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# Statement of Corporate Intent 2020–2025



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

Presented to the House of Representatives pursuant to section 16 of the Crown Research Institutes Act 1992.

The Institute of Environmental Science and Research Limited (ESR) is a Crown research institute. It was incorporated in June 1992 and is wholly owned by the New Zealand Government. The two shareholding Ministers appoint a Board of Directors to govern the organisation. ESR has science facilities in Auckland, Wellington (Porirua and Wallaceville) and Christchurch.

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# ESR is New Zealand's Crown research institute specialising in science for communities

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# Chair and Chief Executive's overview

We are pleased to present ESR's 2020-2025 Statement of Corporate Intent (SCI). This Statement of Corporate Intent presents how we will achieve our goal to solve the big problems facing our customers – and New Zealand.

## He waka eke noa – We are all in this together

As the CRI that is all about people, we are here to keep New Zealand's people, communities and environment safe and healthy.

The COVID-19 public health crisis has shone a light on ESR's value. Since January 2020, ESR has worked at the forefront of the national response to COVID-19 and supporting our nation's common goal of eliminating COVID-19 from New Zealand.

The expertise and responsiveness of our scientists has been a key part of the Government's national response to COVID-19, and we've demonstrated agility and quick-thinking in responding to the challenges and opportunities presented by the crisis. We are proud of ESR's people and contribution alongside New Zealand's team of five million. We are also proud of the essential services our people provided through all alert levels.

As well as adeptly stepping up to support the national crisis response, we have expanded existing research and initiated new programmes to grow understanding of COVID-19 and actively progress New Zealand's economic and social recovery. Scientific insight, innovation and capability will be a critical component of well informed, smart choices about New Zealand's future.

We are pleased that ESR has been recognised by the Government for its work. Recent funding announcements through Budget 2020, including additional SSIF funding and funding for the redevelopment of our Kenepuru site, alongside funding from the COVID-19 Response and Recovery Fund and Ministry of Health contract, have been welcome expressions of confidence and support in ESR at a time that is full of opportunities and challenges.

## We are working to ensure we serve New Zealanders now, and for the future

ESR is an organisation committed to transforming itself to deliver enduring value and impact for the communities we serve. Our motivation to transform has never been greater – the value of strong, clear science voices to support informed decision-making by providing up-to-date and considered science communication, together with innovation, has been proven through the COVID-19 pandemic.

Through the recovery period and beyond, New Zealand's future needs – responding to climate change and its impact on human and environmental health; getting ahead of new, emerging diseases; ensuring the safety of our food chain and maintaining the integrity of the justice system – will require the high value, high impact science we are dedicated to delivering.

Significant work programmes across government will also affect ESR's operating environment, such as the outcome of the Te Pae Kahurangi review, Kei Mua Te Ao (the Government's draft RSI strategy), role of Taumata Arowai (the new Government water regulator), and the findings of the Government's New Zealand Health and Disability System Review. We look forward to making meaningful contributions to these critical areas.

The additional Government funding, alongside our own carefully planned investment, will support ESR to:

- **Secure essential transformation at multiple levels:** ESR's science, services and operating model require continuing investment to transform with rapid changes in science, technology and societal needs. Our transformation programme aims to position ESR for the future; looking at how best we can invest in these critical areas to deal with the long-term pressures on our revenue, and confidently build our key capabilities. The value to our customers and New Zealand from the innovation, insight and expert advice provided by ESR's scientists is the cumulative result of sustained, strategic investment in critical disciplines, novel ideas and diverse talent.
- **Mobilise the development of a fit-for-the-future Kenepuru Science Centre:** by providing for accommodation that supports innovative, collaborative and emerging ways science and research are undertaken, and enable operational effectiveness and flexibility to be optimised. The recently announced capital injection of \$25m from government provides a game shifting opportunity. ESR is conscious that the development must serve New Zealanders and the science system into the future and should not overstretch ESR's financial position to achieve this.



- **Continue building our science and applying our expertise to emerging problems:** by actively working on growing and maintaining our science to ensure that it is impactful and relevant. This includes growing our impact with Māori, working with our partners on innovative approaches and building a portfolio of products and services to deliver the best outcomes for our customers and New Zealand.

**We are working to strengthen our financial position now, and for the future**

Like many entities across New Zealand, COVID-19 has increased our risk profile, which we are actively managing.

As a result of the COVID-19 related downturn, we expect our revenue to drop in FY21 as a result of reductions in domestic and commercial revenue, both nationally and internationally. As stewards of critical scientific capability for New Zealand and as prudent financial managers, this presents the ESR Board and Management with challenging choices. We are focused on balancing these responsibilities and positioning ESR for the future by pursuing our strategic goals of science transformation and developing a diversified portfolio that will grow ESR's commercial pipeline.

We are proactively working to contain costs and expenditure while pursuing new revenue opportunities, defining our critical services and what will be needed to sustain them and improving value and profitability across core contracts.

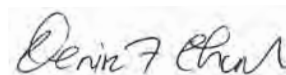
In addition, we are also looking at how we continue with and build research-based solutions to New Zealand's most pressing problems. This includes working closely with our customers and stakeholders to ensure that the science we deliver is valuable, impactful and sustainably funded, alongside building more innovative, and consistently funded, research platforms oriented to New Zealand's current and future needs.

While there is some uncertainty in our operating environment, one thing is clear: we are absolutely committed to working with our partners and stakeholders to deliver critical, relevant and impactful research and science services with, and for, New Zealanders at this time and in the years ahead.

**Mā te huruhuru ka rere te manu** – As ESR builds its science, knowledge and capability, we enable New Zealand communities to soar.



**Amber McEwen**  
Interim Chief  
Executive Officer



**Denise Church**  
QSO, CFInstD  
Chair







# Our vision and core purpose

We support the health, economic, environmental and social wellbeing of New Zealand's people through the power of our forensic, health and environmental science, delivering science solutions and services to meet the complex challenges facing New Zealand.

ESR's vision is to help make New Zealand's people and communities healthier and safer and to improve the environment.

## Statement of core purpose

Our mandate is set by ESR's shareholding Ministers in our Statement of Core Purpose, which states:

"... deliver enhanced scientific and research services to the public health, food safety, security and justice systems, and the environmental sector to improve the safety of, and contribute to the economic, environmental and social wellbeing of people and communities in New Zealand.

ESR provides research and scientific services and knowledge transfer in partnership with key stakeholders including government, industry and Māori to:

- Safeguard the health of New Zealanders through improvements in the management of biosecurity and threats to public health
- Increase the effectiveness of forensic science services applied to safety, security and justice investigations and processes
- Enhance protection of New Zealand's food-based economy through the management of food safety risks associated with traded goods
- Improve the safety of fresh water and groundwater resources for human use and the safer use of biowastes."

## Our unique offering

Everything we do is aimed at keeping New Zealanders and New Zealand safe every day.

We harness the power of our knowledge, research, innovation and services to support improved wellbeing for all New Zealanders. We are the Crown research institute (CRI) whose science contributes to a safe, healthy and prosperous New Zealand by impacting:

- public health
- forensics
- food
- water and the environment.

We are recognised for our science capabilities and trusted advice. We work collaboratively with central and local government, Māori, key stakeholders, industry and other science organisations both nationally and internationally to solve complex problems and emerging threats. Our science capabilities and expertise span several science disciplines such as genomics, microbiology (including virology), risk assessment and risk management, epidemiology, forensics, social science, public-health science, radiation, chemistry, toxicology and data science.

## Our contribution to government objectives

Through our research and services, we contribute to the Government's objectives for improving the wellbeing of all New Zealanders and their families. We are making New Zealand proud through our cutting-edge and world-leading forensics product development. We also support New Zealand's economy through our partnerships in food research and services that contribute to New Zealand's reputation as a leader in the production of sustainable and safe food.

Our research makes a difference and has real impacts in the following areas:

### 1 **Outbreak management, prevention and control of disease-causing agents such as bacteria and viruses:**

We provide leadership, support, diagnostic testing and specialist services to support the Government's responses to these emerging and existing public health threats such as COVID-19 (a novel coronavirus disease that is both highly contagious and can be life threatening), influenza, and measles outbreaks. ESR has contributed to New Zealand's COVID-19 response by being the first laboratory to establish a COVID-19 diagnostic test in New Zealand and undertake routine screening to confirm COVID-19 cases. In March 2020, we signed an agreement with the Government to support COVID-19 diagnostic testing for Pacific Island countries who do not have in-country testing capability. This is an example of how ESR continues to help our Pacific neighbours. ESR is at the forefront of influenza research globally. For the past eight years, ESR has participated in the world-renowned Southern Hemisphere Influenza and Vaccine Effectiveness Research and Surveillance (SHIVERS) programme (see pages 20 and 26 for more information).

**2 Water and waste research:** we are working to improve the quality, protection and management of New Zealand's water, including groundwater and other systems:

- (i) **Groundwater:** this provides much of New Zealand's drinking water, is used for irrigation to grow food and other crops, and is an important component in many industrial processes. Groundwater recharge is essential and provides about 80 percent of the flow for New Zealand's lakes and rivers. We are collaborating with GNS Science, Lincoln Agritech, and Aqualinc Research Limited on projects to:
- develop mitigation approaches to reduce groundwater nitrate levels
  - predict the transport of pathogenic microbes in different groundwater systems
  - develop a groundwater health index based on measures of the natural groundwater ecosystem.
- (ii) **Fresh water:** this is essential for life and clean drinking water is essential for health. New Zealand's fresh water sources and water quality must be protected through careful monitoring and management. Using genomics and bioinformatics, ESR can undertake water microbiology testing and research, including tracking sources of water faecal contamination in fresh water and recreational water.
- (iii) **Biowaste:** together with the Centre for Integrated Biowaste Research, which is co-ordinated by ESR, we are focusing on developing sustainable reuses of biowaste. Our research includes looking at native plants as riparian filters and a source of economic return. ESR researches emerging organic contaminants and microbes in wastewater systems, as well as wastewater epidemiology. ESR is a partner with UNICEF New Zealand to provide water quality advice to the Pacific region and deliver programmes that improve water, sanitation and hygiene practices.
- (iv) **Microplastics:** through the Aotearoa Impacts and Mitigation of Microplastics (AIM<sup>2</sup>) project, we are co-leading research into the effect of microplastics and their impact on New Zealand's people, ecosystems and animals. This knowledge will be critical to developing strategies to manage and mitigate threats from microplastics and will contribute to the long-term wellbeing of New Zealand's people, environment and economy.

**3 Forensics:** ESR is leading the development of cutting edge forensic services and products used by New Zealand Police and in forensic labs worldwide, including Australia, Canada, Dubai, the United Kingdom and in over 46 laboratories across the United States of America. Since its introduction, STRmix™ has been used to interpret deoxyribonucleic acid (DNA) evidence in more than 120,000 cases around the world. Following the Christchurch terror attacks in March 2019 and the Whakaari White Island eruption in December 2019, ESR's teams used this technology to analyse the large number of samples received as quickly as possible.

**4 Drug early warning systems (drug use, prevention and control):** ESR is developing a wastewater-based epidemiology as a mechanism to track licit and illicit drug use across New Zealand. This research has led to the development of a service whereby ESR provides insights to the Ministry of Health and New Zealand Police on the drug use activity of inhabitants within a given wastewater catchment area. This data can be used to inform policy making and as a tool to monitor effectiveness of public health and crime prevention activities.

## Our operating context – opportunities and challenges

Described here are the significant opportunities and challenges in our operating environment that have implications for ESR.

### Government expectations and reforms

- **Government wellbeing vision to deliver intergenerational wellbeing outcomes:** we will continue to position ESR for the future, to be relevant and at the forefront of science, and to maximise long-term impacts in the areas of health, environment, forensics, water and food. This will ensure that we improve current and future wellbeing outcomes and impacts and contribute to the Government's wellbeing vision.
- **Te Pae Kahurangi:** this is the Government's collective review looking at the long-term future and sustainability of CRIs, to secure full value from them. We expect to support, engage with and be ready to respond to the review findings. We will develop an action plan that aligns the work we are currently undertaking through our strategic transformation programme, with the Crown's broader interest in CRIs, and future investment.

- **Māori impact:** we will grow and embed our investment in Māori-led and Mātauranga Māori science and research programmes, partnering with Māori to take a co-design approach in research, science and innovation that is distinct to Māori and will improve Māori economic, social and wellbeing outcomes and impacts.
- **Kei Mua Te Ao:** this is the Government's draft New Zealand strategy on Research, Science and Innovation (RSI). It communicates the Government's objectives and sets an ambitious vision for RSI by 2027. The draft strategy highlights priorities for action and signals the intentions and future direction for RSI. To take advantage of the opportunities from the future direction of RSI, we will ensure our strategic transformation programme is aligned, responsive and prepared.
- **New Zealand Health and Disability System Review:** the findings of this wide-ranging government review of New Zealand's health and disability system will affect the way the health and disability system and sector operate to deliver equitable health outcomes for all New Zealanders. We will be ready to respond to the findings and ensure ESR's science and services continue to evolve to support the health and disability sector to achieve improved health outcomes and reduce health inequities.
- **Taumata Arowai:** the Government's new water regulator is expected to become a legal entity and fully operational towards the middle of 2021, once the *Taumata Arowai – Water Services Regulator Bill* is enacted. We will need to be responsive and have plans in place to support this significant change in regulatory approach once the responsibility for regulating drinking water is transferred from the Ministry of Health to Taumata Arowai.

### Evolving technology

Technology is constantly evolving at pace. Technology changes in automation, genomic analysis, artificial intelligence, increasing mobility and accessibility (such as hand-held devices), data and data analytics, advanced digital collaboration, data sharing and publicly available data sets will transform science. We need to use these advances in technology (such as continuing to build our capability in data science) to develop and transform our science capabilities to create valuable differentiated and proprietary processes, services and products that will transform our science, services and impacts.

### Transforming for growth and greater impact

To change our current delivery approach, we need to continue transforming the way we operate by scaling up our science leadership, capabilities and research. Developing new strategic relationships, partnering meaningfully with

Māori, making existing partnerships stronger and increasing collaboration with government agencies and other research organisations are essential to our New Zealand and global impact. We are further developing the critical capabilities we have identified to prepare us for operating strategically in a future world.

### Financially sustainable

We must secure additional revenue and funding to be able to sustain current core services and continue reinvesting in research and innovation. This means generating a sustainable revenue stream and secure additional Strategic Science Investment Fund (SSIF) and other research funding. Research allows us to develop new science capabilities and anticipate and respond to emerging challenges and disruptive technologies. Identifying and taking advantage of new opportunities for strategic reinvestment in research and innovation will be vital to generating a sustainable revenue stream through commercialising our services and science solutions.

### Changing external trends

Many external trends will have implications for the future and the way we live, work, travel and do business. How society behaves and operates will be influenced by:

- changing social norms (for example, changes in crime and how the justice system manages these changes)
- changing community expectations
- a changing workforce
- changing economic models
- the growing use of collaborative approaches, which will also influence how knowledge, information and data are shared and used.

These trends will affect New Zealand's culture, the health of its people and the environment. ESR will need to be ready to create and deliver innovative science solutions to inform policy advice and decisions in response to these changing external trends.





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# Our strategic direction and future focus

Our strategy is evolving. It reflects our commitment to achieve more for New Zealand's people, communities and environment.

This year, we are refreshing our strategy and starting a transformation programme to create a more flexible and adaptive organisation with a clear view of its purpose and future direction, based on a deeper understanding of its value to customers. ESR will be externally focused, co-creating and delivering value-added science solutions for customers to deliver the best outcomes for New Zealand.

To support an unwavering focus on value, ESR will continually look for new ways to find science solutions to emerging problems. We must keep pace with changes in science and technology, expand our understanding of our value to customers, and develop collaborative and innovative ways of working to solve our customers' problems. We will also strengthen our organisation's operating model to support our focus on value, impact and delivering quality outcomes for our customers and New Zealand.

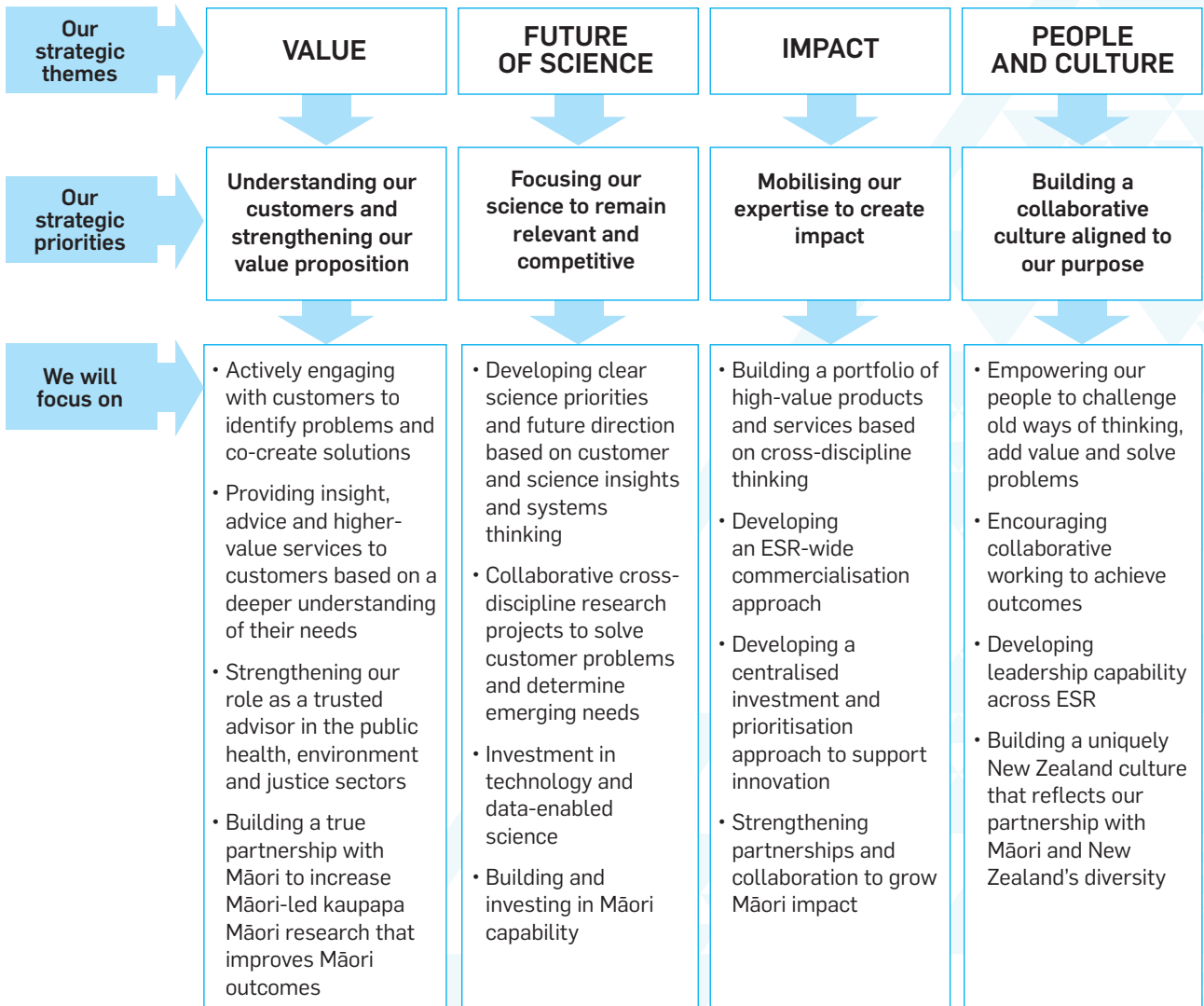
## Our strategic themes and priorities

Our evolving strategy has four key themes. Underpinning these is 'He Pūtaiao, He Tangata: growing our impact with Māori; and work to strengthen our foundations. To successfully execute our strategy, we will need effective and modern approaches, systems, processes and tools to strengthen our core capabilities and transform our operating model.

Our key strategic themes are:

- **Value:** we need to add value to our current and potential customers and to New Zealand and New Zealanders by actively engaging to solve complex problems, find creative solutions and use our science effectively.
- **Future of science:** we need to shift our focus from the science we do to more active engagement and collaboration with customers to identify problems and co-create science solutions that deliver value. Our future science capabilities need to focus on where we can make the most difference now and in the future, using technology-enabled, data-led science to generate insights and develop systems thinking.
- **Impact:** to increase ESR's impact, we need to take a whole-of-organisation approach to products and services. To do this, we will focus on a portfolio approach, developing and using investment and prioritisation frameworks. We will focus on building high-value products and services that reflect cross-discipline thinking, a deeper understanding of our customers and the sectors we serve, and a diversified portfolio that will grow ESR's commercialisation pipeline.
- **People and culture:** To be successful, we will need the skills, leadership and commitment of all our people. We need to empower our people to build new capabilities and generate new ideas through adaptive and flexible thinking, working collaboratively so that we are customer, solutions and outcomes focused.

**ESR's strategic priorities**



**HE PŪTAIAO, HE TANGATA**  
**Growing Māori impact**

**ESR'S FOUNDATIONS**  
**Strengthening our operating model**





## Embedding Māori impact

Embedding Māori impact at ESR is an integral part of its transformation programme. This long-term programme of work aims to lift ESR's Māori impact through investment in Mātauranga Māori. It is directed at advancing and embedding Māori impacts across all organisational strategies. ESR's Māori science strategy 'He Pūtaiao, He Tangata' will also be aligned to this transformational work programme.

Embedding Māori impact will:

- transform our science through increased Māori participation, co-design and contribution to and investment in New Zealand's science system
- build and increase Māori organisational and science leadership and culture at ESR
- develop and build strategic relationships with Māori, to co-develop research and science programmes and drive authentic partnerships and discovery
- develop new revenue opportunities and create a sustainable return on investment.

An action plan for embedding Māori impact will be a key aspect of our transformation programme.

## Our strategic initiatives

We will be investing in the following five strategic initiatives over the next three years, with work to commence on some of these strategic initiatives in 2021:

- 1 Transformation programme:** continue to develop ESR's transformation programme to best position ESR for the future. This will include aligning our strategy to respond to any other science factors, conditions and priorities including Kei Mua Te Ao and the findings of the Te Pai Kahurangi review into CRLs, once the RSI strategy and review have been finalised. We will develop additional strategic initiatives as needed to support ESR's transformation.
- 2 Growing Māori impact:** lift ESR's investment in Mātauranga Māori to advance Māori-focused outcomes and impacts.
- 3 Redevelopment of ESR's science centres:** undertake work to ensure our facilities and infrastructure are fit for purpose for the science we do in the future. Work will begin on redeveloping ESR's Kenepuru Science Centre to replace the existing laboratory and office accommodation buildings. The modern building will increase productivity by promoting collaboration and innovation across our science disciplines and can be adapted to meet changing science and technology needs. Our staff will be accommodated in a safe and healthy building. A modern building will improve energy efficiency and reduce maintenance and running costs, reducing our overall building footprint.

**4 Science to impact:** we are to invest in science in a more strategic, coordinated way to improve our long-term resilience and financial sustainability. We will continue efforts to achieve sustainable financial performance by maximising existing revenue streams from key products such as STRmix™, services and research. We will ensure effective negotiation of ESR's key service contracts with the New Zealand Police and the Ministry of Health. We will also actively search out new commercial opportunities through our research in key areas such as wastewater and biowaste epidemiology research, forensics, groundwater and fresh water research, genome sequencing services and environmental research.

**5 Strengthening ESR's operational model:** we will build an operating model that supports our focus on value, impact and delivering outcomes for our customers and New Zealand. We will strengthen our core capabilities, systems and infrastructure to continually improve how we use our resources (people, science, money and time) to drive efficiencies, meet the future needs of our partner agencies and customers and deliver on our strategic priorities.

## Strategic Science Investment Fund

As a CRI, we receive assigned funding through the SSIF.

Research lets us explore new ideas, creatively solve problems and leverage our expertise to grow our portfolio of science capabilities, products, services and processes while delivering on our mandate to improve wellbeing outcomes. We also need to identify and prioritise research initiatives that will increase research revenue and create commercial opportunities that are aligned to our strategic response of long-term financial sustainability.

Research is part of a continuum that leads to application and change. Reinvesting revenue from commercial activities into further research and development will increase our impact.

### Innovation from research and potential commercial opportunities

We need to build on our track record of commercialising innovative science solutions and services. Previous research has allowed us to develop innovative products through SSIF funding. Some of these innovations are now in the product development phase and/or pilot phase. Examples are:

- **Digital technology tools:** developed by ESR scientists, these provide frontline police officers with the tools to help at crime scenes in real time and preserve the evidence in their work against drug crime.

- **DBLR™:** this ESR application can achieve superfast database searches when used in conjunction with STRmix™. DBLR™ calculates millions of likelihood ratios in seconds, which is used to assess the strength of DNA evidence and how likely it is that DNA found at a crime scene belongs to specific individuals. Combining DBLR™ innovation with our existing STRmix™ solution means scientists can get more value from their DNA evidence. Further product extension is planned.
- **Drugs in wastewater:** this involves testing for evidence of illegal drugs. ESR is developing wastewater epidemiology and currently has a mechanism to track licit and illicit drug use across New Zealand. This is an efficient means of surveilling the drug behaviours of New Zealanders, and any public health interventions applied. This research has led to the development of a service whereby ESR provides insight to the Ministry of Health and New Zealand Police on the national use of licit and illicit drugs. This data can be used to inform policy making and as a tool to monitor the effectiveness of public health and crime prevention activities and reduce social harm.
- **Whole genome sequencing of disease-causing agents:** this provides a wealth of important data and intelligence on the origin and spread of diseases, allowing intelligence to inform appropriate surveillance strategies, contact tracing and public health responses.

### Other research priorities and initiatives

The points below discuss the research initiatives we are undertaking to develop a response and potential possible solutions for some of the biggest global challenges that we face socially, economically, environmentally and in public health. We are also focusing on several other long- and shorter-term research priorities.

- **COVID-19:** ESR has been working to support the Government's response, and helping plan New Zealand's approach, to the global COVID-19 pandemic. ESR's team is on the frontline of the response by providing diagnostic, surveillance and intelligence services to the Ministry of Health.
- **Microplastics pollution:** ESR is co-leading research to understand the effects of microplastic pollution on the environment through the AIM<sup>2</sup> research project.
- **Influenza research:** SHIVERS is part of an international collaboration on influenza and follows both newborn babies and adults to develop a longer-lasting, more effective, global influenza vaccine.
- **Groundwater systems:** Groundwater is an integral part of the fresh water system with 40 percent of New Zealanders depending on groundwater for their drinking water and 80 percent of annual river flow coming from groundwater. Scientists from ESR, GNS Science, Lincoln



Agritech and Aqualinc Research Limited, who are experts in groundwater science and management are collaborating on the Groundwater Science and Research Alliance Aotearoa. This project is working to raise awareness of the need to improve understanding and management of groundwater systems in New Zealand.

- **Biowaste:** More than 50 percent of biowaste in New Zealand goes to landfill. ESR leads the Centre for Integrated Biowaste Research, a collaborative programme delivering innovative solutions for the sustainable re-use of biowastes.

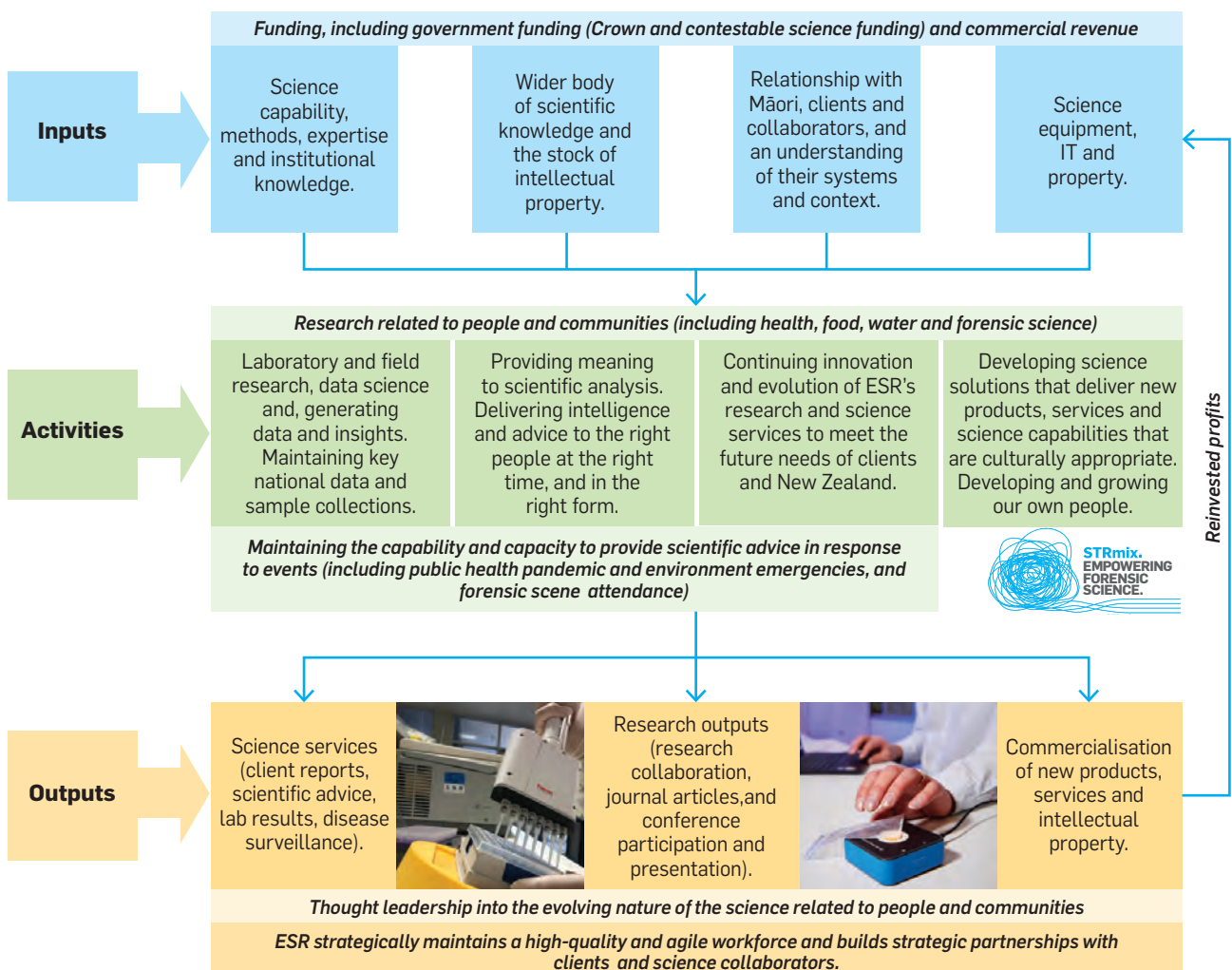
## Our outcomes and impacts

We leverage our science expertise and capabilities to provide trusted data, intelligence, insights, independent evidence, advice and leadership to inform decision-making, policy direction and actions of government agencies, local authorities and industry. By providing objective, trusted and

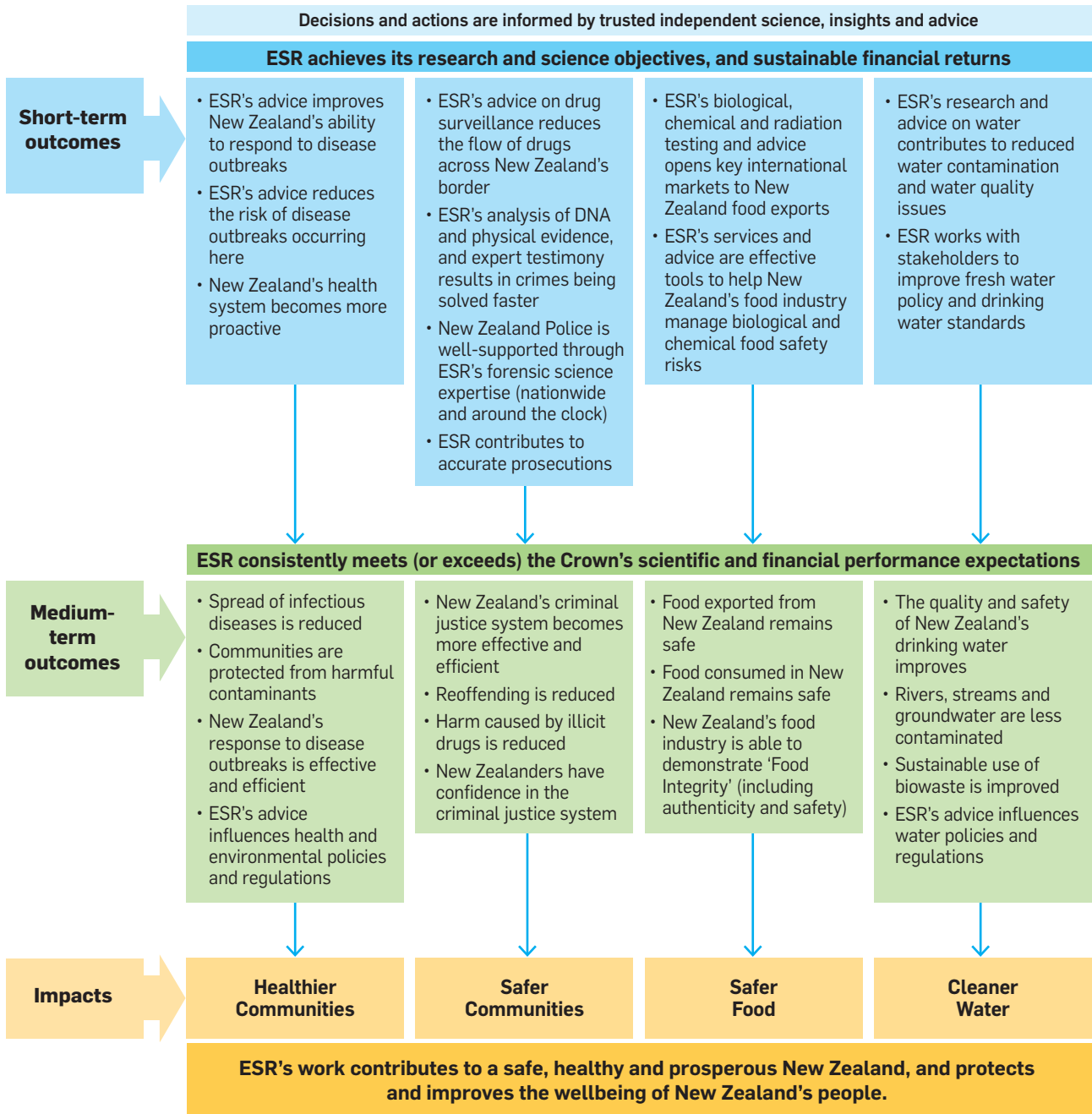
independent evidence, advice and leadership, we support government responses to a range of complex challenges that exist already as well as emerging global challenges (such as COVID-19).

### What we do

#### ESR's inputs, activities and outputs



**ESR's science contribution and research impacts**











# Our performance

We contribute to the wellbeing of New Zealand's people and the economy by providing trusted independent evidence, intelligence, insights and advice that inform the decisions and actions of local authorities, government agencies and industry.

## How we assess our performance

We monitor performance of our science against five generic core operating performance indicators for CRIs.

### Generic Crown research institute core operating performance indicators

		FY 2020/2021 target	2019/20 Forecast
<b>End-user collaboration</b>	<b>Revenue from commercial and other sources per full-time equivalent (FTE)</b>	<b>\$149,000</b>	<b>\$162,100</b>
Research collaboration	Publications with collaborators	70	65
Technology and knowledge transfer	Commercial reports per scientist FTE	0.35	0.3
Science quality	Impact of science publications (measured using web of science citations for the previous calendar year)	3.5	3.5
Financial indicators	Revenue per FTE	\$196,100	\$204,800
	Commercial and other services	\$60.3m	\$65.3m

We also have outcome measures that we use to assess the performance of our science services against the contributions we make to our four outcomes of healthier communities, safer communities, safer food and cleaner water and environment. We report results for these outcome measures annually.





# Science for impact: COVID-19 response and research

As the CRI that is all about protecting people and communities, our science is vital as we support the government's response and contribute to New Zealand and international research to solve the COVID-19 public health crisis.

At ESR, we use our world-leading science to:

- protect people and keep communities healthier by helping to prevent, reduce and manage public health threats both in New Zealand and the Pacific
- keep people safer through the latest advances in forensic science
- keep our food products safe and protect our food-based economy through research, testing and advice
- keep our water cleaner and protect the environment through our research, monitoring and advice.

With the spread of COVID-19 in New Zealand, our expertise in clinical virology, epidemiology, modelling, genomic sequencing, bioinformatics, public health surveillance and response, and data analytics and visualisation is being used to support the Government's planning and response. We are working collaboratively across all levels and with key research partners on several responses and research initiatives to support government decision-making and planning for recovery.

We provide testing for suspected COVID-19 cases, and expert advice to the Ministry of Health's Technical Advisory Group. We support laboratories across New Zealand and in the Pacific with COVID-19 testing.

We successfully sequenced the genome of the first COVID-19 clinical case in New Zealand in early March 2020. Rapid genome sequencing of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus strain that causes the disease COVID-19, plays an important role in providing insights into the origin and spread of the virus by allowing newly sequenced samples to be compared with other sequenced samples in New Zealand. It also helps with identifying suspected clusters responsible for community transmission where epidemiological data is less conclusive. Genomic sequencing work helps inform further contact tracing and containment measures.

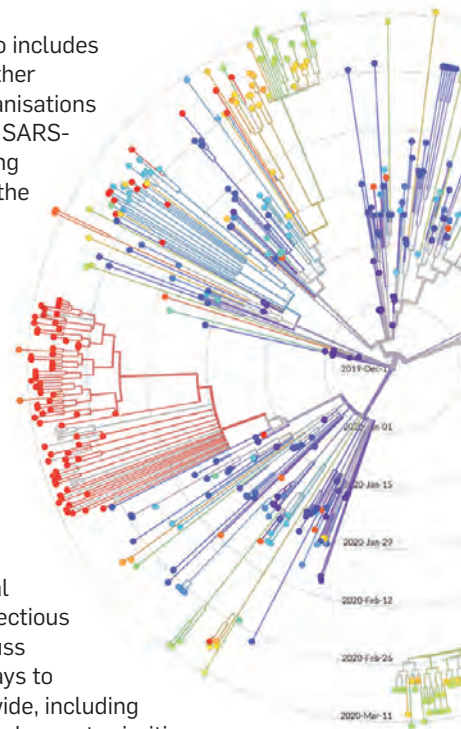
We are researching and developing new public health data surveillance tools to monitor and track infectious diseases in near real time.

Our response to COVID-19 also includes providing on-going advice to other government and research organisations about the potential impacts of SARS-CoV-2. We share our sequencing results and data with GISAID (the Global Initiative on Sharing All Influenza Data). GISAID is a publicly accessible repository for virus sequence data that laboratories worldwide can access. We also update our advice and responses as we develop our understanding of the virus and the disease.

In mid-February 2020, the World Health Organization (WHO) organised a conference in collaboration with the Global Research Collaboration for Infectious Disease Preparedness to discuss the COVID-19 outbreak and ways to control it. Researchers worldwide, including researchers from ESR, identified urgent priorities for research in relation to COVID-19. We continue to attend videoconferences held by the WHO Global Outbreak Alert Response Network – Research to coordinate global research activities.

We will undertake research initiatives that contribute to and support New Zealand and international research efforts in relation to COVID-19. As we submit research bids and apply for research funding through various funding rounds, we are working to ensure these bids support New Zealand's response and will least duplicate research activity under way elsewhere in the world.

Our research and response focuses on three of the impact areas we contribute to: healthier communities, food safety and cleaner water and environment.





## Healthier communities

Our current research of COVID-19 and infectious diseases will focus on epidemiological data collection, analysis, interpretation and data visualisation. These initiatives aim to keep people safe, and through public health surveillance, allow timely responses to infectious diseases.

We will use our expertise and our capability in bioinformatics and data science to set up new systems for enhanced public health surveillance in near real time, establish contact tracing systems and a national data repository for test results.

### Genome sequencing of COVID-19 and emerging infectious diseases

Genome sequencing to extract genetic clues from COVID-19 samples helps develop our understanding of which strains have established in New Zealand. As noted, in early March 2020, we sequenced the genome of the first COVID-19 clinical case in New Zealand and have since sequenced further isolates to support national surveillance and confirm the source of infection. This work helps the global response and research into COVID-19. Combined with epidemiological information on tracing, genome sequencing will help develop an understanding of local community transmission, spread between regions, and potential for reinfection.

Genomics is a powerful tool for tracking pandemics. Obtaining useful and actionable results and insights from genomics data often requires many different pieces of software and data integration. The field of bioinformatics plays a crucial role in analysing biochemical and biological information from large and complex data sets. In ESR's COVID-19 response, we use internationally recognised and established protocols to rapidly generate, analyse and share sequence data to inform public health responses globally. Open and strongly collaborative platforms in viral genomics have enabled a near real-time view of this outbreak on a global scale.

We will support a research project called 'Predict and Prevent COVID-19: a data driven innovation project' by Victoria University of Wellington. This research aims to create and develop methods that will use cutting-edge technologies (such as machine learning and improved phylodynamics) to combine modern sources of data to understand the transmission and spread of COVID-19. The aim is to create technical solutions that will improve the tracking and reporting of data for public health surveillance in near real time and will address the challenges of existing methods.

A research project called 'COVID-19 Pandemic in Aotearoa NZ: Impact, inequalities & improving our response' is being led by the University of Otago with support from ESR. The goal is to develop an effective and fair pandemic response for New Zealand that will guide current and future pandemic responses. Large-scale pandemic control measures to stop the spread of COVID-19, or any other virus, have the potential to worsen health inequalities in population groups (such as Māori and Pasifika) and affect health outcomes for people with existing health conditions. To avoid these harms, experts will provide ongoing analysis from multiple sources about the pandemic's impact while the pandemic is happening. Insights, in the form of practical recommendations, will be communicated to decision-makers at the Ministry of Health, service providers, communities, Pacific nations and the public.

### COVID-19 dashboard

In collaboration with EPI-interactive, we created a near real-time COVID-19 dashboard to provide the Ministry of Health and the public with information about cases of COVID-19 in New Zealand. The dashboard accessible to the Ministry of Health is updated in near real time while the public-facing dashboard is updated daily.

The New Zealand COVID-19 dashboard considers the New Zealand context. It provides information for the public on the number of cases over time, a map of the cases by district health board, the age, sex and ethnicity of cases; and the source case (whether cases are linked to international travel or contact with a known case). Up-to-date data is fed into the dashboard in a format that is accessible for decision makers.

### SHIVERS-II and WellKiwis research

Few global cohort studies of respiratory and flu viruses are available like SHIVERS-II and WellKiwis (see page 26 for more information). These cohorts provide a unique opportunity to expand our SHIVERS-II and WellKiwis research to include testing for SARS-CoV-2. The study will be expanded to allow swabs and blood samples to be taken from participants to identify and follow up any COVID-19 infections. This will provide researchers with the opportunity to better understand immunity and susceptibility to COVID-19 as well as how the virus spreads in a household setting. This will allow better informed and appropriate public health responses, vaccine development and immune therapies.

## Safer food

Part of our response to COVID-19 is providing advice to the food industry via the New Zealand Food Safety Science and Research Centre (NZFSSRC) about the potential for COVID-19 transmission through food sources and packaging.

### Food industry and COVID-19

Through the NZFSSRC, we have been providing research information and advice on questions relating to foodborne transmission and international best practice workforce management to reduce the risk of COVID-19 contamination from food products. As yet, no studies have been published on SARS-CoV-2 survival in or on food products (including fresh food). Advice will be updated as more information becomes available.

## Cleaner water and environment

Detecting the presence of SARS-CoV-2 in sewage and wastewater is a developing area of research. Research programmes are being established worldwide to test sewage following reports by researchers in the Netherlands in early March 2020 that they had detected the presence of SARS-CoV-2 in wastewater treatment plants across the Netherlands.

## Wastewater epidemiology and COVID-19

At ESR, we have been testing wastewater for viruses for many years and have implemented methods for detecting adenoviruses, noroviruses and enteroviruses in sewage to better understand the effectiveness of wastewater treatment processes. The science of wastewater epidemiology allows researchers to understand the health, wellbeing and behaviour of communities.

Researching SARS-CoV-2 in wastewater will allow wastewater epidemiologists to investigate virus levels and how long the virus can survive in faeces. Detecting SARS-CoV-2 in wastewater, particularly in communities where no COVID-19 outbreak is known, will help determine whether additional testing and control measures are needed to prevent further outbreaks.

Together with testing, tracing, isolation and widespread hand and face hygiene, wastewater epidemiology could provide a valuable tool in the work to eliminate COVID-19.









# Science for impact: research priorities and projects

ESR provides contracted essential services and undertakes research in the four impact areas it contributes to:

- healthier communities
- safer communities
- safer food
- cleaner water and environment.

Due to the COVID-19 pandemic, we have developed a research prioritisation and safety process to approve access to our research projects as the country operates and moves down alert levels. This process will serve as a guiding principle for our researchers in the event of a second outbreak of COVID-19 or any other pandemic that might arise.

ESR's research projects and services receive funding from various funding sources. We receive SSIF research funding from the Ministry of Business, Innovation and Employment (MBIE) to support the Human Health and Environment and Forensic Science platforms. We submit research bids to apply for external funding from the MBIE Endeavour and other funds, the Health Research Council, NZFSSRC, Marsden Fund and National Institute of Justice in the United States of America. We also self-fund our research from reinvested profits.

Collaboration is crucial to our success in producing independent and trusted research that increases our science capability, our reputation locally and globally and maximises our impacts. Many of our research projects involve partnerships with other science organisations, scientists and health care providers. To promote Māori wellbeing, we partner with Māori scientists and Māori organisations to advance and embed Mātauranga Māori (knowledge, wisdom and understanding); Kaupapa Māori (subjects, topics, policies and initiatives) and Tikanga Māori (values, practices protocols and beliefs) in our research and science. We use Te Ara Tika Guidelines in our research to ensure the research is designed to meet Māori ethics, is relevant and has clear benefits for Māori wellbeing.

## Wastewater epidemiology strategic research initiative

As part of building our science capability across science disciplines and extending our research impact, we will invest in a strategic research initiative that aims to explore new methods of detecting biological and chemical markers in wastewater. This research will develop our biological, chemical, metabolism and data science capability to build new insights into community health and wellbeing.

Wastewater is a good source of indicators of human activity because it contains a wide range of chemical and biological markers. It provides a direct measurement of population wellbeing. Wastewater-based epidemiology is an emerging international research area. It is one that ESR inherently has strength in through its water and biowaste research teams, epidemiologists and experience in the 'Drugs in Wastewater' programme.

Our existing capability means we are well placed to take advantage of the emerging demand for research in this area. We can position ESR as New Zealand's leading provider of wastewater epidemiology services and research into new methods of detecting biological and chemical markers in wastewater. The opportunity is also available to create data sets and data science capability to develop new insights into community health and wellbeing.

Our Wastewater Epidemiology Research Initiative aims to develop multidisciplinary research (based on wastewater science, economic science and social science) that will provide near real-time insights into community wellbeing and an ongoing data asset that gives a longitudinal perspective on community activity and wellbeing. Much interest has been expressed in this research, and market demand is for excellent, internationally connected and relevant wastewater epidemiology services.

We are making progress on several significant work streams to support this initiative, particularly in researching new methods to identify compounds of interest, social licence and data governance, indigenous data sovereignty, privacy and management.

This research initiative will let us contribute valuable evidence to inform fit-for-purpose public health interventions.



# Healthier communities

We contribute to safeguarding and enhancing the health of New Zealand's people through improvements in the management of human biosecurity and threats to public health.

## Health Science Vision

ESR will ensure New Zealand's scientific and clinical response capability in human health and public health surveillance remains effective and on par with international standards and is enhanced to manage existing and emerging public health threats. We will provide insights and solutions to counter the spread of notifiable and non-notifiable diseases, including the impacts of antimicrobial resistance on disease management. Our solutions inform public health and environmental health policies. We provide response measures to public health and environmental health threats and issues. We will also partner with Māori to co-design and develop culturally appropriate solutions that benefit Māori hauora.

## Inputs and activities contributing to healthier communities

We use our laboratory expertise, health surveillance, clinical, epidemiological and data intelligence networks to identify, monitor and analyse emerging and ongoing public health threats such as antimicrobial resistance, influenza, vaccine preventable diseases and gastroenteritis. To reduce the harm and cost of public health threats, data, evidence, insights and advice are critical for supporting how public health interventions are developed, managed, monitored and assessed. We provide support and coordinate responses to disease outbreaks. Our work is vital in keeping communities healthier and safer.

We operate and manage New Zealand's Notifiable Diseases Database. We test radiation levels, provide regulatory support, training and advice and undertake monitoring through the National Data Centre for worldwide nuclear and radiation threats. We also conduct safety testing of medicines and therapeutic products.

## Research focus, priorities and projects

Our research focuses on human genomics, whole genome sequencing of bacteria and viruses, influenza, wastewater epidemiology, and using data science to support health surveillance, decision-making and early disease intelligence and intervention. Our aim is to develop and increase our science capabilities by continuing to integrate genomics, bioinformatics and data science across our research and services. Our research results and services aim to improve public health outcomes.

The study of a person's genes (the genome and its total genetic material) is called human genomics. This includes understanding how each gene interacts with itself and other

genes, as well as a person's environment. It includes the scientific study of complex diseases (such as cancer and heart disease) because these are caused by a combination of environmental and genetic factors rather than genetics only. Genomics offers the potential for new diagnostic methods to be developed. Whole genomic sequencing can help researchers uncover whether new genetic variations are linked to health conditions. This has important impacts for reducing major diseases and improving health outcomes.

## Clinically relevant human genomics at ESR

In 2019, ESR started a three-year SSIF funded project to enhance its capabilities in human genetics and genomics and as a partner to clinical research and delivery. The project aims to implement a three-year exome sequencing model in a clinical context. Exome sequencing is a targeted genomic method to sequence the protein coding regions of genomic DNA. The ability to speed up the sequencing of large amounts of DNA will support diagnosing the genetic causes of disease. This research project builds relationships with multidisciplinary clinical teams and will help our practical understanding of the human clinical genomic landscape in New Zealand. It will also let us build our sequencing capability from sample preparation so genomic-level data can be reported and presented in a clinically meaningful and visualised form. Our research will support a national approach to clinical human genomics by enabling genetic data to be linked to New Zealand's health data. This will have a direct and immediate impact on clinical care.

## Applying epigenomics and social systems approaches to non-communicable diseases

Epigenomics is the research field that aims to understand how the chemical compounds and proteins making up the epigenome can modify the function of the human genome. When epigenomic compounds attach to DNA, the cells are marked. These marked cells can end up changing the DNA of the genome and make them different from other cells. Exposure to different environmental factors during development and throughout a person's life can chemically modify DNA and the proteins attached to it. Epigenetic changes are responsible for non-communicable diseases like cancer, diabetes, cardiovascular disease and obesity.

ESR's epigenomics research project is long-term and aims to identify DNA methylation and small non-coding



ribonucleic acid biomarkers associated with metabolic disease, including obesity and type 2 diabetes.

This research aims to provide Māori and Pasifika health experts and funders with additional data and tools to manage and improve health equity outcomes and reduce the burden of disease for these population groups. This research will increase our capability and capacity in human genomics and data science.

This project is aligned with the Healthier Lives National Science Challenge, a national research collaboration focused on preventing and treating four of New Zealand's main non-communicable diseases:

- cancer
- cardiovascular disease
- diabetes
- obesity.

## Whole genome sequencing of bacteria and viruses

A significant, ongoing area of research at ESR is establishing sequencing technologies for determining the genome sequences of a wide range of bacteria and viruses, including using bioinformatics expertise to analyse this data and make sense of it.

Bacterial genomes typically have between 2 million and 5 million bases of sequence data. As well as comparing different isolates, whole genome sequencing allows the bacteria genomes to be identified. This can be useful in determining the source of isolates and whether two or more isolates are likely to have the same source and genetic features (such as virulence and antimicrobial resistance).

We perform sequencing of *Listeria*, *Escherichia coli* O157, *Salmonella* and other disease-causing organisms.

We have used whole genome sequencing on novel coronaviruses from patients in New Zealand. This allows comparison with international strains to help determine transmission pathways between patients, which helps inform contact tracing and disease management.

## Social media observatory

The social media observatory project is a three-year collaboration with the University of Auckland that started in 2019. The project aims to develop an information resource from a variety of social media data sources, using data science capabilities to create near real-time interactive dashboards to monitor disease outbreaks. These interactive dashboards will be used to support rapid public health surveillance and decision-making.

## SHIVERS influenza and respiratory virus research

Through its research investigating influenza and respiratory viruses, and how their spread can be reduced and prevented, ESR contributes significantly to international and New Zealand research in this field.

Since 2012, ESR participates in New Zealand's contribution to an international, multi-year collaborative research programme called the Southern Hemisphere Influenza and Vaccine Effectiveness Research and Surveillance (SHIVERS). SHIVERS supports the research work of the National Institutes of Health and St Jude Children's Research Hospital in the United States of America and aims to investigate influenza virus strains and the efficacy of vaccines. It also aims to understand how a person's immunity is shaped for life by their first exposure to influenza viruses.

The WellKiwis Influenza Study started in 2019 and is the third project in the overall SHIVERS programme. It aims to enrol 200 pregnant women from Wellington each year over three years to have their babies participate in this influenza research project. From the age of two months, all 600 children enrolled will be monitored over seven years to understand how their immune system responds to flu viruses and flu vaccines.

Recently, ESR expanded this work and secured additional funding to research household transmission and COVID-19. This quick response to include COVID-19 monitoring will provide vital intelligence to the understanding of how SARS-CoV-2 spreads in New Zealand homes.

This research will contribute to developing a universal influenza vaccine.

## Impacts our work contributes to

Our work contributes to the following impacts:

- improving the understanding of complex and challenging public and environmental health issues and threats
- improving our readiness and response to public health threats
- improving human biosecurity
- reducing the burden of infectious diseases and other health threats
- mitigating risks to human health from radiation
- improving the safety of medicines.

## Healthier communities performance indicators

Outcome measure	What the outcome measures indicate	Output delivery measure
<b>ESR provides effective support for outbreak responses (Ministry of Health's satisfaction is 'good' or higher)</b>	Ministry of Health's satisfaction with disease outbreak responses is an indicator of the value of ESR's science and advice to the management of outbreaks	<ul style="list-style-type: none"> <li>• Time-critical turnaround times are met</li> <li>• Ministry of Health's satisfaction with ESR's services rates as 'good' or better</li> </ul>
<b>Disease surveillance information is distributed to all key decision-makers</b>	Distribution of surveillance information to key decision-makers is critical for limiting the spread of infectious diseases	>95 percent of Ministry of Health's project brief milestones and deliverables are consistently met
<b>Impact case studies</b>		





# Safer communities

Increase the impact forensic science makes by ensuring the right science at the right time and at the right quality is accessible to support improved decision-making at all stages of the frontline policing and justice investigation processes.

## Forensic Science Vision

We will develop and evolve our science to ensure our forensic expertise is accessible at all stages of the system to inform and support prevention, detection and resolution of crime. In partnership with stakeholders, we will develop, validate and implement rapid, point-of-care solutions, together with high-end science research and consultancy, to ensure the right information is available at the right quality and time. ESR will provide a responsive and flexible approach to crime scene science, and its forensic services and expertise will be in demand worldwide.

### Inputs and activities contributing to safer communities

We provide forensic services to a broad range of end users within New Zealand and internationally. Our reputation and expert services support the delivery of reliable results to improve decision-making and justice outcomes. Within New Zealand, our key partners include New Zealand Police, the courts, defence and prosecution lawyers, the New Zealand Customs Service, coroners, pathologists, prisons, and WorkSafe New Zealand. We also provide expert analysis internationally.

We identify, interpret and collect evidence from crime scenes, including clandestine methamphetamine laboratories and firearms scenes. Our forensic services are accredited to the ISO 17025 international quality accreditation requirements by the American National Accreditation Board.

### Research priorities and projects

Our research is targeted at expanding our science capabilities and developing new solutions that support our partners to meet their goals of protecting and keeping communities safer.

## Diagnosing sports-related concussion from saliva using ribonucleic acid markers

We are experts in detecting minute traces of ribonucleic acid (RNA) in complex samples. New research is directing our capability towards a novel and challenging problem – the detection and management of concussion (or mild traumatic brain injury). This is a three-year research project that combines the science expertise of our forensic and health staff.

Currently, no method is available to quickly and accurately diagnose a sports-related concussion (SRC) by identifying

biological markers. Methods for diagnosing an SRC involve assessing a range of factors including clinical symptoms, physical signs, cognitive impairment, neurobehavioral features, and sleep-wake disturbance. A major challenge is that diagnosing an SRC relies heavily on subjective symptom reports from patients combined with physicians' best clinical judgement.

We will work with researchers from the University of Auckland and clinicians at the Axis Sports Concussion Clinic in Auckland to collect and analyse saliva samples from athletes who have been diagnosed as suffering from an SRC.

Our objective is to identify RNA markers in saliva that can be used to confirm an SRC diagnosis. Using massively parallel sequencing, bioinformatics and machine learning, we will identify RNA species and potential RNA signatures that clearly distinguish between individuals who have suffered an SRC and those who have not. This research will enable us to build capability and capacity in RNA technologies, including investigating whether devices for RNA marker detection can be developed and sold commercially.

The ability to diagnose an SRC, either immediately after the incident (on the sideline of a sports game) or at a later stage, will significantly improve treatment and rehabilitation, with beneficial outcomes for the individual. In the longer-term, if RNA markers are identified that robustly detect an SRC, this tool could be applied in hospital settings, elder care environments and at point of care in family harm situations.

## Mining bloodstain pattern data

ESR is a world leader in bloodstain pattern analysis, the science of generating insights and informing reconstructions through the interpretation of patterns of blood staining at a crime scene. New research is applying the power of machine learning and data analytics to this area of analysis, to assess opportunities for automation and statistical interpretation of patterns.

The goal of this three-year project is to determine if a quantitative approach to pattern characterisation can be developed that capitalises more completely on the large amount of data present in most bloodstain patterns. This will be accomplished using machine learning-based methods such as deep learning. To complement this, probabilistic methods for data interpretation based on Bayesian logic will be developed.

This research will lay the groundwork for a new method that could fundamentally change the way bloodstain pattern analysis is done. It will ensure ESR stays at the forefront of bloodstain pattern analysis research, which underpins its commercial training delivery.

### **Vein pattern extraction for forensic investigation**

The internet has resulted in an explosion in the illicit trade of child sexual abuse material (CSAM). While several software tools can be used for identifying and categorising CSAM, no specific tools are available for identifying individuals in the images. To address this, ESR is collaborating with Unitec on a three-year research project to further develop novel image processing and machine learning technology to uncover the vein patterns of subjects in normal digital images. The recovered vein pattern provides a unique biometric signature for an individual, similar to a fingerprint or DNA, which can be used as an investigative tool for identifying someone from a small portion of their skin captured in an image.

This research aims to build and validate a tool that can extract vein patterns from normal (RGB) photos, comparing them with other images and/or people, and providing a statistical weighting of any associations between two images.

Such an investigative tool will support resolving crimes involving image capture, where traditional analysis methods are unable to progress investigation, and so reduce social harm and keep children in communities safer.

### **Product development and prototypes**

Through our research, we have developed prototypes (either a service or a product) that may generate a potential commercial opportunity. These prototypes aim to provide advanced forensic solutions for the justice sector and recording activities at crime scenes.

Examples include testing new technological tools to support the New Zealand Police and New Zealand Customs at the frontline and at mail service centres to detect entry of illegal drugs and dangerous goods.

We are also focusing on developing strategically important forensic solutions from our existing STRmix™ and DBLR™ forensic tools.

### **Impacts our work contributes to**

Our work contributes to the following impacts:

- creating a consistent, national approach to forensic services with robust systems that support evidence-based policing
- preventing, detecting and solving crimes using accessible forensic solutions, tools and intelligence
- supporting New Zealand's criminal justice system using expert, reliable, independent and trusted forensic evidence to inform criminal investigations
- providing analytical expertise in DNA, trace evidence, toxicology and drugs
- reducing drug and alcohol offending and abuse by providing greater insights into sources of drug harm
- preventing drugs from crossing New Zealand's borders by working closely with the New Zealand Customs Service.

## Safer communities performance indicators

Outcome measure	What the outcome measures indicate	Output delivery measure
Percentage of DNA samples linked to a person (target 70 percent)	DNA and physical evidence provide critical information for criminal investigations	90 percent fulfilment of contractual obligations under the service level agreement
<p>Total number of cases where ESR provides the New Zealand Police with forensic evidence analysis</p> <p>Percentage of homicide and sexual assault investigations finalised within 12 months</p> <p>Number of research projects undertaken by ESR for the Evidence-Based Policing Centre</p>	Evidence-Based Policing research informs Police tactics and decision-making, enhancing policing and directing police resources to where they are needed most	90 percent Police satisfaction with ESR's timeliness and quality of service
Impact case studies		







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# Safer food

We play an important role in food safety by using our microbiology and chemical expertise to investigate a range of food safety issues and manage food safety and quality risks associated with traded goods and mahinga kai. Our food science research, services and advice contribute to protecting and enhancing the integrity of New Zealand's food-based economy.

## Food Science Vision

ESR will develop enhanced technologies and scientific knowledge to reduce risks from chemical and microbiological hazards in food, including food collected in the wild (mahinga kai).

### Inputs and activities contributing to safer food

ESR's role in New Zealand's food safety system spans the full spectrum of food science research and services. We provide risk analysis and laboratory services to the Ministry for Primary Industries. We support and partner with NZFSSRC and other government, research and industry organisations to improve food safety, protect the quality of New Zealand's food, and prevent the harm caused by foodborne illness. We use our research to investigate, diagnose and monitor bacterial, viral, chemical, physical and radiological hazards across a range of on-farm and in-plant sources of food contamination. Our science is critical for providing robust and sound scientific evidence and advice to inform responses to foodborne disease outbreaks. Our food science services also help regulatory food safety policy development.

### Research focus, priorities and projects

Our research focuses on developing and trialling aptamer-based sensors to detect pathogenic microorganisms, whole genome sequencing of pathogenic microorganisms and investigating novel techniques for food safety using endolysins. We are also focusing on how we can use data science techniques to generate new intelligence from existing data to solve problems and explore potential commercial opportunities.

Through our research and services, we aim to reduce the risk of contaminated food and so improve public health. Our work contributes to protecting New Zealand's food economy by ensuring food safety risks are managed, new food safety issues are prevented and the health of New Zealanders is protected.

## GenomESR food safety

Determining the entire DNA make-up or the whole genome sequence of foodborne pathogens can help scientists identify and trace the origins of these pathogens in complex food processing environments.

This three-year research project aims to develop and communicate science that supports food safety applications, both for a commercial whole genome

sequencing service and our ongoing involvement in externally funded collaborative research projects in the food industry.

Through this project, we aim to grow our listeria genomics reputation and expertise by analysing genomic diversity in listeria isolates from food and environmental sources. We will also assess the potential of using metagenomics to detect and type *Yersinia* in food enrichments. From our growing database of Shiga toxin-producing *Escherichia coli* genomes, we will implement source attribution modelling for both research projects to inform investigations of sporadic and outbreak isolates.

We will help in developing a research project funded by the NZFSSRC that will focus on the genomics of cronobacter (a germ that can live in dry places such as powdered milk and infant formula). We aim to set up a resource database that can be used to store metagenomic data as well as other sample information. This database can be interrogated for use in other research projects and then potentially for commercial opportunities.

## Aptamer-based sensing of pathogenic microorganisms

This three-year collaborative research project with NZFSSRC will increase our in-house capability to develop and trial aptamer-based sensors for detecting pathogenic microorganisms.

Novel sensing technology offers a robust and efficient alternative to conventional laboratory analytical techniques and diagnostic services. It does this by using sensors to collect data from a range of inputs in an environment and analyse the results in real time.

Rapid, point-of-use sensing devices have the potential to significantly transform the way traditional laboratory diagnostic services are delivered across multiple sectors, including those of ESR's key impact areas of health, environment, food and forensics. These sensors may supplement or replace traditional laboratory-based testing services.

## Endolysins for One Health

This research project aims to maintain capability in novel techniques for food safety.

Endolysins are bacteriophage-derived enzymes that can kill bacteria by disrupting bacterial cell walls to rupture the cell at the end of its virulence cycle.

Endolysins have broad applications for controlling existing and emerging pathogens in food, water and health. Research to develop these bacteria-killing enzymes will also help in work to eliminate antibiotic resistant isolates.

## Impacts our work contributes to

Our work contributes to the following impacts:

- improving the safety of New Zealand's food across all food sources
- protecting the integrity and reputation of New Zealand as a safe provider of food exports and products
- rapidly detecting and diagnosing pathogenic microorganisms in contaminated food
- rapidly diagnosing and mitigating episodes of illness and outbreaks caused by contaminated food
- reducing risks to human health from contaminated food.

## Safer food performance indicators

Outcome measure	What the outcome measures indicate	Output delivery measure
Impact case studies	Impact case studies in our Annual Report provide qualitative information on cases where ESR has improved food safety	Number of projects delivered for the NZ Food Safety Science Research Centre











# Cleaner water and environment

Through ESR's water research, we are committed to improving the quality and safety of drinking water, surface water and groundwater resources for human use, including the safer, sustainable management of biowastes. We ensure our solutions have a sound scientific base and enduring stakeholder support and are culturally appropriate.

## Water and Environment Science Vision

We aim to protect the health of New Zealanders and the environment by developing new treatment and management options for wastewater, groundwater, effluent, greywater, sewage sludge and other organic waste, with a focus on land application and re-use. We will use our knowledge and research to develop enhanced technologies and solutions to improve the quality, management and regulatory oversight of drinking water, rivers, streams and groundwater.

### Inputs and activities contributing to cleaner water and environment

Our knowledge and expertise are in the areas of water microbiology, groundwater, drinking water management, climate change, biowaste and legionella testing. We use our research and services to develop, provide advice and design solutions to identify contamination sources in drinking water and water systems and conduct water quality testing and investigations into outbreaks of waterborne diseases. We also research groundwater and fresh water systems, microplastics and the effects of biowaste on wastewater, water systems and the environment.

We collect and analyse national compliance data for the Ministry of Health's Annual Report on Drinking Water Quality and provide advice to the Ministry of Health to support policy development for safe drinking water.

We provide support and advice to most Pacific countries at a national, regional or local level on improvements to drinking water quality, hygiene and sanitation to improve public health and reduce threats to the environment.

### Research focus, priorities and projects

Our research focuses on the quality and safety of New Zealand's water systems, including groundwater modelling and mitigation methods, antimicrobial resistance in wastewater and the effects of biowaste and microplastics on the environment. The research aims to reduce environmental threats to water systems and supplies and groundwater, and build our science capability in these areas.

Our research also supports collaborative Kaupapa Māori community development drinking water and wastewater projects and Mātauranga Māori in environmental decision-making.

## Microplastics in the environment

Public and regulatory concern is increasing about the impact of microplastics on the environment, food and health. International research shows microplastics are pervasive in the environment. It is estimated more than 15 trillion pieces of microplastic debris are in the world's oceans, over 80 percent of which originate from land-based activities. The potential risks from microplastics in the environment is a global problem.

Microplastics interact with the environment to affect the health and resilience of groundwater, drinking water and unique ecosystems. This affects our food sources and the economy and is an increasing risk to human, animal and marine health. It is important to understand how we can mitigate these health and environmental threats.

AIM<sup>2</sup> is the first comprehensive research project investigating threats and impacts of microplastics on New Zealand and its unique ecosystems and taonga. AIM<sup>2</sup> started in 2019 and is a collaborative, five-year national research programme funded by MBIE.

ESR and Northcott Research Consultants Ltd are co-leading the project team, which includes scientists from the universities of Auckland and Canterbury, the Cawthron Institute and Scion. The project team is working closely with various primary sector industry bodies, regional councils and territorial authorities, non-governmental organisations, iwi and communities.

The research aims to:

- develop a nationwide overview of microplastics pollution in the environment and assess environmental, public health, economic risks and impacts on wellbeing
- determine microplastic pollution from water, coastal marine ecosystems, sediment and the animal and plant life of fresh water
- determine microplastic pollution risks and how microplastics act as a direct chemical contaminant source, absorb contaminants and make them bioavailable. (This work will link to studies defining the ecotoxicology and ecological effects of microplastics in ecosystems.)
- conduct experiments on the interaction of plastics with the environment.



The findings of AIM<sup>2</sup> will also help to further international knowledge and understanding of microplastic pollution.

### Groundwater mitigation

We are researching methods to develop, design and demonstrate effective groundwater mitigation methods for oxic alluvial aquifers. This long-term research project will involve using innovative approaches such as biogas induced denitrification (BID) in groundwater and denitrifying permeable reactive barriers (PRBs).

Together with the PRBs and BID approaches, we are modelling the characteristics of these aquifers using advanced shallow depth geophysics and groundwater microbial community analysis. This will let us design, deliver and implement effective mitigation tools for use that will help optimise the balance between increasing land use intensity and associated contaminants (such as nitrates).

This has important implications for improving the safety and quality of New Zealand's groundwater.

### Groundwater health index

The groundwater eco-system is vital for processing contaminants that end up there from various land uses.

Detecting and understanding how the organisms in the groundwater ecosystem change and respond to contaminants can alert water managers to potential contamination inputs that require mitigation strategies.

The Groundwater Health Index is a long-term SSIF research project aligned with the National Science Challenge 'New Zealand's Biological Heritage'. This research aims to identify and record the diversity of groundwater ecosystems (microbial to macrofauna) to protect drinking water both now and for the future.

### Developing enhanced groundwater modelling methodologies and capability

This project, funded through ESR's SSIF and aligned with the National Science Challenge 'Our Land and Water', will develop and extend our expertise in modelling the transport and fate of pathogens and nutrients in heterogeneous aquifers. Research objectives focus on the prediction of indicators, surrogates and pathogen transport in selected groundwater systems in New Zealand. The survival of selected pathogens (such as *Campylobacter*) in groundwater will be determined because this has a significant effect on transport and fate. This research will also focus on the impact that denitrification has on the fate and transport of nitrate in groundwater systems.

### Detecting sources of microbial contamination in drinking water

In 2019, we started a three-year research project to find out whether the sources of microbial contamination in drinking water are from human, ruminant, wildfowl or other sources. This research looks at whether we can adapt methods to directly detect low levels of microorganisms (bacterial, protozoan and viral pathogens) in larger water volumes using real-time quantitative polymerase chain reaction (qPCR) methods.

Research will involve using data science tools to present results of analysis in new interactive, geographic information-based web tools that let users customise analysis of data and integrate the results with other data sources.

We will also develop parallel metagenomics tools with a focus on evaluating these tools relative to qPCR methods for sensitivity and the quantitative nature of metagenomics.

These methods include applications to drinking water, recreational water use and mahinga kai harvesting. We will work with Māori communities to trial these methods and develop case studies.

### Centre for Integrated Biowaste Research (CIBR)

More than 50 percent of waste that ends up in New Zealand's landfills is biowaste. This is any waste material that can decompose with or without the presence of oxygen. Examples include solidified grease, fruit and vegetable scraps, coffee grinds, garden waste, natural textiles, manure and sewage sludge.

Biowaste contains high concentrations of organic matter and valuable nutrients that can be used. It's important to find innovative, sustainable and low-cost options for re-using biowaste and managing the amount that enters New Zealand's environment.

Led by ESR, with input from other CRIs, universities and research partners, the Centre for Integrated Biowaste Research is a virtual, collaborative and multidiscipline research centre that is investigating the efficiency of pathogen removal in waste treatment systems, focusing on low-cost, sustainable options. It is also exploring more sustainable options for reusing biowaste by building greater understanding of the environmental risks and benefits of applying biowaste to land.

This long-term research aims to deliver value-added science that improves human wellbeing and protects the environment.

## Antimicrobial resistance in wastewater

The use of antibiotics in New Zealand is comparatively high by international standards. Overuse of antibiotics is associated with increased health complications and mortality due to antimicrobial resistance (AMR).

In 2019, we started a three-year project to build capability and capacity in wastewater research and increase our understanding of the environmental sources that contribute to the spread of AMR. Wastewater can provide unique surveillance data on the arrival and spread of newly arriving resistant organisms and/or genes.

Our research focuses on human wastewater treatment plants as a potential environmental source of antibiotic resistant bacteria and AMR genes that may contribute to the spread of AMR. We will also consider the role of various wastewater streams, storm water and the receiving environmental waters in the transmission of AMR to humans and animals.

Testing these various sources will allow us to monitor antibiotic resistant bacteria, AMR genes and antimicrobial agents in human and animal populations.

## Impacts our research will contribute to

Our work contributes to the following impacts:

- maintaining clean, safe and well-managed drinking water for New Zealanders
- improving water quality of rivers, streams and groundwater
- increasing the safe re-use of biowaste
- identifying and mitigating environmental threats to human health from chemicals, microbes and physical contaminants
- reducing the burden of waterborne illness outbreaks.

## Cleaner water and environment performance indicators

Outcome measure	What the outcome measures indicate	Output delivery measure
<b>Percentage of New Zealanders with access to drinking water that meets the national standards</b>	When ESR's research is accepted for publication and cited by other researchers, it indicates innovative research approaches and/or important findings were made	<ul style="list-style-type: none"> <li>• Annual Report on Drinking-water Quality delivered on time</li> <li>• Number of publications of our water and environment research</li> </ul>
<b>Number of territorial local authorities and interest groups we provide water quality advice to</b>	The number of local authorities that ESR provides advice to is an indicator of the nation-wide contribution its water science makes	
<b>Impact case studies</b>		







# Our people and organisation

People and culture are critical to ESR's success. We are focused on building a culture based on trust and empowerment that is highly collaborative, agile and innovative and that will position ESR well for the future.

## About us

### Our organisation and culture

Organisational culture continues to be a major driver of performance. We are working to build a uniquely New Zealand culture incorporating partnerships with Māori and increasing the diversity of people on our staff. ESR will build a culture that empowers and enables its people to work effectively and be agile in a rapidly changing environment with changing service deliverables for clients with different needs. Effectively implementing and managing culture change requires more than just focusing on changing the behaviours of individuals or the organisation. We will provide visible support and modelling from leadership and the right systems and processes to reinforce the desired behaviour.

To support our leaders and staff, organisational transformation initiatives will be designed and clearly communicated, to prepare and guide our people through future changes as our transformation progresses.

### Workforce planning and capability development

Our people are fundamental to the delivery of our strategic priorities. We will focus on shaping our workforce to ensure we plan for and build capabilities that align with future needs. We will create more integrated initiatives and approaches to drive people capability development in a diverse, yet highly specialised, workforce. To increase the confidence and capability of all our staff to work with our Māori partners, we are implementing a Māori capability development programme.

We will continue to invest in the development of our leaders, to ensure they are equipped to build the capability of their teams, lead our culture and facilitate growth, change and innovation. This includes a framework that identifies and nurtures key talent and supports organisational succession planning for key leadership and specialist roles.

To support our leaders and staff, organisational transformation initiatives will be designed and clearly communicated to prepare and guide our people through future changes as our transformation progresses.

### Science capability

To meet current and future needs, we have conducted two stages of a major science capability review into ESR's science capabilities and skill base. Stage three of the review will be re-scoped as part of our strategic

transformation programme. Transforming our science also includes building on 'He Pūtaiao, He Tangata', our Māori impact strategy, including the establishment of a Māori-led Mātauranga programme.

We maintain relationships with universities, other CRIs and scientific research societies. We will actively and strategically promote new collaborations that support our transformational goals and science impacts. We fund postgraduate studentship opportunities, encourage active participation in national and international conferences and encourage staff to undertake meaningfully aligned doctoral studies. We encourage and support scientists who have new innovative ideas for science, particularly those at the earlier stages of their careers, by funding their research through our Pioneer Fund.

### Good employer obligations

At ESR, we value diversity and benefit from the knowledge and unique perspectives of a workforce that includes people of New Zealand European, Māori, Pasifika and Asian origin. Women represent nearly two-thirds (64 percent) of our employees and work at all levels and roles in our organisation.

We will continue to show our commitment to being a good employer and advocating organisation-wide equal employment opportunity practices relating to recruitment and selection, development, management and retention of staff. This will include a focus on ensuring Māori are aware of employment opportunities at ESR. Any performance measures developed from changes to our people and capability strategies as a result of our transformation work programme will set a baseline for future reporting.

We will continue to build our health and safety capability by demonstrating continuous improvement in the areas of health, safety and wellbeing. We are developing a work programme that will strengthen ESR's health and safety culture and align policies and practices with New Zealand best practice.

## Resources

### Information technology

The successful delivery of our science services has become inextricably linked with technology as science continues to evolve. The evolution from the workbench to the workstation, combined with the exponential increase in

the storage space required to support genomics science, will require significant change within our information technology (IT) systems, information management and their governance. In response, we have adopted the all-of-government Infrastructure as a Service, which provides on-demand access to high-capacity, high-performance IT resources. We continue to build the IT platform to cater for our growing data science capability, starting with strengthening ESR's national public health surveillance network. We look to adopt cloud-based systems wherever possible. Microsoft Office 365 platforms have been rolled out to modernise our corporate systems and introduce efficiencies, by using automation and artificial intelligence, and to empower our staff with ready access to on-demand services. The IT roadmap closely aligns with ESR's strategy, with a focus on digital science and promoting collaboration and the sharing of resources and information.

### Intellectual property

We have policies and procedures in place relating to the access, use, maintenance, enhancement, exploitation and transfer of intellectual property and know-how. These ensure effective product and service development and the effective management of intellectual property. They also maximise the application of the results of research and technological developments, including transfers to end users and other third parties for the benefit of New Zealand. General principles and procedures relating to the intellectual property, research and benefits of research held by ESR meet the requirements of the Transfer Agreement between ESR and the Crown.

### National reference collections

We maintain the New Zealand Reference Culture Collection (Medical section). We also help other CRIs, universities and laboratories by providing access to the cultures in the collection on a cost-recovery basis. We provide access to the reference collection except where access is clearly not to the benefit of New Zealand. The costs of collection, archiving and maintenance will be recovered only to the extent that they have not been paid for from public funding.

Costs for retrieval of information from databases and reference collections are recovered where a third party wishes to obtain large portions of information from a database or reference collection for direct commercial use. In these cases, we reserve the right to negotiate a copyright, royalty or licence fee.

We do not dispose of any national database or reference collection without the prior written consent of shareholding Ministers and will immediately notify shareholding Ministers if, in the ESR Board's view, we cannot reasonably maintain the integrity, security and quality of any national database or reference collection. We will remain responsible for the reference collection until after shareholding Ministers have

notified the ESR Board of their determination regarding the future maintenance of, or access to, the database or reference collection. We advise shareholding Ministers in a timely manner of any disputes over access to, or the use of, the reference collection held by us. Under the terms of the Transfer Agreement, shareholding Ministers can appoint a person with relevant expertise to decide the matter.

### Property and facilities

ESR continues to focus on maximising the efficiency and utility of its science facilities in Auckland, Wellington and Christchurch. The property strategy will take account of the future operating model, proximity to major clients, access to skilled staff, ability to support growth into international markets, the potential for using hubs and co-locating with other science organisations, business continuity and financial considerations.

The overarching goals of our property strategy are to:

- determine the most efficient and effective site use to meet business needs
- ensure that facilities support the specialised scientific capabilities required for excellent service to clients
- apply whole-of-life asset management practices to ensure that the assets remain robust and reliable to support our core business functions and long-term strategic science goals.

A range of options has been considered for addressing the ageing facilities in Kenepuru, including co-locating with other CRIs and science organisations. A detailed business case was developed in October 2019 for the replacement of the laboratories at Kenepuru by 2022/23. Initial layouts and concept design have started, and several design groups will work with the architects to develop detailed building layouts.

### Legislation and business policies

ESR is subject to a wide range of legislation. From an overarching perspective, we operate in accordance with the purpose and principles as stated in the Crown Research Institutes Act 1992 and have statutory obligations under other Acts, including the Crown Entities Act 2004 and the Companies Act 1993.

Public sector legislation such as the Public Records Act 2005 and Official Information Act 1982 applies, and specific services that ESR provides require compliance with several statutes including but not limited to the Misuse of Drugs Act 1975 and the Land Transport Act 1998.

The Privacy Act 1993 and Copyright Act 1994 are core pieces of applicable legislation, together with employment-related legislation including the Employment Relations Act 2000 and the Health and Safety at Work Act 2015.

We have comprehensive business policies and procedures in place that ensure we meet all our statutory obligations.

## Our board of directors

The responsibilities of the board of directors include acting on behalf of, and being accountable to, the shareholding Ministers (the Minister of Finance and the Minister of Research, Science and Innovation) to fulfil regulatory expectations under the Companies Act 1993, the Crown Research Institutes Act 1992, and the Public Finance Act 1989.

Denise Church QSO, CFInstD (Board Chair)

Richard Gill

Dr Andy Shenk

Professor Cristin Print

Kate Thomson

## Our senior leadership team

Dr Keith McLea, *Chief Executive (until 10 July 2020)*

Dr Libby Harrison – *General Manager, Health and Environment*

John Bone – *General Manager, Forensic and Digital Services Development*

Dr Brett Cowan – *General Manager, Research and Chief Scientist*

Amber McEwen – *General Manager, Business Services*

Trish Bolger – *General Manager, People, Culture and Communications*

Deidre Hill – *General Manager, Strategy and Transformation*





# Financial performance

## COVID-19 and key assumptions

ESR's financial outlook for the next three years is dominated by the impact of COVID-19.

As at June 2020, the impact of COVID-19 – and the related government response measure – on the New Zealand and global economies – remains highly uncertain. ESR's three-year forecast reflects this uncertainty.

COVID-19 has affected many of ESR's revenue streams over the course of the last quarter of FY20, and this impact is expected to continue into FY21.

Commercial revenues are expected to be most affected, across both domestic and international markets. The uncertainty around the economic impacts – and the timing of re-opening of international borders – has driven a forecast reduction in commercial revenues to 50 percent of pre-COVID-19 levels for FY21.

While not as significant, COVID-19 has also affected some research activity and revenue received from some core government contracts. These impacts are expected to peak in FY21, with revenues recovering through FY22 and achieving pre-COVID-19 levels in FY23.

The effect on ESR's profitability and cash reserves is, however, mitigated by additional government funding as announced in Budget 2020 (refer Budget 2020 funding below), including COVID-19 recovery and response funding. The first tranche of this funding was received by ESR in FY20. The expectation is that FY21 response and recovery funding will reflect the extent to which ESR's revenue recovers more quickly or is less affected by COVID-19 than anticipated.

Other key assumptions incorporated into the FY21 SCI financial forecast are:

- tight control is maintained over operating costs, including recruitment, as ESR navigates its way through the ramifications of COVID-19
- significant internal efficiencies are achieved in order to maintain the sustainability of core government contracts, with significant savings being realised from FY22
- ESR continues to invest in its transformation work programme, including the redevelopment of the Kenepuru Science Centre – supported by government funding of \$25 million from FY23.

## Budget 2020 funding

The 2020 Budget increased funding for ESR to help the organisation maintain critical science and research capability for New Zealand, and to mitigate some of the impact of COVID-19.

## COVID-19 recovery and response funding

To help Crown research institutes alleviate the effects of COVID-19, the Government has allocated additional funding for the sector of \$45.1 million in FY20 and \$72.3 million in FY21. This funding will take the form of grant income for ESR and will flow through the profit and loss in the year received. The funding is specifically to maintain science capability and the provision of essential services and to continue supporting capital investment programmes.

ESR has received \$1.6 million from the COVID-19 Innovation Acceleration Fund to support a project that will look at how we can deliver a cost-effective environmental monitoring data source that will help determine the incidence of COVID-19 in communities. This work could translate into a critical early warning surveillance opportunity, linking with other surveillance and monitoring tools. This is a tangible example of the impact our excellent science can have on the health and wellbeing of our communities.

## SSIF programmes cost pressure uplift

ESR also received an increase in SSIF programmes funding of \$3 million per year from FY21. This additional SSIF funding will supplement investment in areas including wastewater, groundwater and fresh water research, and ESR's He Pūtaiao Māori Impact Group.

## Capital investment: Kenepuru facility

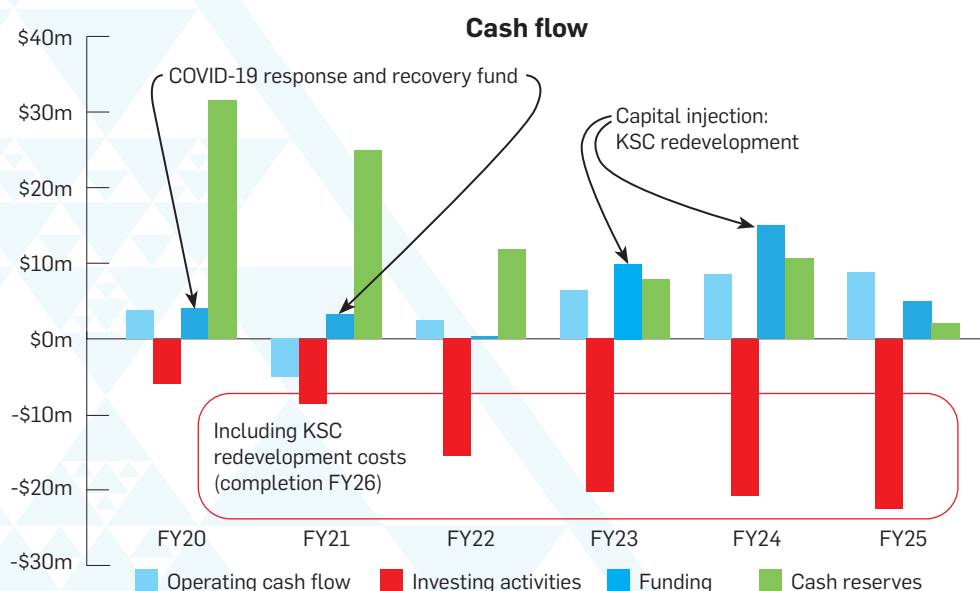
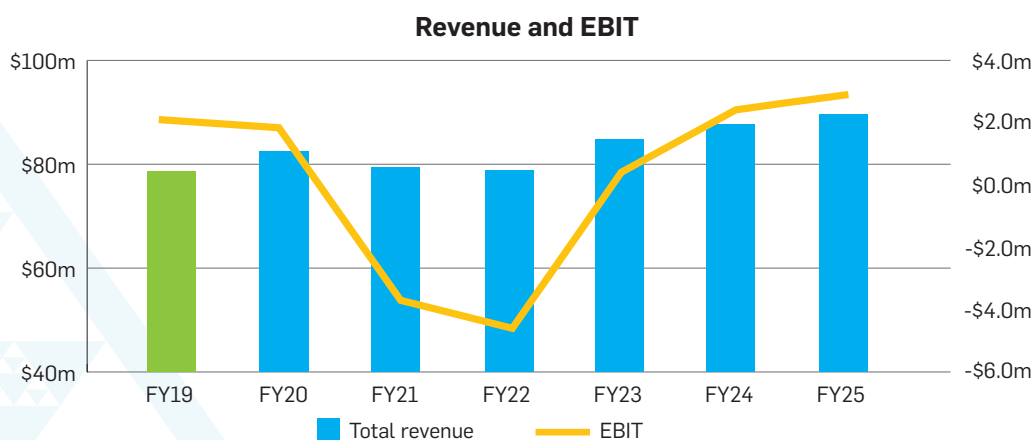
ESR has been provided with funding of \$25 million across FY23 (\$10 million) and FY24 (\$15 million) to help in the replacement of the ageing Kenepuru Science Centre. The redevelopment of the Kenepuru Science Centre will result in an energy efficient building with lower building running and maintenance costs. Non-monetary benefits include a flexible building that can be reconfigured to meet changing science needs and improve the health, wellbeing and productivity of staff.

## Revenue and profitability

As noted above, COVID-19 is expected to have a significant impact on ESR's revenue, profitability and cash flows over the three-year SCI period, with these effects being significantly mitigated by additional government funding.

Short-term profitability is also affected by increased investment in the transformation programme of work as detailed in this document. The SCI incorporates an 80 percent increase in annual funding of transformation initiatives over the SCI period. This programme is essential to ensure ESR's long-term relevance and financial sustainability.

Earnings before interest and taxes are forecast to recover quickly from FY22, returning ESR to profitability from FY23.



## Balance sheet management

With the Government support noted above, ESR's existing cash reserves accumulated over the last five years and the anticipated recovery in revenues by FY23, ESR will be able to maintain the focus and investment in transformation initiatives and to continue with the planned replacement of the Kenepuru Science Centre. Detailed design work will start in FY21 and construction the year after.

Redevelopment of the Kenepuru Science Centre is planned to be completed by FY26.

## Risks

While the SCI financial forecast reflects a conservative pace of recovery from the impact of COVID-19, other risks remain to achieving ESR's financial targets:

- renegotiation of core government contracts will occur in FY21 – the terms of these contracts are a critical aspect of ESR maintaining financial sustainability
- cost of the Kenepuru Science Centre redevelopment – cost projections include appropriate contingencies,

however, risk cost inflation may exceed expectations as a result of the broader programme of government-funded infrastructure projects over the next several years

- revenue growth, particularly the recovery in international commercial revenues, is dependent on the timing and way in which international borders are re-opened post-COVID-19.

## Dividend

It is not anticipated that ESR will have the funds available for distribution due to the planned reinvestment in transformation, science capabilities and facilities.

## Commercial value

Section 16(3) of the Crown Research Institutes Act 1992 requires ESR to provide an estimate of the current commercial value of the Crown's estimate. The net asset position (or total equity) is a reasonable proxy for the commercial value of the Group. The net asset position, as shown in accordance with ESR's accounting policies for 30 June 2019 was \$56.3 million.

## Financial performance indicators

	FY19 Actual	FY20 Forecast	FY21 Plan	FY22 Plan	FY23 Plan
<b>Revenue (\$000s)</b>	78,584	82,536	79,426	78,845	84,845
Revenue Growth	3.2%	5.0%	-3.8%	-0.7%	7.6%
<b>Operating results (\$000s)</b>					
Operating expenses	71,001	75,055	76,882	77,190	78,452
EBITDAF	7,579	7,477	2,544	1,656	6,393
Depreciation and amortisation	5,706	5,852	6,192	6,192	6,192
EBIT	1,872	1,628	(3,649)	(4,537)	201
Net profit after tax	1,858	1,678	(2,111)	(3,076)	153
Total assets	79,747	79,567	76,335	73,202	83,297
Closing shareholders funds	56,317	57,995	55,884	52,809	62,962
Capital expenditure	4,848	5,852	8,500	15,485	20,302
Capital expenditure % to revenue	6.2%	7.1%	10.7%	19.6%	23.9%
<b>Liquidity</b>					
Current ratio	1.8	2.6	2.4	1.5	1.3
Quick ratio (Acid test)	2.6	3.6	3.1	1.9	1.6
<b>Profitability</b>					
Return on equity	3.4%	2.9%	-3.7%	-5.7%	0.3%
Return on total assets	2.4%	2.0%	-4.7%	-6.1%	0.3%
Operating margin	9.6%	9.1%	3.2%	2.1%	7.5%
Operating margin per FTE (\$)	19,300	18,600	6,300	4,100	15,800
<b>Operational risk</b>					
Profit volatility	26.0%	1.0%	49.1%	65.5%	55.0%
<b>Growth/Investment</b>					
Capital renewal	0.8	1.0	1.4	2.5	3.3
Dividend	-	-	-	-	-
<b>Financial strength</b>					
Gearing (Debt/Debt equity) %	-	-	-	-	-
Equity ratio (Equity/Total assets) %	71%	73%	73%	72%	76%
Cash and short term deposits (\$M)	30.5	31.6	24.9	11.8	7.9
Debt (\$M)	-	-	-	-	-



## Statement of significant accounting policies

### Reporting entity

These financial statements are for the Institute of Environmental Science and Research Limited and its subsidiaries ('ESR' and the 'Group').

ESR is a Crown entity incorporated and based in New Zealand. Its registered office is 34 Kenepuru Drive, Porirua.

ESR is a Crown research institute that provides specialist scientific services and research to the public health, food safety, security and justice systems, and the environmental sector.

### Statement of compliance

The financial statements have been prepared in accordance with the requirements of the Crown Entities Act 2004, the Crown Research Institutes Act 1992, the Companies Act 1993 and the Financial Reporting Act 2013.

These financial statements have been prepared in accordance with Generally Accepted Accounting Practice in New Zealand (NZ GAAP). They comply with New Zealand equivalents to International Financial Reporting Standards (NZ IFRS), International Financial Reporting Standards and other New Zealand accounting standards and authoritative notices as appropriate for for-profit entities.

### Basis of preparation

The financial statements are prepared on the basis of historical cost, except for financial instruments, certain leased assets and long service leave as identified in the specific accounting policies and accompanying notes.

The financial statements are presented in New Zealand dollars, and all values are rounded to the nearest thousand dollars (\$000).

The budget and target figures presented in these financial statements are unaudited.

### Changes in accounting policies

Accounting policies have been applied on a basis consistent with the prior year except where they are affected by the adoption of NZ IFRS 16.

### Critical accounting estimates and judgements

The preparation of financial statements requires judgements, estimates and assumptions that affect the application of policies and reported amounts of assets and liabilities, income and expenses. The estimates and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances. Actual results may differ from these estimates. The estimates and assumptions are reviewed on an on-going basis.

The judgements that have the most significant effect on amounts recognised in the financial statements are applied in the determination of revenue.

### Revenue from contracts with customers

#### *Satisfaction of performance obligations*

Revenue for contract deliverables is recognised as the related performance obligation is satisfied, either at a point of time or over time.

The Group has determined that the various deliverables included within a contract for the sale of forensic analysis software are capable of being distinct. Revenue from software licences and training is recognised at a point in time when, respectively, the customer has been provided with access to the software licence and training has been delivered. Software upgrades and support revenues are recognised over time. Software upgrade revenue is recognised over time because the Group has a stand-ready obligation to provide software upgrade and enhancements as and when they are available. Software support revenue is recognised as the customer uses the support purchased with the software licence.

For the majority of other contract deliverables, the Group has concluded that the satisfaction of performance obligations occurs over time. In these circumstances, the Group has determined that an input method is most appropriate in measuring progress on a contract because there is a direct relationship between the Group's effort (that is, labour hours and other costs incurred) and the transfer of services to the customer. In these circumstances, the Group recognises revenue on the basis of labour hours expended and other costs incurred, relative to the total expected cost to complete the service.

Revenue from the balance of commercial and research activities is recognised at a point in time. This is the point at which the Group has determined it has transferred control of the related good or service to the customer.

#### *Determination of transaction prices*

The transaction price for bundled deliverables associated with software licence sales is allocated to each performance obligation based on the stand-alone selling price or estimate based on industry benchmarks.

#### *Principal versus agent considerations*

The Group has concluded that it is the principal in its revenue arrangements because it controls the goods or services before they are transferred to the customer.

#### *Variable consideration*

Where the consideration in a contract includes a variable amount arising from a value-based rebate, the Group estimates the amount of consideration to which it will be

entitled in exchange for transferring the goods or services to the customer. The Group applies the most likely amount method to determine the amount of consideration to which it will ultimately be entitled.

### **Financing components**

The Group does not have any contracts where the period between the transfer of the promised goods or services to the customer and payment by the customer exceeds one year. As a consequence, the Group does not adjust any of the transaction prices for the time value of money.

## **Principles of consolidation**

### **Subsidiaries**

The consolidated financial statements incorporate the assets and liabilities of all subsidiaries of ESR and the results of the operations of all subsidiaries.

Subsidiaries are those entities controlled, directly or indirectly, by the Parent. Subsidiaries are consolidated from the date on which control is transferred to ESR. They are de-consolidated from the date that control stops.

The acquisition method of accounting is used to account for the acquisition of businesses by the Group. The cost of an acquisition is measured as the fair value of the assets given, equity instruments issued, and liabilities incurred or assumed at the date of exchange. Identifiable assets acquired and liabilities and contingent liabilities assumed in a business combination are measured initially at their fair values at the acquisition date, irrespective of the extent of any non-controlling interest. The excess of the cost over the fair value of the Group's share of the identifiable net assets acquired is recorded as goodwill. If the cost of acquisition is less than the Group's share of the fair value of the identifiable net assets of the subsidiary acquired, the difference is recognised directly in the profit or loss.

### **Associates**

An associate is an entity over which the Group has significant influence. Significant influence is the power to participate in the financial and operating policy decisions of the investee but is not control or joint control over those policies.

The Group's investments in its associates are accounted for using the equity method. Under the equity method, the investment in an associate is initially recognised at cost and subsequently adjusted to recognise the Group's share of changes in net assets of the associate since the acquisition date. Goodwill relating to the associate is included in the carrying amount of the investment and is not separately tested for impairment.

In applying the equity method of accounting, the Group's share of the post-acquisition profits or losses of its associated companies is recognised in profit or loss and its

share of post-acquisition other comprehensive income is recognised in other comprehensive income. These post-acquisition movements and distributions received from the associated companies are adjusted against the carrying amount of the investment.

Unrealised gains on transactions between the Group and its associated companies are eliminated to the extent of the Group's interest in the associated companies. Unrealised losses are also eliminated unless the transaction provides evidence of an impairment of the asset transferred.

After application of the equity method, the Group determines whether it is necessary to recognise an impairment loss on its investment in its associates. At each reporting date, the Group determines whether there is objective evidence that the investment in the associate or joint venture is impaired.

If there is such evidence, the Group calculates the amount of impairment as the difference between the recoverable amount of the associate and its carrying value, and then recognises the loss within the statement of profit or loss.

When the Group's share of losses in an associated company equals or exceeds its interest in the associated company, including any other unsecured non-current receivables, the Group does not recognise further losses, unless it has obligations or has made payments on behalf of the associated company.

### **Property, plant and equipment**

Items of property, plant and equipment are initially recorded at cost and subsequently at cost less accumulated depreciation and impairment. The cost of property, plant and equipment includes the value of consideration given to acquire the assets and the value of other directly attributable costs that have been incurred in bringing the assets to the location and condition necessary for their intended use.

The carrying amounts of property, plant and equipment are reviewed at least annually, to determine any indication of impairment. Where an asset's recoverable amount is less than its carrying amount, it will be reported at its recoverable amount and an impairment loss will be recognised.

Losses resulting from impairment are reported in the statement of profit or loss and other comprehensive income.

Realised gains and losses arising from the disposal of property, plant and equipment are recognised in the profit or loss and other comprehensive income in the periods in which the transactions occur.

Depreciation is charged on a straight-line basis at rates calculated to allocate the cost of an item of property, plant

and equipment, less any estimated residual value, over its estimated useful life, as follows:

Type of asset	Estimated useful life
Land	Not depreciated
Freehold buildings and building fit out	10 – 50 years
Leasehold improvements	10 years
Plant, equipment and vehicles	3 – 10 years
IT equipment and internal software	3 – 12 years

### Intangible assets

#### Computer software

Items of computer software that do not comprise an integral part of the related hardware are treated as intangible assets with finite lives. Intangible assets with finite lives are recorded at cost, and subsequently recorded at cost less any accumulated amortisation and impairment losses. Amortisation is charged to the statement of profit or loss on a straight-line basis over the useful life of the asset (between 3 and 12 years).

#### Customer contracts

This intangible asset represents the fair value of future revenue streams from customer contracts acquired under business combinations. Initial recognition of the intangible asset is stated at fair value. Subsequent to initial recognition, acquired intangible assets are stated at initially recognised amounts less accumulated amortisation and any impairment. Amortisation of acquired intangible assets is made according to the straight-line method over their estimated useful life, not exceeding 10 years.

#### Research and development costs – internally generated intangible assets

Expenditure on research is expensed when it is incurred.

Development expenditure incurred on an individual project is capitalised if the process is technically and commercially feasible, future economic benefits are probable and ESR intends and has sufficient resources to complete development and to use or sell the asset.

Any expenditure capitalised is amortised over three years from the point the asset is ready for use, which is the period of expected future sales from the related project.

#### Impairment of non-financial assets

Intangible assets that have an indefinite useful life or intangible assets not yet ready to use are not subject to amortisation and are tested annually for impairment.

Assets subject to depreciation and amortisation are reviewed for impairment whenever events or changes in circumstances indicate that the carrying amount may not

be recoverable. An impairment loss is recognised for the amount by which the asset's carrying amount exceeds its recoverable amount. The recoverable amount is the higher of an asset's fair value less costs to sell and value in use. For the purposes of assessing impairment, assets are grouped at the lowest levels for which separate cash flows are identifiable (cash-generating units).

### Taxation

#### Current tax

Current tax is calculated with reference to the current period's taxable profit or loss calculated using tax rates and tax laws that have been enacted or substantially enacted by reporting date. Current tax for the current and prior periods is recognised as a liability (or asset) to the extent that it is unpaid (or refundable).

#### Deferred tax

Deferred tax is calculated using the comprehensive balance sheet liability method regarding temporary differences arising from differences between the carrying amount of assets and liabilities in the financial statements and the tax base for those items.

Deferred tax assets and liabilities are not recognised if the temporary differences giving rise to them from the initial recognition of assets and liabilities (other than as a result of a business combination) affect neither taxable income nor accounting profit.

Deferred tax assets are recognised for deductible temporary differences and unused tax losses only if it is probable future taxable amounts will be available against which deductible temporary differences or unused tax losses and tax offsets can be used.

Deferred tax assets and liabilities are measured at the tax rates expected to apply when the assets are recovered, or liabilities are settled using tax rates and tax laws that have been enacted or substantially enacted by the reporting date.

#### Cash and cash equivalents

Cash means cash on hand, demand deposits and other highly liquid investments in which ESR has invested as part of its day-to-day cash management. The following definitions are used in the statement of cash flows.

- Investing activities are those activities relating to the acquisition, holding and disposal of fixed assets and investments.
- Financing activities are those activities that result in changes in the size and composition of the capital structure of ESR and this includes both equity and debt not falling within the definition of cash. Dividends paid in relation to the capital structure are included in financing activities.



- Operating activities are the principal revenue-producing and other activities that are not investing or financing activities.

### **Investment cash**

Investment cash represents cash held in bank deposits with original maturities of between 3 and 12 months. Investment cash movements are included in investing activities in the statement of cash flows.

### **Trade and other receivables**

Trade receivables are recognised initially at fair value and subsequently measured at amortised cost using the effective interest method, less any provision for impairment.

Collectability of receivables is reviewed on an ongoing basis. A provision for doubtful debts is established from day one in the acknowledgement that the expected credit losses model assumes the circumstances are very limited under which a debt has no risk (implying a nil provision is not appropriate). Bad debts are written off in the period in which they are identified.

### **Inventories**

Stocks of consumables and work in progress are stated at the lower of cost and net realisable value. Cost is determined on a first-in, first-out basis.

### **Trade and other payables**

Trade payables are obligations to pay for goods or services that have been acquired in the ordinary course of business from suppliers. Accounts payable are classified as current liabilities if payment is due within one year or less. If not, they are presented as non-current liabilities. Trade payables are recognised initially at fair value and subsequently at amortised cost using the effective interest method.

### **Employee benefits**

#### ***Wages, salaries and annual leave***

Liabilities for wages and salaries, including annual leave, that are expected to be settled within 12 months of the reporting date are recognised in respect of employees' services up to the reporting date and are measured at the amounts expected to be paid when the liabilities are settled.

Obligations for contributions to defined contribution retirement plans are recognised as an expense in the statement of profit or loss and other comprehensive income as they fall due.

#### ***Long service leave and retirement leave***

Liabilities for long service and retirement leave are recognised as employee benefit liabilities and measured as the present value of expected future payments to be made in respect of services provided by employees up to the reporting date. Consideration is given to the expected future salary levels, experience of employee departures and

periods of service. Expected future payments are discounted using market yields at the reporting date for government bonds with terms to maturity and currency that match, as closely as possible, the estimated future cash outflows.

### **Leases**

Leases in which a significant portion of the risks and rewards of ownership are retained by the lessor are classified as operating leases.

#### ***Right-of-use assets***

The Group recognises right-of-use assets at the start date of the lease (that is, the date the underlying asset is available for use). Right-of-use assets are measured at cost, less any accumulated depreciation and impairment losses, and adjusted for any remeasurement of lease liabilities. The cost of right-of-use assets includes the amount of lease liabilities recognised, initial direct costs incurred, and lease payments made at or before the start date less any lease incentives received. The recognised right-of-use assets are depreciated on a straight-line basis over the shorter of their estimated useful lives and the lease terms. Right-of-use assets are subject to impairment.

#### ***Lease liabilities***

At the start date of the lease, the Group recognises the lease liabilities measured at the present value of lease payments to be made over the lease term.

In determining the non-cancellable term of lease, the Group considers all relevant facts and circumstances that create an economic incentive for the lessee to either exercise an option to extend a lease or to terminate the lease.

In calculating the present value of lease payments, the Group uses the incremental borrowing rate at the start of the lease, if the interest rate implicit in the lease is not readily determinable. After the start date, the amount of lease liabilities is increased to reflect the accretion of interest and reduced for the lease payments made. In addition, the carrying amount of lease liabilities is remeasured if there is a modification, a change in the lease term or a change in the in-substance fixed lease payments.

### **Share capital**

Ordinary shares are classified as equity. Incremental costs directly attributable to the issue of new shares or options are shown as appropriate in equity as a deduction, net of tax, from the proceeds.

## **Revenue**

### ***Revenue from contracts with customers***

Revenue from contracts with customers is recognised when control of the goods or services is transferred to the customer at an amount that reflects the consideration to which the Group expects to be entitled in exchange for those goods or services.

For some contracts, revenue is recognised based on the actual service provided to the end of the reporting period as a proportion of the total services to be provided, as the customer receives and uses the benefits simultaneously or the Group has an enforceable right to payment for performance completed to date. The revenue recognised is typically determined based on actual labour hours and other costs incurred.

Estimates of revenues, costs or extent of progress toward completion are revised if circumstances change. Any resulting increases or decreases in estimated revenues or costs are reflected in profit or loss in the period in which the circumstances that give rise to the revision become known by management.

In case of fixed-price contracts, the customer pays the fixed amount based on a payment schedule. If the services rendered by the Group exceed the payment schedule, a contract asset is recognised. If the payments exceed the services rendered, a contract liability is recognised.

### ***Sale of software***

The Group sells expert forensic analysis software. Contracts for the sale of this software comprise several deliverables: software licence, software upgrades, training and support.

Revenue for each deliverable is recognised as the related performance obligation is satisfied, either at a point in time or over time. Revenue from software licences and training is recognised at a point in time when, respectively, the customer has been provided with access to the software licence and training has been delivered. Software upgrade revenue is recognised over time because the Group has a stand-ready obligation to provide software upgrades and enhancements as and when they are available. Software support revenue is recognised as the customer uses the support purchased with the software licence.

Invoicing or payment for software upgrades and support is generally made in advance of the satisfaction of these performance obligations. A contract liability is recognised to the extent payment received or due exceeds the services rendered by the Group.

The transaction price is allocated to each performance obligation based on the standalone selling price or is estimated based on industry benchmarks.

### ***Strategic science investment funding***

ESR receives strategic science investment funding from the Government to perform scientific research activities. Strategic science investment funding is treated as a government grant and recognised at fair value in the statement of profit or loss and other comprehensive income when the requirements under the funding agreement have been met.

### ***Interest income***

Interest income is recognised in the statement of profit or loss and other comprehensive income on a time proportion basis, using the effective interest rate method.

### ***Foreign currency***

Items included in the financial statements of each of the Group's entities are measured using the currency of the primary economic environment in which the entity operates. The Group financial statements are presented in New Zealand dollars, which is ESR's functional currency.

Foreign currency transactions are recorded at the foreign exchange rates in effect at the dates of the transactions. Monetary assets and monetary liabilities denominated in foreign currencies are translated at the rates of exchange ruling at the end of each reporting period.

### ***Goods and Services Tax***

Items in the statement of profit or loss and other comprehensive income and statement of cash flows are disclosed net of Goods and Services Tax (GST). All items in the statement of financial position are stated net of GST with the exception of receivables and payables, which include GST invoiced.

### ***Dividends***

A provision is made for the amount of any dividend declared on or before the end of the financial year but not distributed at balance date.

### ***Financial instruments***

The designation of financial assets and financial liabilities by ESR into instrument categories is determined by the business purposes of the financial instruments, policies and practices of management, the relationship with other instruments and the reporting costs and benefits associated with each designation.

### ***Financial assets***

The Group classifies its financial assets either at amortised cost or at fair value through profit and loss. Management determines the classification of its financial assets at initial recognition.

Financial assets at amortised cost are non-derivative financial assets with fixed or determinable payments that

are not quoted in an active market. They are included in current assets, except for maturities greater than 12 months after the reporting date, which are classified as non-current assets. ESR's financial assets at amortised cost comprise trade and other receivables, investment cash and cash and cash equivalents in the statement of financial position.

Regular purchases and sales of financial assets are recognised on the trade-date – the date on which the Group commits to purchase or sell the asset. Financial assets are derecognised when the rights to receive cash flows from the investments have expired or have been transferred and the Group has transferred substantially all risks and rewards of ownership. Financial assets at amortised cost use the effective interest rate method.

The Group recognises an allowance for expected credit losses for all financial assets not held at fair value through profit or loss. Expected credit losses are based on the difference between the contractual cash flows due in accordance with the contract and all the cash flows that the Group expects to receive, discounted at an approximation of the original effective interest rate.

#### **Financial liabilities**

Financial liabilities held by ESR include trade and other payables, employee benefits and finance lease liabilities.

Such financial liabilities are recognised initially at fair value less transaction costs and subsequently measured at amortised cost using the effective interest rate method.

#### **Derivatives**

Derivative financial instruments are recognised both initially and subsequently at fair value. They are reported as either assets or liabilities depending on whether the derivative is in a net gain or net loss position. ESR does not use hedge accounting and as such, derivatives are classified as held-for-trading financial instruments with fair value gains or losses recognised in the statement of profit or loss and other comprehensive income. Such derivatives are entered into for risk management purposes.

### **Adoption status of relevant new financial reporting standards and interpretations**

#### **NZ IFRS 16 Leases**

The Group has adopted NZ IFRS 16 Leases from 1 July 2019, which introduce a single lessee accounting model and require a lessee to recognise right-of-use assets and liabilities for all leases with a term of more than 12 months, unless the underlying asset is of low value. In accordance with the transition provisions in NZ IFRS 16, the Group has adopted the new rules using the modified retrospective approach, no adjustment was required to the opening balances of retained earnings for the 2019 financial year and prior periods have not been restated.



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PASSIONATE PEOPLE

50

SITES ACROSS  
NEW ZEALAND

6,000

SCIENCE PROJECTS  
EACH YEAR

40

NATIONALLY SIGNIFICANT  
DATABASES & COLLECTIONS





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