Treasury are used as the appropriate discount rates, the salary increase factor is based on forecast information and employee pattern of leave has been determined after considering historical data.

## Financial instruments

### CAPITAL MANAGEMENT

The Group manages its capital to ensure that entities in the Group will be able to continue as going concerns while maximising the return to shareholders through the optimisation of the debt and equity balance. The capital structure of the Group consists of cash and cash equivalents, and equity attributable to equity holders of the parent, comprising issued capital and retained earnings.

The Group is not subject to any externally imposed capital requirements.

### CURRENCY RISK

The Group undertakes certain transactions denominated in foreign currencies.

Exchange rate exposures are managed within approved policy limits using forward foreign exchange contracts. These derivative financial instruments are initially

recognised at fair value on the date the derivative contract is entered into and are subsequently remeasured to their fair value at the end of each reporting period.

Derivatives are carried as assets when the fair value is positive and as liabilities when the fair value is negative. The resulting profit or loss is recognised in profit and loss immediately, unless the derivative is designated effective as a hedging instrument, in which event the timing of the recognition in profit or loss depends on the nature of the hedging relationship.

The effective portion of changes in the fair value of cash flow hedges is recognised in other comprehensive income and accumulated in a cash flow hedge reserve.

The gain or loss relating to any ineffective portion is recognised immediately in profit or loss.

### INTEREST RATE RISK

The Group operates a call account and has short-term deposits on which interest is earned. Where possible the Group manages exposures to interest rate fluctuations through prudent management of its treasury operations. In managing interest rate risks the Group aims to reduce the impact of short-term fluctuations on earnings. Over the longer term, however, permanent changes in interest rates will have an impact on profit.

### CREDIT RISK MANAGEMENT

The financial instruments which expose the Group to credit risk are principally bank balances, short-term investments and accounts receivable. The Group monitors credit risk on an ongoing basis. Bank balances and short-term investments are held with New Zealand registered banks in accordance with the Group's treasury policy. No collateral is held by the Group in respect of bank balances, short-term investments or accounts receivable. The maximum exposure to credit risk is represented by the carrying value of each financial asset in the Balance Sheet.

## LIQUIDITY RISKS

The Group manages liquidity risk by maintaining adequate reserves, cash deposits and reserve borrowing facilities, by monitoring forecast and actual cash flows and matching the maturity profiles of financial assets and liabilities, all of which are of a short-term nature. The Group continues to generate sufficient cash flows from operations to meet financial liabilities.

## Trade and other payables

Trade and other payables are non-interest bearing. In recognition of the Government's requirements to support the economy by ensuring prompt payment, we are now targeting to make payments within 10 working days from receipt of invoice.

The carrying value of creditors and other payables approximates their fair value.

## Related party transactions

The Crown is the ultimate shareholder of the Company. No other transactions with New Zealand government owned entities are considered as related party transactions in terms of NZ IAS 24.

## Leases

GNS Science considered adopting NZ IFRS 16 Leases during the financial year ended June 2021. Given that the value of leases is not material to the overall Balance Sheet, and the impact on profit and loss was negligible it was decided not to adopt NZ IFRS16.

## Preparation disclosures

### STATEMENT OF COMPLIANCE

The financial statements have been prepared in accordance with New Zealand Generally Accepted Accounting Practice. They comply with New Zealand equivalents to International Financial Reporting Standards and other applicable Financial Reporting Standards, as appropriate

for profit oriented entities. The financial statements also comply with International Financial Reporting Standards.

Accounting policies are applied consistently to all periods presented in the financial statements unless otherwise stated.

### MEASUREMENT BASIS

The financial statements of the Group are prepared on an historical cost basis, except that derivative financial instruments are measured at their fair value. Transactions in foreign currencies are converted at the New Zealand rate of exchange ruling on the date of the transaction. Monetary assets and liabilities at year end are converted to New Zealand dollars at the exchange rate ruling at balance date. The financial statements are presented in New Zealand dollars which is the Group's functional currency. All values are rounded to the nearest thousand dollars.

### INTEREST IN JOINT ARRANGEMENTS

A joint arrangement is an arrangement whereby the Company or its subsidiaries have joint control over an entity. Joint control is the contractually agreed sharing of control of an arrangement, which exists only when decisions about the relevant activities of that entity require the unanimous consent of the parties sharing control. A joint arrangement is either a joint operation or a joint venture. For a joint operation the Group recognises its share of assets, liabilities, revenues and expenses on a line-by-line basis using the proportionate method. For a joint venture the Group recognises its interest in a joint venture as an investment and accounts for that investment using the equity method.

### CLASSIFICATION OF FINANCIAL ASSETS AND LIABILITIES

The Group holds loans and receivables. These are measured at cost less impairment, or in the case of trade receivables, reduced by an allowance for doubtful debts.

Financial liabilities, excluding derivative financial instruments, are classified as 'other financial liabilities'. Other financial liabilities are initially measured at fair value, net of transaction costs. Other financial liabilities are subsequently measured at amortised cost, with interest expense recognised on an effective interest basis.

### CRITICAL ACCOUNTING ESTIMATES AND JUDGEMENTS

In applying the accounting policies, there is the requirement for judgements, estimates and assumptions to be made about the carrying amounts of some assets and liabilities. The estimates and assumptions are based on historical experience and other relevant factors. Actual results may differ from these estimates.

Accounting policies where critical estimates have been made include property, plant and equipment, intangible assets, impairment of assets and liabilities and employee benefits. Judgement has been applied in determining not to value heritage assets for financial reporting purposes.

### NEW STANDARDS AND INTERPRETATIONS NOT YET ADOPTED

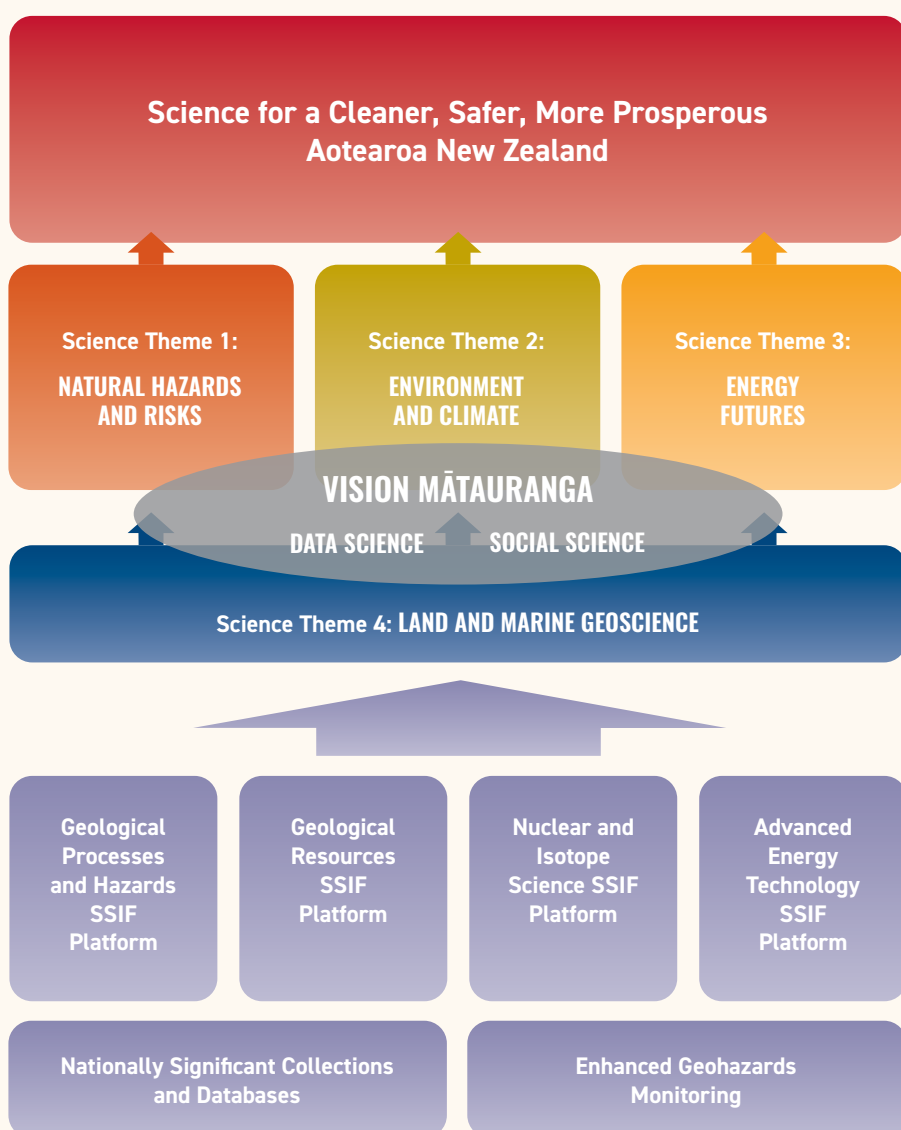
There are no new accounting standards affecting the 2020-21 or 2021-22 Financial Years.

Dr Nicola Crauford  
Chairman

Dr John Sharpe  
Director  
25th June 2021

# APPENDIX ONE

## ALIGNMENT OF SSIF INVESTMENT TO OUR VISION AND SCIENCE THEMES



# APPENDIX TWO

## GNS SCIENCE KEY PERFORMANCE INDICATORS

| INDICATOR                                  | MEASURE<br>YEAR ENDING 30 JUNE   | TARGET<br>2020-21 | TARGET<br>2021-22 |
|--|--|-------------------|-------------------|
| <b>STRATEGIC INTENT</b>                    |  |                   |                   |
| <b>Priority setting</b>                    | Surveyed end-users have confidence that GNS Science considers their sector's priorities when setting their research priorities (%) | >70%              | >70%              |
| <b>Team selection</b>                      | Surveyed end-users have confidence that GNS Science has assembled 'best' teams for research delivery (%)                           | >85%              | >85%              |
| <b>SCIENCE IMPACT</b>                      |  |                   |                   |
| <b>Research delivery</b>                   | Research milestones (critical steps) on track or completed   | >87%              | >87%              |
| <b>Impact case studies</b>                 | Impact case studies published  | 3                 | 3                 |
| <b>Knowledge transfer</b>                  | Surveyed end-users have adopted knowledge from GNS Science in the past three years (%)   | >90%              | >90%              |
| <b>SCIENCE EXCELLENCE</b>                  |  |                   |                   |
| <b>Peer-review</b>                         | Programme reviews carried out  | 3                 | 3                 |
| <b>Science quality</b>                     | Impact of scientific publications (weighted citation index)*   | 3.2               | 3.2               |
| <b>Research collaboration</b>              | Papers co-authored with collaborators  | 92%               | 92%               |
| <b>SCIENCE RELEVANCE</b>                   |  |                   |                   |
| <b>End-user collaboration</b>              | Revenue per FTE from commercial sources (\$000)  | 56                | 62                |
| <b>Technology &amp; knowledge transfer</b> | Commercial reports per scientist FTE   | 1                 | 1                 |
| <b>FINANCIAL</b>                           |  |                   |                   |
| <b>Revenue generation</b>                  | Revenue per FTE (\$000)  | 228               | 230               |
| <b>EMBEDDING VISION MĀTAURANGA</b>         |  |                   |                   |
| <b>Māori engagement</b>                    | Projects with Māori stakeholders embedded in the research  | 5                 | 5                 |
| <b>HIGH PERFORMANCE CULTURE</b>            |  |                   |                   |
| <b>Health &amp; Safety</b>                 | Recordable injuries per 200,000 work hours (rolling 12-month average)  | <2.5              | <2                |
| <b>Staff engagement**</b>                  | Percentage of staff engaged in working for GNS Science   | >68%              | >72%              |

\* Mean 2-year impact factor for SCImago-assessed journals, weighted by the number of GNS Science publications.

\*\* Based on the Qualtrics Survey cluster of questions and definition for staff engagement.

# APPENDIX THREE

## OUR NATIONALLY SIGNIFICANT COLLECTIONS AND DATABASES

We are the custodian of eight Nationally Significant Collections and Databases. As well as ensuring that the databases and collections are kept up-to-date with newly acquired samples and data, we will maintain and improve system functionality and infrastructure to ensure ready access both internally and externally for research, commercial applications, and public information.

- The **Regional Geological Map Archive and Data File** is the national repository of geological maps and regional geological information for Aotearoa New Zealand and its territories, generated over the past 150 years by GNS Science and its predecessors. The geological maps and information cover a wide range of scales and are used for many purposes by researchers, resource exploration and engineering companies, hazard and risk assessors, and government.
- The **National Petrology Reference Collection and PETLAB Database** is a curated archive of more than 100,000 rock, soil and mineral samples, mostly from Aotearoa New Zealand and its territories, collected since 1865. The samples and associated geoanalytical data are used by Aotearoa New Zealand and international industry and research geoscientists to better understand Earth composition and resource prospectivity.
- The **NZ National Paleontological Collection and Associated Databases** is a collection of fossil samples from Aotearoa New Zealand and its territories dating back to the early 19th century. It includes vertebrate, invertebrate and plant macrofossils, animal and plant microfossils, trace fossils, and fossil-bearing rocks or rocks that have been sampled for microfossils. Together with the Fossil Record File, and a number of other paleontological databases, the collection provides key biostratigraphic data to refine the geological time scale, with broad benefits to the resources industry, evolutionary biologists, paleo-ecologists and climate modellers. It also contains the raw data on past environmental change.
- The **NZ Fossil Record File** is a register of more than 100,000 fossil locations in Aotearoa New Zealand and the Ross Dependency described since 1865. The data provide essential information for biostratigraphic analysis and refinement of the geological time scale, which is used by stakeholders across the resources, geohazards and environment sectors.
- The **National Groundwater Monitoring Programme**, operating since 1998, provides water quality indicators, including major ions, nutrients, metals and arsenic, for groundwater sampled regularly in all 15 regions of Aotearoa New Zealand. The data provide critical information to water regulators, researchers and consultants to effectively manage water resources.
- The **National Earthquake Information Database** contains essential data on all significant earthquakes recorded in New Zealand since 1840. Accessed via the GeoNet website, these data are used extensively by earthquake hazard modellers and risk analysts, as well as insurance companies and CDEM agencies in Aotearoa New Zealand and overseas.
- The **NZ Volcano Database** is a data resource containing various databases and datasets, including photographs, that are critical to volcano science. The data are used for volcanic unrest detection and eruption forecasting, setting Volcanic Alert Levels and Aviation Colour Codes, and research into magmatic and eruptive activity.
- The **NZ Geomagnetic Database** is a vehicle for transferring critical Southern Hemisphere geomagnetic data collected at Scott Base (Antarctica), West Melton (Canterbury) and Apia (Samoa) to the global INTERMAGNET database. The near real-time data play an important role in constructing and testing global reference models of the geomagnetic field. Geomagnetic reference field models are widely used by scientists, by the military, in transport, and by the community in smartphones and other mobile devices to provide orientation information.

# Science working for New Zealand

The Crown Research Institutes (CRIs) proudly work, individually and collectively, to create a more prosperous, sustainable and innovative New Zealand

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*āta mātai, mātai whetū*

**E/S/R**  
Science for Communities



 Manaaki Whenua  
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SITES ACROSS  
NEW ZEALAND

6,000

SCIENCE PROJECTS  
EACH YEAR

40

NATIONALLY SIGNIFICANT  
DATABASES & COLLECTIONS

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