



National Environmental Science Program

National Environmental Science Program (NESP)

Sustainable Communities & Waste Hub
annual progress report 1 January to
31 December 2023



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Acknowledgement of Country

We acknowledge the Traditional Owners of Country throughout Australia and their continuing connection to land, sea, sky, and community.

We pay our respects to them and their cultures and to their Elders past and present.

Our Indigenous research partnerships are a valued and respected component of National Environmental Science Program (NESP) research.

Letter from the Hub Leader

This report provides our update on the progress of the Sustainable Communities and Waste Hub from 1 January 2023 to 31 December 2023.

The Sustainable Communities and Waste Hub is funded by the Australian Government under the National Environmental Science Program (NESP) and aims to deliver high quality research that improves outcomes for Australia to reduce the effects of plastic, support sustainable people-environment interactions and offer options to minimise impacts of hazardous substances and air pollutants, using its cutting-edge technical capabilities, particularly in the fields of waste and materials processing.

We are now in the third year of operation, and our multiyear projects are all well underway across our three themes – sustainable communities, remote and regional solutions and waste resources. Working with our research partners and research-users, we are providing an impact pathway to solving some of the tough issues facing Australian communities around liveability and nature connection, air quality, waste management, recycling and circular economy.

Our projects are providing the information needed to solve key challenges, including for hard to recycle materials like e-waste and tyres; to provide guidance on how to address the increasing impact of microplastics; address the impacts on human health from woodfire heater smoke; support regional and remote communities to develop more effective ways to empower their voice and sovereignty in water management, and move Australia towards a more circular economy, to name a few. Key highlights from our co-designed research this year have included:

- IP1 – Two key national surveys: 1) A nature connection survey which received over 4,000 responses with good representation across states, urban to regional areas and key demographics. 2) A survey of regional and remote Local Government Areas (LGAs) to assess the current progress in water management and liveability, including for urban heat, climate adaptation and urban greening.
- IP2 - The team visited regional Australian communities to understand the challenges of waste management first-hand. A technical roadmap for regional and remote areas was also developed, providing insight into current and upcoming technologies for specific waste streams.
- IP3 - A leaching method statement to inform risk assessments and handling was developed to generate information and data about the availability of chemicals of particular concern from waste streams and/or repurposed materials. The longer-term aim is to develop leaching guidance that might be promoted nationally for waste and waste reuse scenarios.
- IP4 - In collaboration with Indigenous health researchers from the Healthy Environments and Lives (HEAL) network and the Djurali Centre, we hosted a Key Thinkers Forum on Air Quality, Asthma and Indigenous Health. This event brought together a community of stakeholders with an interest in air quality and Aboriginal and Torres Strait Islander health, and helped to map existing projects and opportunities for new activities that address Indigenous identified research priorities.
- IP5 – The publication of two key documents – 1) An Australian Mass flow analysis that shows the level of recycling and circularity of the Australian economy and established a baseline circularity rate of 3.7% for Australia. The report also found that Australia is among the top-ten extracting countries globally and the largest exporter of virgin materials in absolute volumes and among the largest in per capita terms. 2) A report exploring the opportunities for increasing value recovery from end-of-life tyres and conveyor belts in Western Australia.

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This year also saw an Indigenous-led emerging priority project approved to quantify and analyse materials of plant biomass being harvested on Country combined with other plastic waste materials.

The aim is to use these waste materials to manufacture green ceramics that could be used in housing and other infrastructure opportunities by local Indigenous communities.

Hub is expecting amazing outcomes and progress towards co-implementation/co-delivery in 2024 and later years. Some of the key highlights includes:

- Commencement of new Hub Indigenous led project which is a collaborative partnership between Firesticks Alliance Indigenous Corporation and researchers from Impact Priority 2. This will be an important process of activating innovation within Indigenous knowledge into mainstream solutions for environmental restoration, improving agriculture, and Aboriginal advancement for employment and cultural practice revival.
- The IP1 contribution to Nature Connection Storytelling project will be to support the MTWAC community. For subsequent years Water sensitive and liveable communities project, the research design adopts place based participatory action research and case studies of Indigenous led governance.
- For IP2.02.01, a detailed study into microplastics will focus on synthetic grass. The project will investigate the composition, prevalence and impact of the material in our environments. IP2.02.02 will continue to develop pilot trials and report on some of the knowledge gained and lessons learnt. The Annual Technology Forecast will also see further refinement following the feedback from stakeholders.
- IP3 will build on the strong research foundation generated in 2023 to continue to generate high quality data and methodologies for the characterisation of risks associated with identified chemicals in EOL tyres and e-waste and determine the value for other complex waste materials.
- IP4 studies will provide air quality and health findings for vulnerable Indigenous populations which will support the development of appropriate messaging and policies to protect health from smoke events. The models being generated under IP4.02.03 will support the selection of appropriate climate change mitigation policies by demonstrating the benefits of applying a range of climate change policies to improve air quality.
- IP5.02.01 will continue material flow analysis and expand the time-series to include environmental impacts and scenario modelling in RP2024. IP5.02.03 expected that peer to peer learning will occur in the online community, councils will want to participate in trials co-design and implementation; and benefit from learning (locally) and share them widely (across the population). Yarning sessions will be completed and the relevant communities will be invited to provide their feedback.

I thank our dedicated researchers, research-users and partners for the amazing work achieved this year and I look forward to sharing the results of our impact pathway journey next year.

Yours sincerely

Prof Veena Sahajwalla, Hub Leader

Management

The National Environmental Science Program (NESP) is a long-term commitment by the Australian Government. The program funds environmental and climate research. The second phase of NESP (NESP2) builds on the foundations of past work, and funds 4 research hubs from 2020–21 to 2026–27.

The Sustainable Communities and Waste (SCaW) Hub is a consortium comprising five world-class research institutions led by the University of New South Wales, Sydney (UNSW Sydney). They include the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Monash University (Monash), the University of Tasmania (UTas) and Curtin University (Curtin). The Hub provides a collaboration space for academics, government, industry and the community, with the shared objective of enhancing sustainable community outcomes and reducing negative waste impacts.

Our research agenda is co-designed with the Department and other research-users at all levels of government, industry, non-government organisations (NGOs), national associations and Indigenous and other community groups in urban, regional and remote Australia.

Our Hub Vision is to improve the health, resilience, connectedness and prosperity of urban, regional and remote communities across Australia, with reduced impact on the environment (Figure 1).



Figure 1: SCaW Hub’s Vision

The SCaW Hub embarked on its third year in 2023. This year has been a consolidation of the codesign process, with all projects now well into implementation. This year also saw the identification of a second emerging priority, approved by the Department in December 2023, to redirect bio-waste away from incineration, towards utilisation as a valuable remanufacturing resource. Governance processes and operating systems continued to be strengthened and refined in 2023, with the Hub Leadership team continuing to work with IP Leads to ensure each IP had the support needed to implement research in accordance with timeframes set.

There were some changes to personnel within the Hub (refer to Figure 2). On 17 July 2023, Dr. Dixit Prasher joined the SCaW hub to support Operations and Knowledge Brokering. In September 2023, Professor Matthew Kearnes took over from Dr. Heinz Schandl as the Waste Impact Initiative lead for

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SCaW hub to strengthen Hub's delivery on Waste Impact Management Research. His Research focuses on the social constitution of processes of technological and environmental change. Dr. Heinz Schandl, CSIRO remains the co-lead on IP5 projects. Dr. Stefan Kaufman, Monash University also took over the IP5 co-lead role from Ruth Lane. In November 2023, Stuart Snell stepped down from Hub's Communications and Media manager role and was replaced by Ms. Sarah Bassett, who has extensive experience as a journalist and media Knowledge Broker.

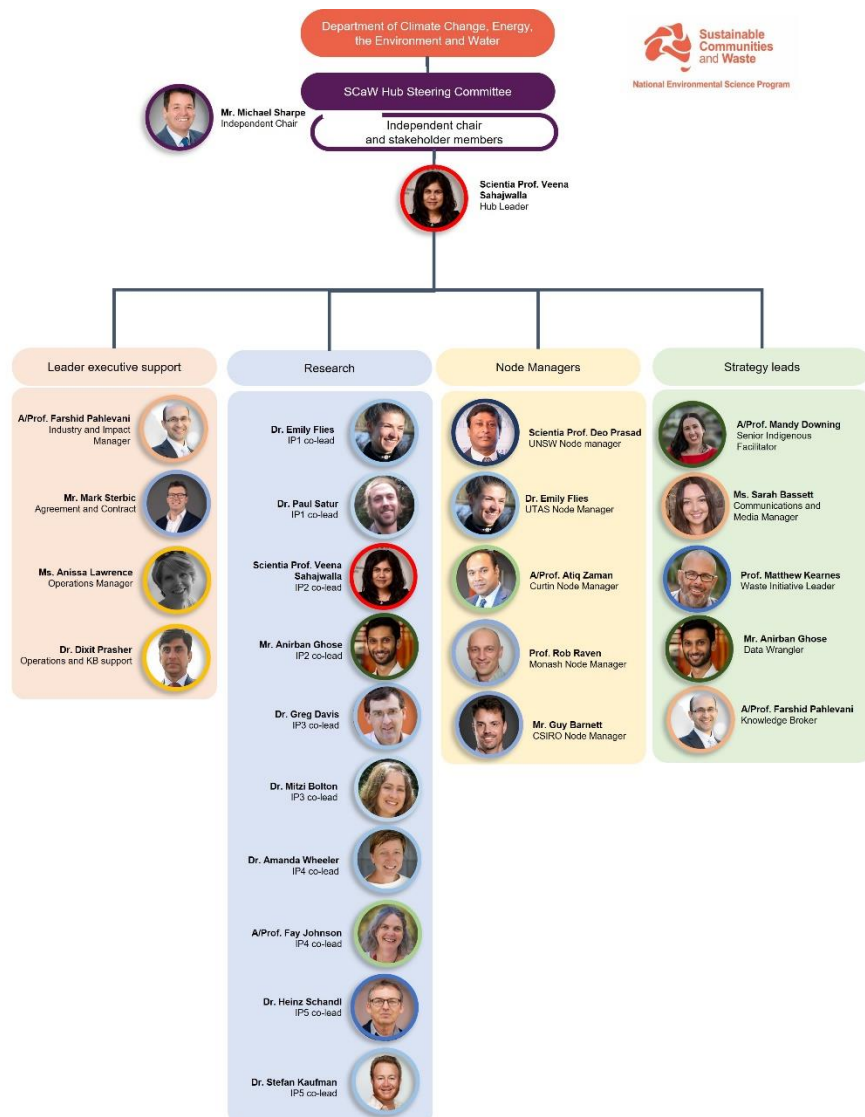


Figure 2: 2023 SCaW Hub Operational and Governance Structure

Research

NESP hubs deliver world-class, practical, evidence-based research to inform decisions. This investment helps build adaptation capacity and resilience in our natural environment and communities.

NESP research has real impact through partnerships and collaboration between researchers and research-users, including policymakers, to deliver proven outcomes. Environmental decision-makers are key partners and are encouraged to articulate their needs to researchers; provide feedback on the quality and usefulness of the research outputs; and be engaged in the communication of how this information has informed policy.

NESP research listens to and prioritises the research needs of Indigenous land and sea managers, weaves together Indigenous and western environmental knowledge systems and celebrates Indigenous-led approaches to strengthening and sharing knowledge.

New and existing NESP research findings are available to use and accessible at Australian Government and hub websites.

Key Thematic Areas

SCaW Hub research impacts as shown in Figure 3, across three thematic areas as follows:

- **Sustainable Communities** explores ways to enhance and inform sustainable social outcomes, policy and cultural challenges, and the health, wellbeing and liveability of Place, including what is needed to protect, preserve and increase prosperity.
- **Waste Resources** explores the ways that materials, such as microplastics, tyres and e-waste can be recovered and revalued through innovative technological solutions and helps to provide a better understanding of waste flows through society.
- **Remote & Regional Solutions** explores how place-based, fit-for-purpose solutions can be developed as a response to local needs across Australia, in remote and regional communities as well as urban. It focuses on building economies of purpose rather than purely economies of scale.

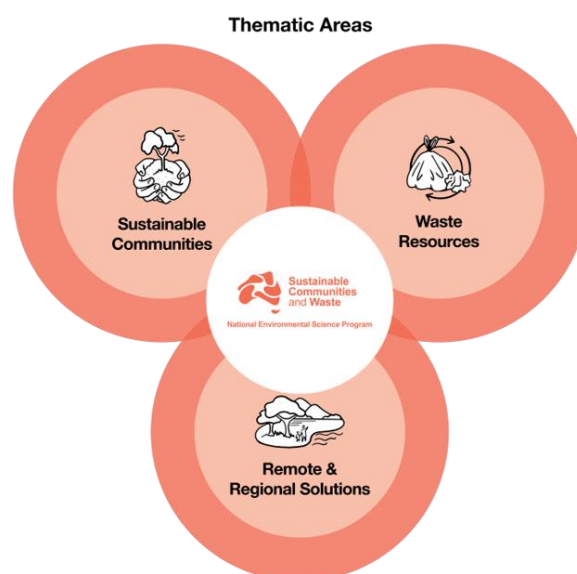


Figure 3: SCaW Hub 3 Key Thematic Areas

The SCaW Hub has five Impact Priority (IP) Areas that collectively deliver outcomes against our three thematic areas. Each of these IP areas comprises several research projects, identified and then

developed through co-design during RP2021/2022, led by collaborations of researchers across institutions. Our projects and thematic areas are mapped in Figure 4, with more detail provided in Attachment A.

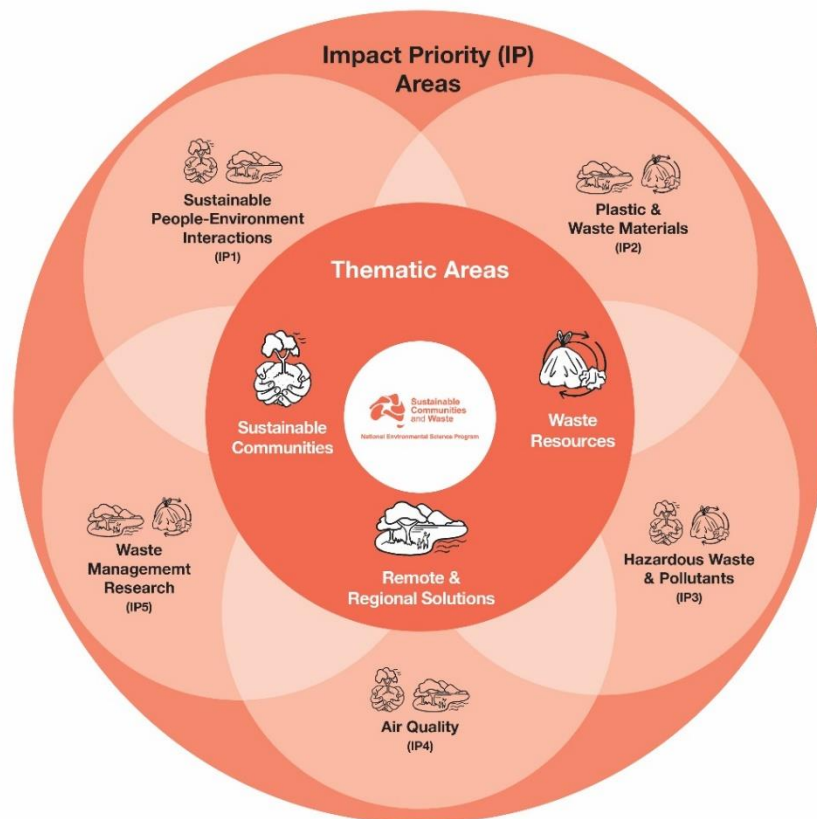


Figure 4: SCaW Hub 3 Key Thematic Areas and 5 Impact Priority (IP) Areas

IP1.02 - Sustainable People–Environment Interactions

IP1 explores links between human wellbeing, and environmental and ecosystem health. Through research and collaboration with various stakeholders and using a Nature-based Solutions (NbS) lens, this research is developing knowledge and tools to inform and stimulate change for the shared benefit of humans and nature.

This Impact Priority area also aims to empower regional, remote and Indigenous communities to become more sustainable and to improve liveability. It is also supporting delivery of *Australia’s Strategy for Nature 2019–2030*, *National Climate Resilience and Adaptation Strategy 2021–2025*, and a renewed *National Water Initiative 2004*.

Thematic Areas

- Sustainable Communities
- Remote & Regional Solutions

IP2.02 – Reduced Impact of Plastics and Other Materials

IP2 seeks to develop innovative solutions to mitigate the negative impact of problematic materials on the environment. The outcomes of this research are expected to have implications for the waste management industry, policymakers, and society at large. By developing innovative solutions that

address the negative impact of waste materials, IP2 aims to promote cleaner and healthier environments while contributing to a more sustainable future.

IP2 researchers are guided by national priorities including, "The National Waste Policy 2018" and the "2019 National Waste Policy Action Plan" and supported by further plans including modernisation of recycling and manufacturing capability and sustainable protection of national materials supply (critical materials).

Thematic Areas

- Waste Resources
- Remote & Regional Solutions
- Sustainable Communities

IP3.02 – Management of hazardous waste, substances and pollutants

Chemicals in our waste streams pose undefined risks, which inhibit our ability to safely move towards achieving national and state policy action targets to divert materials from landfill and accelerate reuse. The presence of chemicals of potential concern (CoPC) can impact recyclability of waste and the safe reuse of materials in the economy, and the establishment of robust circular economies. Through the generation of high-quality data related to the mass and potential availability of chemicals in our waste streams, this project will assist safe recovery and reuse of resources obtained from wastes and enable national resource recovery targets, by bridging the gaps in knowledge that allow adequate risk characterisation.

Thematic Areas

- Waste Resources
- Sustainable Communities

IP4.02 – Improved Air Quality, Forecasting and Assessment

While air quality in Australia is generally good, significant health impacts continue from bushfire smoke, planned burns, wood-heaters, and local industrial pollution. IP4 explores how to reduce air pollution and its impacts in Australia.

Thematic Areas

- Remote & Regional Solutions
- Sustainable Communities

IP5.02 Waste Impact Management Research

IP5 focuses on providing information, data and management tools; informing design for repurposing waste and circular economy; informing the institutional and governance needs of community-based resource recovery and circular economy initiatives; and waste management and resource recovery opportunities for Indigenous communities.

Thematic Areas

- Waste Resources
- Remote & Regional Solutions

Progress towards research delivery

IP1 – Sustainable people–environment interactions (led by UTAS and MU)

Both projects continued their progress this year, working with partners and collaborators to address research-user priorities.

IP1.02.01: Nature connection

As a starting point for creating a nation of people who value nature, we need to build an understanding of what valuing and connecting to nature means to Australians and explore what enables or hinders nature access and/or experience, and the mechanisms that generate the desired benefits. By conducting a national survey, we aimed to answer the following research questions:

- What are the characteristics of nature connection across Australia?
- In what ways does connecting with nature increase or activate pro-environmental/sustainability behaviours and impact wellbeing?
- How do these relationships vary across Australian geography, demography and green space types?

We launched the co-designed survey in July 2023 and received over 4,000 responses with good representation across states, urban to regional areas and key demographics. Primary outcomes were presented to research-users in 2023 and outputs from this work will be released in 2024.

In response to consultation and research and to bring depth to our understanding of nature connection, the Nature Connection Storytelling Project was developed and launched via a website¹ in November 2023. The project has three key outcomes:

- Develop a repository of stories about nature connection and its impacts, and a national nature connection story map, initially piloted in Tasmania
- Create an accessible platform for gathering and sharing stories of nature connection
- Work with partners to gather stories in a range of forms (written, oral, visual) that collectively demonstrate a diverse variety of experience, impacts and implications.

The website is now collecting stories of nature connection and its benefits from diverse Tasmanians with the aim of expanding to the sites in the mainland in the coming years. In 2024, using the stories collected, researchers will analyse, characterise, map and communicate what nature means to Australians, and document and articulate how we value nature.

IP1.02.02 Water Sensitive and Liveable Communities

This project aims to establish contextually, and culturally sensitive pathways related to sustainable water management and liveability outcomes in regional and remote communities. It seeks to understand the key requirements, challenges, and opportunities for supporting capabilities in water and liveability systems change in the communities and their local institutions through two research streams:

¹ Refer <https://thenatureconnectionproject.com.au>

Stream 1: Improving access to knowledge capital and products for regional and remote communities and establishing a national platform supporting institutional processes, systems change outcomes and capacity-building needs for optimising water and liveability outcomes.

Stream 2: Establishing the conditions to support the transformation of the Australian water sector through reinvigorated Indigenous water science and governance.

The research streams are connected and will explore new knowledge and practices supporting liveability and water sustainability outcomes over the subsequent years.

During phase one of the stream 1, this project has focused on establishing the foundational premise of our research by establishing connections, comprehending the landscape of opportunities and challenges, and collaborating with key stakeholders and practitioners to address these. This collaboration has resulted in the co-establishment of a research agenda that will facilitate continuous learning within the Australian regional and remote context.

Key activities undertaken during this year were:

- A thorough desktop analysis to gain insights into the recent adoption of knowledge tools and products, with a particular emphasis on water sensitive cities related to water management and liveability.
- A national survey of Local Government Areas (LGAs) to assess the current progress in water management and liveability, including for urban heat, climate adaptation, and urban greening/blueing. This survey focused on understanding organisational responsibilities, capabilities, and challenges specific to regional and remote LGAs.
- A series of key stakeholder workshops to delve deeper into the insights gathered from the surveys and broaden perspectives beyond the LGA scope. These workshops also provided opportunity to identify the requirements for a collaborative platform encompassing knowledge products, tools, and resources to support ongoing capability development in regional and remote settings.
- Identification of several anchoring institutions and piloting the Anchoring Institution model through Living Laboratories in regional and remote contexts.

Through these activities, the project has set a strong foundation for further research and development initiatives aimed at enhancing water management and liveability in regional and remote areas of Australia.

IP2 – Reduced impact of plastics and other materials (led by UNSW)

In 2023 both projects continued implementation of the project, working with key research-users from the Department, industry and community groups, including both Indigenous and government, building on the foundational work in previous years.

IP2.02.01: Understanding Microplastics

While research on microplastics and their threat to ecosystems and humans is developing, a lot remains uncertain. Evidence of the uncontrolled, irreversible, and long-term ecological hazards due to microplastics do exist for some coastal waters and sediments. Scientists predict that microplastics will be a widespread ecological risk within a century if left unchecked. Co-design activities in 2021 highlighted the need for an improved understanding of the impacts of microplastics in Australia on the environment to guide policy and best practice management responses.

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In 2023, the research team continued work on the development of a national monitoring protocol for micro and nano plastics. Currently, no standards exist for sampling and testing microplastics. A nationally consistent monitoring system and national database for microplastic pollution are required to improve knowledge of the prevalence and impact. Activities undertaken included identification and validation of a gap in monitoring protocols for nano-plastics; completion of a literature review of testing methodologies and will be finalised with the Department for publication in 2024; and techniques were established to test and validate their efficacy for monitoring of micro and nano plastics.

Research in micro and nano plastics can be divided by sources and sinks. While there is extensive research on the impact of micro and nano plastics in specific sinks, including biota and coastal regions, there is limited understanding of the mechanisms and generation of different sources of micro and nano plastics. The IP2 research team has established relationships with AUSMAP (citizen science project for the collection and quantification of microplastics), Ocean Protect (commercial manufacturer of storm water filters), and Sea Shepherd (not-for-profit sample collection in remote locations) to develop a better understanding of micro and nano plastic sources.

In 2024 and beyond, the team will be conducting experimental interventions aimed at reducing the impact of micro and nano plastics.

IP2.02.02: Finding fit for purpose technological recycling solutions for regional and remote communities across Australia

Regional and remote² communities lack fit-for-purpose solutions for fundamental waste problems. Regional and remote locations present unique challenges in managing waste, including seasonal weather-driven isolation, and access to major roads or towns. These areas often lack kerbside waste collection and access to recycling and re-manufacturing centres³. Several organisations have worked to understand the complex challenges and make recommendations for how best to address them⁴.

In 2023, the team visited regional Australian communities to understand the challenges of waste management first-hand. This included workshops in areas such as Uralla, Gunnedah and Tamworth. Researchers from the IP2 team had the opportunity to present to local council members, community members and local industries to understand the challenges and opportunities presented when introducing technological solutions for waste and remanufacturing in regional and remote communities. A partnership was initiated with Charles Darwin University researchers to facilitate IP2 to access remote communities. This year, the team has focussed on developing a technical roadmap for regional and remote areas. This report was structured to provide insight into current and upcoming technologies for specific waste streams. This report and corresponding dashboards will be delivered in 2024.

² The definition of regional and remote uses the Australian Statistical Geography Standard (ASGS) categorisation Refer <https://www.abs.gov.au/ausstats/abs@.nsf/mf/1270.0.55.005>

³ Refer <https://www.awe.gov.au/environment/protection/waste/how-we-manage-waste/recycling-modernisation-fund/supporting-waste-infrastructure-regional-remote>

⁴ Previous work includes Australian Local Government Association (2018) Submission to the Department of the Environment and Energy: In response to the review of the Product Stewardship Act. August 2018; Infrastructure Australia (2021) 2021 Australian Infrastructure Plan; Local Government Association of Queensland (LGAQ) (2021); Queensland Indigenous Waste Strategy: Respecting Country - A sustainable waste strategy for First Nations communities; NACCHO (2020) Submission to House of Representatives Standing committee on Industry, Innovation, Science and Resources into Australia's waste management and recycling industries. Submission Number 223. Downloaded 19 October 2021. Pp1-8; North Queensland Regional Organisation of Councils (NQROC) (2020); North Queensland Waste and Resource Recovery Strategy 2020-2030. October 22, 2020; Northern Territory Environment Protection Australia (NTEPA) (2015) Waste Management Strategy for the Northern Territory 2015-2022.; Productivity Commission (2021) Right to Repair – Draft Report; RDATN feasibility study: <https://www.rdatropicalnorth.org.au/about/initiatives/fnq-plastics-industry-proposal/>.

IP3 – Management of hazardous waste, substances and pollutants (led by CSIRO and Monash)

This 2-year project seeks to assist in the safe recovery and reuse of resources obtained from waste, and to bridge the gaps in knowledge that allow adequate risk characterisation. In 2023 (year 1), a first version sampling guidance document was prepared to enable the design and implementation of appropriate sampling campaigns and generation of high-quality chemical characterisation data for samples (Boxall et al., 2023). The sampling guidance document will be provided to stakeholders (e.g., EPAs and state government representatives) previously engaged in RP2021. Using the sampling guidance document, samples of recycled tyre crumb and end use products containing recycled rubber, and e-waste samples were procured from industry partners.

Analysis of the composition of materials was undertaken, based on sample type and chemicals of potential concern (CoPC). Further chemical prioritisation to meet the requirements of the Department continued (i.e., reporting limits and thresholds set at relevant concentrations, and as a trigger for further analysis), with the following outputs achieved in 2023:

- A leaching method statement was prepared to generate information and data about the availability of chemicals from samples. The leaching method statement outlines standard leaching experiments and non-standard leaching experiments to determine leachable (and/or releasable) CoPC fractions from the waste streams and/or repurposed materials in relevant conditions to inform risk assessments and handling. The longer-term aim is to develop leaching guidance that might be promoted nationally for waste and waste reuse scenarios.
- Preliminary leaching tests were conducted, with leaching solutions and data to be used to develop further method statements related to ecotoxicology and risk assessment. A minimum information standard was developed and used to communicate data reporting formats to external analytical laboratories.
- All data generated was captured and stored in accordance with FAIR guiding principles and Environmental Information standards.
- As a precursor to year 2 of IP3.02.01, initial planning for a critical review and development of ecotoxicology and risk assessment methodology is underway.
- Findings of research to date were presented at the SETAC Australasia conference in August 2023.

IP4 - Air quality, forecasting and assessment (led by UTAS and CSIRO)

During 2023, a range of activities commenced for each of the four projects under IP4. The IP4.02.01 team successfully collaborated with Indigenous health researchers identified through the Healthy Environments and Lives (HEAL) network⁵ and the Djurali Centre to host a Key Thinkers Forum (KTF). The KTF on Air Quality, Asthma and Indigenous Health brought together a community of stakeholders with an interest in air quality and Aboriginal and Torres Strait Islander health, and helped to map existing projects and opportunities for new activities that address Indigenous identified research priorities in this domain. In organising the forum, a major aim was to privilege the voices and perspectives of Aboriginal and Torres Strait Islander people and carers. More than half the speakers and facilitators identified as Aboriginal and/or Torres Strait Islanders with representatives from a range of First Nations communities from across Australia.

A follow up half-day online workshop was held in October to check in on progress of activities with collaborations established from the KTF. The organising committee continued to meet twice a month

⁵ Refer <https://healnetwork.org.au/>

and as a result an Indigenous-led project has evolved around developing effective smoke messaging during episodic smoke events.

IP4.02.02 research activities progressed with the completion of a literature review and a final report submitted and approved by the stakeholders. Throughout 2023, the CCAM model for 2013-2017 (the 5-year baseline run) was completed. This provides the meteorology input data that will be used for the broader modelling. 05-year runs (2048-2052) for two of the Global Climate Models (ACCESS 1.5 & NORSEM at SSP370) were also completed. This included analysis of all meteorology for key variables involved in air quality – temperature, wind speed, rainfall, fraction of cloud cover. Models are on track and no concerns have been raised.

In IP4.02.03, the final report on wood heater smoke project stakeholder workshop was reviewed and approved by the stakeholders. During the year, additional funding (\$250,000) from Asthma Australia was granted via a national competitive funding initiative to trial the wood heater replacement intervention with a local council. Additional seed funding (\$20,000) was awarded to the team from the HEAL network to trial a behaviour change initiative to educate wood heater owners. In 2023, Local governments from Mount Barker, SA; Armidale, NSW; Canberra, ACT; Launceston, TAS; Yarra Ranges, VIC; and Mornington, VIC were approached to participate in the wood heater intervention program. The Discrete Choice Experimental phase of the study progressed as planned. A second phase directed at wood heater users is in progress. Air quality sensors were distributed during the year to Launceston and Canberra.

For IP4.02.04, a journal article was published on the findings of our HEPA intervention study, with a key finding that HEPA filters combined with natural ventilation are most effective way to improve air quality year-round. Other activities during the year included:

- drafting HEPA guidance consisting of FAQs for users of these portable air cleaners in classrooms.
- production of an online LCS (low-cost sensor) tool and associated information sheets on how to select low-cost air pollution monitors. The 5 information sheets are tailored specifically for different stakeholders: researchers, local councils, community groups, schools, and domestic users.
- a workshop in May 2023 on “How to protect schoolchildren from air pollution” that brought together 20 participants from research, government, education, not-for-profit, health, built environment, and technology sectors.
- a preliminary literature survey on safe havens and commencement of scoping potential stakeholders and partners for safe havens activities.

IP5 - Waste impact management research (led by CSIRO and MU)

Progress was made during 2023 on the four research projects developed in 2022 through stakeholder engagement and co-design.

IP5.02.01: Australian metrics for materials, waste and resource recovery summarised in a circularity gap report and dataset

This project undertook a comprehensive material flow analysis (MFA) for the Australian economy employing internationally agreed methodology and standards. The MFA approach included analysis of materials extraction, trade, waste and emissions, and recycling flows. The assessment, a follow on from the first undertaken in 2015, used 2019 data, with the results summarised in a technical report and published in peer-reviewed literature. The report established a circularity rate of 3.7% for Australia in 2019. The report also found that Australia is among the top-ten extracting countries globally and the largest exporter of virgin materials in absolute volumes and among the largest in per capita terms. A

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comparison between the 2015 and 2019 reports provided opportunity to assess Australia's progress towards a low carbon, resource efficient and circular economy.

IP5.02.02: Exploring opportunities for increasing value recovery from used tyres and conveyor belts in Western Australia

End-of-life tyre (EOLT) and conveyor belt management is a challenging and dynamic area of waste management. It is impacted by the introduction of Waste Export Ban for whole tyres, a desire to move towards a more circular economy and reduce the negative impacts of wastes especially in the environmentally and culturally sensitive regions where these wastes are often generated and disposed. In a project jointly funded by the NESP, Western Australian (WA) Department of Water and Environmental Regulation (DWER) Waste Authority, Tyre Stewardship Australia (TSA), researchers from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Curtin University explored opportunities for increasing value recovery from EOLTs and conveyor belts in WA. The approach included reviewing relevant regulatory and policy related to the management and disposal of EOLT; reviewing data on EOLT and conveyor belt arisings in WA on a regionally specific basis; and comparing the data with current and planned processing capacity. Gaps, barriers and opportunities were also identified for developing market potential for recycled materials produced from EOLTs and conveyor belts. The report, published in May 2023 provided recommendations for state and federal governments to improve value recovery from EOLTs and conveyor belts. Some recommendations are already being considered for amending the controlled waste regulations in WA. On-going work is reviewing best practice case studies of tyre and/or conveyor belt recycling that could provide learnings for implementation in WA.

IP5.02.03: Governing community-based resource recovery and circular economy initiatives

In 2023, we focused on understanding how local governments can act as "transition brokers" - connecting communities, businesses, and policymakers to drive regional circular economy (CE). We developed a national survey to map these to material stream challenges, their capacities, partnerships and existing innovations. Our work in 2022 suggested the hypothesis that remote and regional circular innovation would rely to a greater degree on local government and civil society than business and entrepreneurs (circular society, not circular economy). By engaging with the challenges of CE innovation in remote and regional Australia, we expect to be able extend and improve theory and practice on CE transition brokering and the role of local government.

This is an Australian and possibly global first in that it focuses on comparing regional/remote councils and urban councils. It is also the first attempt we are aware of to translate Cramer's network governance transition broker capabilities into a self-assessed scale.

Highlight activities included:

- Development and deployment of a national survey: We obtained a sample of 95 usable completions, approx. 50% each from urban and regional/remote locations, facilitating comparisons. The dominant reason for not participating given by those contacted in regional and remote councils included relevant staff being unavailable in the timeframe and a surprising 21 remote and regional councils reported having no relevant staff
- Presentation at Circularity 2023: Sharing our initial findings and inviting innovative local governments to collaborate and share knowledge to a group of over 100 participants.

IP5.02.04: Scoping study creating opportunity from waste in Aboriginal communities in Western Australia

Australian communities, especially in remote areas, face significant challenges in waste management due to inadequate infrastructure, long distances to disposal facilities, and limited collection services.

These issues are exacerbated by tourism growth and technological advancements leading to increased electronic waste. Unsustainable waste practices, common in linear economies, have environmental and health consequences. Circular economy approaches, focusing on industrial ecology and the reduce, reuse, recycle (3R) principles, present an opportunity to address these challenges. Previous findings under the project emphasize applying circular economy practices to Indigenous communities in Western Australia, where remote and regional areas are predominantly inhabited by Aboriginal populations.

The current study seeks to promote sustainable waste management, job creation, and environmental improvement in these communities. Core focus areas include providing information on identified waste management issues and subsequent circular economy practices and solutions among Indigenous communities in Australia. During 2023 a number of yarning circles were held with Elders and community representatives in Western Australia to seek feedback and understand community priorities in addressing waste problems. These yarning circles are continuing into 2024, following which recommendations for next steps and future research will be identified, including the best approach to engage with Indigenous peoples as part of this research.

IP5.02.05 – Place-based cross hub integration project

There was no additional activity for the planned initiative in the Swan Canning River catchment and this project ended in June 2023.

Research projects

Attachment A lists the projects funded under the SCaW Hub and provides information on the project status, information on outputs and links to products for all projects (where available). Exceptions to the *NESP data and information guidelines* are also noted there.

The following table provides a summary of progress for each major 2023 deliverable across IP areas and Hub:

Responsible IP Area	Deliverables/milestones	Date Completed	Status & Comments
IP1.02.01	Annual report on project's RP2022 activities	7 April 2023	Completed
IP1.02.01	Co-design workshops for RP2024 commenced	1 August 2023	Completed
IP1.02.01	First on-country Aboriginal cultural awareness training completed	1 August 2023	Completed
IP1.02.01	Detailed project RP2024 developed	29 August 2023	Completed
IP1.02.01	Report on strategies for equitable urban greening and nature connection in regional communities	31 December 2023	Completed. Submitted to DCCEEW for approval in April 2024
IP1.02.01	First draft of an Indigenous-led project developed	31 December 2023	Completed
IP1.02.01	Co-designed national survey examining nature	31 December 2023	Completed

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Responsible IP Area	Deliverables/milestones	Date Completed	Status & Comments
	connection and its benefits delivered		
IP1.02.02	Annual report on project's RP2022 activities	April 2023	Completed
IP1.02.02	Research-user identified research priorities to address research-user identified and prioritised gaps in knowledge capital and improvements to the interoperability of existing knowledge products	August 2023	<p>Completed.</p> <ul style="list-style-type: none"> • Report of the National Survey on Regional and Remote Local Government Areas (LGAs) 2023 was produced. • A series of slides was produced detailing an overview of key findings and future priorities. This is undergoing final review with the stakeholder advisory group and will soon progress to the NESP Knowledge Broker team to support the finalisation of these for circulation.
IP1.02.02	Detailed project RP2024 developed	August 2023	<p>Completed. Despite initial delays, a detailed RP2024 agenda was established comprising a First Nations Water component and a regional/ Remote communities' water-liveability component. Currently, this agenda is in early scoping with key partners and DCCEEW research-users.</p>
IP1.02.02	National convening of Indigenous scholars and Indigenous water practitioners to explore: aqua nullius (workshop 1), Indigenous water science practices and governance (workshop 2), and strategies to negotiate the use of Indigenous science methods and water governance (workshop 3).	October 2023	<p>Completed. Workshops were carried out throughout 2023. These revealed the critical sensitivity of water governance for First Nations' physical and cultural well-being and the need to progress slowly, with great care, particularly in this referendum year and now in the wake of the No vote. A number of subsequent 'Indigenous-only' network strengthening, and collaborative processes have been planned ahead of the production of any future publicly accessible details. Despite initial delays, a detailed RP2024 agenda</p>

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Responsible IP Area	Deliverables/milestones	Date Completed	Status & Comments
			comprising a First Nations Water component and a regional/Remote communities' water-liveability component was established. This agenda is in early scoping with key partners and DCCEEW research-users.
IP1.02.02	Workshops reports	November 30, delayed to Feb 2024	Completed. Submitted to DCCEEW for approval. With all First Nations workshop participants in a mourning/ Sorry business period following the recent referendum outcomes, this process was not progressed in accordance with project schedule.
IP2.02.01	Inception meetings/discussions (sub project IP2.02.01)	30 January 2023	Completed
IP2.02.01	A preliminary report on tyre dust and recommendations for interception pilots	30 June 2023 Delayed to 30 September 2023	Completed. Submitted to DCCEEW for final approval
IP2.02.01	Updated RP2024	30 September 2023	Completed/ Updated RP2024 submitted to the Department on 29 Sept 2023.
IP2.02.01	A progress report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution	30 October 2023, Delayed to 01 July 2024	This report requires updated information and collecting that information cause delay
IP2.02.01	A final report on microplastic fundamentals	30 November 2023	Completed. Submitted to DCCEEW for final approval.
IP2.02.02	Inception meetings/discussions (sub project IP2.02.02)	30 January 2023	Completed.
IP2.02.02	Demonstration of case study 1 - Remote Community Project Progress Report	30 July 2023	Completed. The in-person progress report was provided to Mike Burns on the 18th of October in Canberra. This was after a visit by the Infrastructure and Collection Section to the SMaRT Centre to see the Microfactories work taking place.

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Responsible IP Area	Deliverables/milestones	Date Completed	Status & Comments
IP2.02.02	Annual Technology forecast for evaluated technologies	30 September 2023	Completed. Submitted to DCCEEW for final approval.
IP3.02.01	Scope refined for IP3.02.02 for RP2023 and RP2024	30 April 2023	Completed. Scope refined and in place – delivery planned to be advanced where possible. Regular DCCEEW meetings in Jan-March.
IP3.02.01	Methodology framework for analytical and leaching tests.	30 June 2023	Completed. Methodologies refined post-DCCEEW meetings.
IP3.02.01	Scope review for IP3.02.01 for RP2024	30 June 2023	Completed. Weightings across items in the project scope agreed, with some efforts to bring forward ecotoxicology and leaching work.
IP3.02.01	Progress update for characterisation and leaching work	24 October 2023	Completed. Updated provide to DCCEEW. End of life tyre and e-waste materials undergoing chemical analysis and leaching tests.
IP4.02.01	Progress report for RP2022 (amendment to proposal)	1 March 2023	Completed
IP4.02.02	Presentation and discussion of Literature Review	15 July 2023	Completed
IP4.02.02	Gathering model input data	15 October 2023	Completed
IP4.02.02	Decide and run baseline conditions	15 December 2023	On Track. Inputting meteorological data currently, on track to run baseline conditions
IP4.02.03	Six regions and councils across Australia identified	1 April 2023	Completed
IP4.02.03	Data collection needs established	1 July 2023	Completed
IP4.02.03	Adequate air quality monitoring infrastructure in place	1 July 2023	Completed
IP4.02.04	LCS decision tool report	1 March 2023	Completed. Fact sheets published on Hub's website
IP4.02.04	HEPA comparison and intervention study report	1 November 2023 (Partially completed)	Intervention study completed and published in academic journal (complete).

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Responsible IP Area	Deliverables/milestones	Date Completed	Status & Comments
			Comparison work in draft form and provided in Milestone 2 report; awaiting stakeholder feedback to finalise and publish.
IP5.02.01	Report on Australia's material flows and circularity and peer-reviewed journal paper. A four-page summary for the report is in preparation.	November 2023	Journal paper has been published in January 2024 and report launched on 7 March 2024.
IP5.02.02	Report on regulatory and policy settings, environmental impacts of tyre and conveyor belt disposal, material flow and processing capacity analysis for used tyres and conveyor belts in WA and evaluation of market potential for products derived from used tyres and conveyor belts.	May 2023	Published on SCaW Hub web site
IP5.02.03	Survey deployment	October - November 2023	Completed.
IP5.02.03-	Publication of three regional LGA in depth case studies	November 2023	In progress, will be completed by March 2024
IP5.02.03	Survey initially reported via presentation at Circularity 2023	November 2023	Completed
IP5.02.04	Short summaries of outcomes of each yearning circle	In progress Due in May 2024	Yarning sessions are in the process of completion
IP5.02.04	Yarning circles (group discussion) on the identified waste management issues and presentation of research outcomes with the relevant community members will be conducted to seek feedback and suggestions.	In progress Due in May 2024	Upon analysing and summarising the initial findings, the relevant communities will be invited to provide their feedback by the end of March 2024. This project is codesigned with Indigenous community.

Cross-cutting initiatives

Due to changes in our Initiative lead, in 2023 we adopted an Initiative champion strategy to make sure all cross-hub activities were progressing. In this model, different researchers and IP leaders leading a cross-hub collaboration coordinate the activities under the guidance of Hub Leader, Professor Veena Sahajwalla.

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Various key cross-hub activities and internal SCaW Hub cross collaboration progressed this year, with a focus on ensuring synergies and alignment between IP areas:

- IP1.02.01 The on-country cultural awareness and sensitivity training session coordinated with our Indigenous partners and the three other Hubs based at UTAS resulted in the development of an Indigenous-led, cross-Hub project. This is the first cross-hub project to involve all four Hubs, bringing together expertise from all four Hubs to support the health country planning process for our Indigenous partner, melythina tiakana warrana Aboriginal Corporation (MTWAC).
- IP1.02.02 Water Sensitive and Liveable Communities continued conversations with the Climate Systems Hub in the development of a research agenda that can support the Climate Adaption Initiative through supporting an improved evidence base for adaptive decision-making for climate resilience.
- IP2.02.01 is developing a cross-cutting initiative with the Marine and Coastal (MAC) Hub to investigate the impact of microplastics. The IP2 researchers are bringing their expertise on analysis and identification of microplastics, while MAC hub researchers are collecting samples and providing understanding on the toxicological impact of microplastics.
- IP3.02.01 continued to coordinate with IP2.02.01 and IP5.02.02 for tyre-related research to consolidate the Hub's research impact on tyre management in Australia. Representatives from each IP met with Tyre Stewardship Australia in December 2023 to discuss research strategy and coordination. IP3 already has an established relationship with TSA and will continue to collaborate and work with them as the project progresses. A cross-Hub EOL tyre research factsheet and landing page on the Hub website is being developed to describe the consolidated breadth of EOL tyre research occurring in the Hub and in relation to the external research environment.
- IP4.02.02 continued engagement with the climate adaptation cross-cutting program of the Climate Systems Hub. This project completed a scoping study to gather existing knowledge from the international literature and engaged with national and state environmental policymakers to ascertain what potential emission reduction actions are likely to be undertaken by Australia. The project leveraged the modelling capabilities of the IP4 team to progress this work as well as modelling capability in the Climate Systems Hub and will contribute to cross-hub activities. It is expected that effort will be supported by the Climate Systems Hub for this work in future years.
- IP5.02.01: While the materials flow analysis work has not been a cross-cutting initiative, there is potential for the data analysis to support initiatives across the SCaW Hub and to inform the NESP program more broadly. Results are being shared across the hubs.
- IP5.02.03 and IP2.02.02 are working together to share findings to support councils and regions. The data set created by IP5.02.03 in 2023 (combined with the third-party waste data analysis underway in 2024) will provide a basis to choose and contextualise place-based interventions in 2024-25. It is expected that this may lead to collaborative interventions with IP2 and possibly IP1 and IP3. The data set may also be useful for profiling areas that other projects are working in and will be integrated into the Hubs data sharing and stewardship activities.

The work of the Initiative Lead was supported by the evolving governance and agreed operating principles of the SCaW Hub that foster collaborative networks within the Hub and horizontal integration of research topics. The integration of the Initiative lead and the waste impact management research agenda is a key role of the Hub leadership team. As partnerships within the SCaW Hub further mature, the impact of the Initiative Lead role will continue to grow.

Emerging priorities

Each year, specific emerging priorities may be identified by the Department, hubs or third parties for delivery as research projects. If endorsed by the Department, a hub will develop research project/s to address the emerging priority.

Hubs are flexible and adaptable to respond to emerging priorities, with the ability to rapidly scale output, bring in external expertise or respond if additional resources are made available. Hubs are required to set aside 10% of NESP funding being spent per calendar year (in any category) so they can respond to emerging priorities; these funds can be rolled into the subsequent year if they are not used. Emerging priority projects are developed outside a hub's annual research proposal process. Once emerging priority projects have been approved, a hub's research plan and activity budget for the relevant calendar year will be amended, and emerging priorities will be included in the hub's annual progress reports.

In August 2023, an emerging priority was identified for the SCaW Hub and was approved by the Department in December 2023. This is a collaborative partnership between project leader Firesticks Alliance Indigenous Corporation and researchers from IP2. This project will quantify and analyse materials of plant biomass being harvested on Country combined with other plastic waste materials with a view to use these waste materials to manufacture green ceramics that could be use in housing and other infrastructure opportunities by local Indigenous communities associated with the Country concerned. With the project being Indigenous led, it will be Category 1 under the new NESP Three Category approach for Indigenous engagement. This project relates to each of the Hub's three overarching thematic areas: remote and regional solutions; waste resources; and sustainable communities.

Performance against milestones

Performance against funding agreement milestones

All milestones for the reporting period and to date have been met as per the funding agreement (Milestones 1 (Signing of Agreement by the Department) to 17 (Acceptance of final Research Plan 2024 by the Department)).

Performance against the research plan milestones

Information on project progress and performance is provided in Attachment A.

Measuring success

Hub outcomes and outputs

With the Hub in its third year, the focus was on mobilising teams, commencing research, and continuing the collaboration with project partners and research-users. Outputs were delivered in line with the Research Plans for 2022 and 2023. Outcomes for 2023 focused on delivering best-practice research as we move forward along the impact pathway. As the research progresses over the next

few years, the outcomes will become more evident to demonstrate the impact delivered by the Hub to governments, industry, and communities, including Indigenous.

IP1 – Sustainable people–environment interactions (led by UTAS and MU)

IP1.02.01 Nature Connection

In 2023, several knowledge products were completed, a national survey on nature connection was undertaken and our Nature Connection Storytelling website was launched which serves as a portal for collecting and sharing stories about the benefits of nature connection.

The knowledge products from 2023 include five reports, two academic publications and a website/data portal for collecting and sharing nature connection stories. Report topics included: the Environmental Indicators of Wellbeing (and the partner journal article “A mountain of health benefits? Impacts of ecological restoration activities on human wellbeing”); a report on the Human Values of Dark Skies; the Health and Wellbeing Benefits of Caring for Country; Inclusive Urban Greening in Regional Areas; and Nature-based Solutions in Australia (and the partner journal article “Nature-based solutions in Australia: A systematic quantitative literature review of terms, application and policy relevance”).

These knowledge products have served to inform the Measuring what Matters process for the Department of Treasury (Environmental Indicators of Wellbeing) and are being sought after by partners like the Climate Works Centre and Pew Charitable Trust (Nature-Based Solutions), and Northeast Bioregional Network (Health and Wellbeing Benefits of Caring for Country).

An Indigenous-led, cross-Hub project has been developed through the on-country cultural awareness and sensitivity training session we coordinated with our Indigenous partners and the three other Hubs based at UTAS. This project brings together expertise from all four Hubs to support the health country planning process for our Indigenous partner, melythina tiakana warrana Aboriginal Corporation (MTWAC).

IP1.02.02 Water Sensitive and Liveable Communities

In 2023, Stream 1 conducted a national survey in Australia and received responses from 102 Local Government Areas (LGAs) with a response rate of 26%. The purpose of the survey was to gain insights into the capabilities of LGAs in terms of water planning and management, urban heat mitigation, climate adaptation, and amenity-based practices. The survey included several questions, and quantitative indicators were developed to measure the performance of LGAs. The spatial distribution of these indicators was used to investigate patterns and clustering of surveyed criteria. For example, LGAs reported similarities in terms of relying on external consultants, securing funding, and managing stormwater. However, LGAs observed differences in terms of regional/remote LGA contexts that have unique characteristics in terms of geography, biophysical settings, population density and mobility, presence of indigenous culture and values, infrastructure service capabilities, and traditional practices in natural resource management (NRM) that arguably play a much more significant role in supporting liveability outcomes for communities. A detailed survey report was produced to detail all findings. Three knowledge holder workshops were also conducted to deepen insights and plan ahead following the survey. Presentation slides were created to summarise the workshop findings.

Under the research stream, 2 working groups have conducted multiple discussions with workshop participants and organisations working on Indigenous water rights and management. A model was proposed for a supporting platform to be delivered at a scale that can enable interregional, cross-regional networking and data sharing. To support this research agenda, a series of living laboratories is proposed to be established throughout the Australian regional and remote context. Discussions have revealed several potential opportunities to date. The core priority of the early next stages of this

project will be to identify the locations of at least two living laboratory settings and begin arrangements to establish them.

IP2 – Reduced impact of plastics and other materials (led by UNSW)

IP2.02.01: Understanding Microplastics

IP2 researchers have built partnerships with important stakeholders to further the understanding of microplastics. The first partnership is with AUSMAP, which has yielded 2 key outcomes. Firstly, the Hub has been able to access current and historic samples of microplastics from collection points around synthetic turf playfields. These samples are important in understanding the load of microplastic in our water ways prior and post installation of synthetic playfields. Secondly, the partnership has provided research-user feedback on the analysis of microplastic framework. The second partnership is with Ocean Protect. This partnership has yielded access to valuable testing grounds for road markings and tyre dust. The samples collected from gross pollution traps have shown promising results for understanding microplastics from tyre and road wear in 2024.

The researchers have produced a progress report on a nationally consistent monitoring system (protocol), with the aim to release the final version in 2024. A final report on 'Understanding microplastic' has been submitted to the Department and will be produced into fact sheets in 2024. A preliminary report on tyre dust has been produced and experimentation will begin in 2024.

IP2.02.02: Finding fit for purpose technological recycling solutions for regional and remote communities across Australia

In 2023, researchers worked on understanding the gaps in technology by visiting regional and remote areas to speak with problem owners. From this understanding, a yearly progress report for the Department and other research-users summarising progress and results of the multi-year project was produced. For 2023, this included findings relating to criteria (metrics) to evaluate technologies, a synthesis of existing waste demographic frameworks and metrics, and evaluation of technologies.

IP3 - Management of hazardous waste, substances and pollutants (led by CSIRO and Monash)

IP3.02.01: Quantifying mass and potential release of chemicals of potential concern in our wastes and recovered resources

Using end-of-life (EOL) tyres and e-wastes as our initial target waste streams (case studies), key outputs for 2023 delivered against the objectives of the project were:

1. To validate sampling and analytical strategies by intensifying analysis of targeted e-waste and EOL tyre components focused on quantification of CoPC concentrations and mass in such waste components.

In 2023, the sampling guidance for complex waste materials was published along with a fact sheet and is now being distributed to research-users (e.g., EPAs, state government, and industry representatives) engaged in the RP2021 co-design process to identify hazardous waste research priorities. The guidance document has already been used to procure additional industry tyre crumb and secondary product samples, and e-waste samples. Initial discussions have occurred with collaborators about the application of the sampling guidance document with other waste streams, not otherwise investigated under IP3 (i.e., biosolids, organic wastes).

Using the initial datasets produced in RP2022, the analytical schedule for existing samples (recycled rubber materials, lithium-ion batteries, and printed circuit boards) was extended to include polymers, microplastics and other relevant chemicals. New samples were also analysed in the same manner to build the database of information related to waste materials.

2. To establish the leachable (and/or releasable) chemicals of potential concern (CoPC) fractions from the waste streams and/or repurposed materials to inform risk assessments and handling.

A leaching method statement was developed for the assessment of leachable CoPC from complex waste streams. The method statement outlines the use of standard leaching tests (i.e., Australian Leaching Standard Procedure, US EPA Method 1313) and non-standard leaching tests (designed with environmentally relevant conditions in mind) to determine the leachability of CoPC under material reuse scenarios. Initial standard leaching tests have been conducted on some samples. Purpose designed, leaching equipment required to undertake leaching on products obtained from industry are currently being fabricated for use.

3. To establish methodologies for ecotoxicological studies that may be warranted based on leachable CoPC from e-waste and EOL tyre components.

Data generated from standard and non-standard leaching experiments will be used to develop a method statement for ecotoxicology assessments, planned for the next research plan in 2025. A critical review of ecotoxicology assessment related to the case study materials is underway (planned as a year 2 objective for RP2023/24).

Additionally, liaison and networking undertaken with recycling industry companies is strengthening partnerships to support safe reuse of waste.

IP4 - Air quality, forecasting and assessment (led by UTAS and CSIRO)

All four IP4 projects have been designed with input from stakeholders, the Department and collaborators.

IP4.02.01: Let's yarn about smoke

The March 2023 Key Thinkers Forum (KTF) on Air Quality, Asthma and Indigenous Health brought together a community of stakeholders with an interest in air quality and Aboriginal and Torres Strait Islander health and helped to map existing projects and opportunities for new activities that address Indigenous identified research priorities in this domain. A follow-up half day online workshop was hosted in October. A CSIRO Indigenous Research Grant application submitted, if successful, will work with collaborators identified through the KTF to establish a communications framework around smoke messaging during extreme smoke events.

IP4.02.02: How will a changing climate and emissions reduction measures impact sources of air pollution and secondary pollutant formation?

A final report of the scoping review was submitted and approved by the research-users. It will be made available for publication on the SCaW website in 2024.

IP4.02.03: Wood-heaters: developing and testing novel solutions to a persistent problem.

The workshop final report was reviewed and approved by the research-users the report is available on the SCaW website. Additional funding (\$250,000) from Asthma Australia has been granted via a national competitive funding initiative to trial the wood heater replacement intervention with a local council. Additional seed funding (\$20,000) was awarded to the team from the HEAL network to trial a behaviour change initiative to educate wood heater owners.

IP4.02.04: Evaluation of interventions to reduce air pollution in safe havens and use of Low-Cost Sensors to identify areas of concern.

A journal article on the findings of our HEPA intervention study was published, with the key finding that HEPA filters combined with natural ventilation is most effective way to improve air quality year-round. Drafted HEPA guidance was also developed consisting of FAQs for users of these portable air cleaners in classrooms. An online LCS (low-cost sensor) tool and associated information sheets

tailored for researchers, local councils, community groups, schools, and domestic users also developed on how to select low-cost air pollution monitors.

IP5 - Waste impact management research (led by CSIRO and MU)

Project IP5.02.01: Australian metrics for materials, waste and resource recovery summarised in a circularity gap report and dataset

This project delivers to the circular economy focus of DCCEEW and informs the work of the Ministerial Advisory Group for the Circular Economy and the National Circular Economy Framework for Australia. It does so by presenting datasets and indicators that can be used to set circular economy targets and to monitor and evaluate policy effectiveness. The Mass flow analysis for Australia was finalised during 2023.

Project IP5.02.02: Exploring opportunities for increasing value recovery from used tyres and conveyor belts in Western Australia

A report and industry snapshot on Exploring opportunities for increasing value recovery from end-of-life tyres and conveyor belts in Western Australia, Boxall NJ, Tobin S, Minunno R, Cheng KY, Zaman A, Kaksonen AH. (2023) was published on SCaW Hub website in 2023.

Project IP5.02.03: Governing community-based resource recovery and circular economy initiatives (subsequently renamed in RP2024 as Governing community-based waste management and resource recovery and circular economy initiatives)

During 2023 a co-designed survey was piloted with 6 local government informants and then deployed to 540 local government organisations. The initial analysis was then shared by way of a presentation at Circularity 2023. This created opportunity to invite innovative local governments to collaborate and share knowledge to a group of over 100 participants.

Project IP5.02.04: Scoping study creating opportunity from waste in Aboriginal communities in Western Australia (subsequently renamed in RP2024 as Identifying opportunities from waste management and resource recovery and the circular economy for indigenous communities and businesses)

As part of the planned research activities, key outputs included identification of an Aboriginal community in Western Australia; completion of 6 yarning sessions; completion of 2 field visits to understand the waste issues within the Aboriginal communities; and analysis of the findings of the yarning sessions and validation through a community participation (in progress).

IP5.02.05 – Place-based cross hub integration project

The planned cross-Hub initiative in the Swann Canning River Catchment did not come to fruition. The Indigenous engagement in IP5.02.04 still offers opportunities for cross-Hub engagement in this region.

Short- to medium-term outcomes – quantitative measures

Table A: Quantitative performance measures (short- to medium-term outcomes) Note: For the third year of NESP2 hubs, the reporting period is 1 January 2023 to 31 December 2023. Unless specified otherwise, the term 'Research-user' refers to Departmental and/or external users.

No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
1	Proportion of projects (active or completed in the reporting period) for which there is a research-user actively engaged in the project: <ul style="list-style-type: none"> a) co-design b) research delivery c) use and research uptake 	# co-designed projects / # total projects a) Hub 11/13 IP1- 2/2 IP2- 2/2 IP3- 1/1 IP4- 2/4 IP5- 4/4 # projects with research delivery / # total projects b) Hub -7/13 IP1- 2/2 IP2- 2/2 IP3- 0/1	<p>Sub Point a)</p> <p>IP1- During reporting period IP.02.01, codesigned with both partners and research-users, involved partners in research delivery and is being used by partners and research-users. IP1.02.02 conducted one national survey with LGAs across Australia. Knowledge holder workshops were also organized to deepen insights and extend beyond the LGA perspective.</p> <p>IP3 – Has one ongoing project with the Department is the primary research-user. The research plan for RP 2023 was co-designed with our research- users in the Department. Findings, data and information are routinely communicated, and input provided by research-users to ensure the continuity and relevance of research undertaken in IP3. Our research-users are critical for delivery of IP3 research to their internal and external stakeholders. The sampling guidance prepared by IP3 is being circulated for feedback with our research-users and their internal and external stakeholders. The sampling guidance is expected to be used when</p>

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No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
		IP4- 1/4 IP5- 2/4 # projects achieving end use / # total projects c) Hub 3/13 IP1- 0/2 IP2- 1/2 IP3- 0/1 IP4- 1/4 IP5- 1/4	planning sampling events for other complex waste materials not otherwise investigated through IP3 (e.g., biosolids, organic waste). IP4- IP4.02.01 co-design of Key Thinker's forum with HEAL Network and Djurali Centre. IP4.02.03 is collaborating with local government to evaluate different interventions Sub Point b) IP2 – The use and research uptake of the Regional and Remote project is yet to be realised. Once the forecast and dashboard has been released, we hope to see further uptake of the findings. IP4- IP4.02.04 has generated factsheets on the use and implementation of low-cost air sensors. Sub Point c) IP4- IP4.02.04 has generated factsheets on the use and implementation of low-cost air sensors for update by a range of research-users
2	Research outputs in the reporting period provided to research-users on time and as identified in the approved research plans: a) total number b) proportion	Total Number a) Hub – 30 IP1- 10 IP2- 3 IP3- 4 IP4- 9	Sub Point a) IP1 – During the reporting period, IP1.02.02 produced one detailed survey report. Spatial maps displaying the water management perspective in a remote regional context have also been developed. A series of slides detailing key findings and future priorities has also been produced. IP2 – One of the outputs has been delayed to 2024 for the Department. Two outputs are from IP2.02.01

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No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
		IP5- 4 # outputs delivered on time/overall RP2023 expectation b) Hub -30/33 IP1- 10/11 IP2- 3/4 IP3- 4/4 IP4- 9/9 IP5- 4/5	(Milestone 2 & 5) , one output is from IP2.02.02 (Milestone 3). IP3 –All milestones were delivered as planned IP4 – All four projects delivered the RP2023 milestones, meeting the KPI. There were five fact sheets, an online tool for low-cost sensor selection, a FAQ added to the existing HEPA cleaner online tool, a workshop report on wood heaters, a review of the climate science, the hosting of the Key Thinkers Forum.
3	Proportion of completed research projects that are confirmed to meet the needs of departmental research-users as identified at project co-design stage	# completed projects meeting DCCEEW end-user needs / overall completed research projects IP1- 0/2 IP2-01/3 IP3- 0/1 IP4- 0/4 IP5- 0/4	IP1 – All projects are ongoing. IP2 – Two projects are ongoing. One project IP2.02.03 “Plastic-Reinforced Artificial Reef Structures; Improving Understanding” was completed in June 2023 IP3 – The project is ongoing. IP4 – All projects are ongoing. All are meeting the research-user needs. IP4 meeting every other month to discuss progress. IP5 – All projects are ongoing.

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No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
4	<p>Number of projects that:</p> <p>a) are Indigenous-led</p> <p>b) meet research and management priorities of Indigenous stakeholders</p> <p>c) are Indigenous-led projects that also meet research and management priorities of Indigenous stakeholders.</p>	<p>a) Hub -2</p> <p>IP1- 2</p> <p>IP2- 0</p> <p>IP3- 0</p> <p>IP4- 0</p> <p>IP5- 0</p> <p>b) Hub -6</p> <p>IP1- 2</p> <p>IP2- 2</p> <p>IP3- only indirectly</p> <p>IP4- 1</p> <p>IP5- 1</p> <p>c) Hub -2</p> <p>IP1- 2</p> <p>IP2- 0</p> <p>IP3- 0</p> <p>IP4- 0</p> <p>IP5- 0</p>	<p>Sub Point a)</p> <p>IP1 – IP1 have projects that are Indigenous-led. For IP1.02.01 research stream 3 is Indigenous led. For IP1.02.02 Research Stream 2 is Indigenous led</p> <p>Sub Point b)</p> <p>IP2 – Both projects have met with Indigenous groups to ensure priorities are met.</p> <p>IP3 – The project has a heavy chemical analytical and laboratory-based technical schedule. We consider research and management priorities of Indigenous stakeholders as they arise in Hub meetings.</p> <p>IP4 – IP4.02.01 has resulted in a grant application being submitted to CSIRO Indigenous Research Grant. This was co-designed and will support an Indigenous post-doctoral fellow if successful.</p> <p>IP5 - IP5.02.03 – no significant Indigenous involvement in 2023 but will be possible in 2024 place based initiatives. Relevant data generated in 2023 survey re current collaboration and interest in collaborating with Aboriginal groups.</p>

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No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
5	Number of peer-reviewed, NESP-funded publications during the reporting period	4	<p>IP1 – IP1.02.01 published two peer-reviewed journal paper.</p> <p>IP4 - IP4.02.04 published one peer-reviewed manuscript.</p> <p>IP5 - IP5.01.02: Peer-reviewed one journal paper in the Journal of Industrial Ecology.</p>
6	Number of NESP research citations in other researchers' publications during the reporting period	0	
7	Number of completed NESP products, research publications, datasets and metadata that are discoverable and accessible in accordance with <i>NESP data and information guidelines</i> and the funding agreement	20	<p>IP1 – All knowledge products produced in 2023 are open access and publicly available. Our survey data is not made publicly available as per our ethics application, but the reports and results will be.</p> <p>IP2 – Sharing of datasets and metadata will commence in 2024 following the <i>NESP data and information guidelines</i> and the strategy set by the NESP SCaW Hub Data Wrangler.</p> <p>IP3 – One sampling guidance and associated factsheet available on the Hub website. Two presentations at SETAC Australasia, 2023.</p> <p>IP4 – IP4.02.04 have published fact sheets. IP4.02.03 have published the workshop report. The climate change model review is pending a CSIRO DOI and then will be available to host online on the Hub website. The Key Thinkers Forum report is pending ICIP discussions prior to being shared.</p>
8	a) The number of datasets and management tools produced by hub research and made public.	a) 2 b) 2	Sub point a)

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No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
	<p>b) The number of other datasets and management tools that benefited from hub research and outcomes.</p> <p>Management tools include but are not limited to monitoring systems; web-based decision support systems; environmental management tools for Indigenous communities, waters and land management; plans of management for Indigenous Protected Areas (IPAs), co/jointly managed parks, marine park plans of management, conservation agreements.</p>		<p>IP1- IP1.02.01 nature connection storytelling website is a publicly accessible repository of qualitative data (stories). Our urban greening report is also a management support tool to guide regional urban greening.</p> <p>Sub point b)</p> <p>IP3 - The datasets generated in this project are not publicly discoverable but meet data and information standards as required by the Hub and research-users' needs. Datasets and information generated under IP3 have been used as inputs to the ARChiE database that is being developed by DCCEE. We are in communication with Data wrangler and department research users to find the best approach for non public research products (e.g., data sets). The bulk of the data is currently being shared with the DCCEE and will be made publicly available upon publishing the results in peer-reviewed journals.</p> <p>IP4 - is focussed on developing such datasets and tools for public release throughout the life of the Hub.</p>
9	<p>a) Number (full-time equivalent) during the reporting period of PhD students</p> <p>b) post-doc and early-career researchers</p> <p>c) mid-career researchers</p> <p>d) Indigenous researchers</p> <p>e) individual volunteers (total)</p> <p>f) individual Indigenous volunteers (total)</p> <p>g) Indigenous sub-contractors</p>	<p>Hub – 19.1 FTE</p> <p>a) 4</p> <p>b) 6.2</p> <p>c) 8.5</p> <p>d) 0.2</p> <p>e) 0</p> <p>f) 0</p> <p>g) 0.2</p>	

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No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
10	Number of knowledge-sharing and communication events and activities held or shared: a) with on-ground managers (general) b) jointly with Indigenous researchers and Traditional Custodians c) that are Indigenous-led	Hub - 13 a) 10 b) 1 c) 2	<p>On-ground managers are defined as working in a place where practical work is done to manage Country or an environmental or climate change issue; that is, where things are actually happening on-ground (not at a distance or in theoretical manner).</p> <p>Sub Point a) IP5- IP5.02.03, presented at Circularity 2023 and involved on ground managers from local and state government, and industry, and Indigenous organisation representatives.</p> <p>Sub point b) IP4 – IP4.02.03 is working with three government departments to co-design interventions to reduce wood heater emissions. IP4.02.01 hosted a Key Thinkers Forum with Indigenous collaborators.</p> <p>Sub point c) IP1- Attended an on-Country cultural awareness training with our Indigenous partners and in December, attended their cultural celebration with our Storytelling Pod to share Indigenous stories of nature.</p>
11	Proportion of hub staff and researchers who have completed: a) Indigenous cultural capability training	a) 44 /45 b) 26 / 44	All hub members have undertaken cultural capability training through Your Mob. Any additional training such as ICIP training is at the discretion of

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No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
	b) Indigenous cultural and intellectual property training c) both Indigenous cultural capability training and Indigenous cultural and intellectual property training	c) 24 / 41	IP leads. All IPs are informed when training is offered each year.
12	Proportion of hub projects overall that fall within the categories of the Three-category approach: a) Category 1: Indigenous led b) Category 2: Co-design c) Category 3: Communicate	a) 1 / 13 b) 5 / 13 c) 7 / 13	Sub point a) Category 1: IP4=01 Sub point b) Category2: IP1=02, IP2=02, IP5=01 Sub point c) Category 3: IP3=01, IP4= 03, IP5 = 03
13	Proportion of hub projects that have been developed in consultation with the hub Indigenous facilitator or the Indigenous Facilitation Network	5 / 13	Projects are in IP1, IP2, IP4 and IP5.
14	Number of guidelines about best-practice that the hub has produced or co-produced in the reporting period, for: a) knowledge brokering (e.g., https://www.nespthreatenedspecies.edu.au/publications-and-tools/connecting-research-with-policy-guide-to-writing-for-policy-makers) b) Indigenous partnerships and products (including design of flagship engagement activities e.g., Our Knowledge Our Way ; Three Category Approach) c) environment and climate management within the scope of the hub's research (e.g. Guidelines for the translocation of threatened plants in Australia, Third Edition ; https://www.nespmarine.edu.au/project/project-d2-standard-operating-procedures-survey-design-condition-assessment-and-trend)	a) 5 b) 1 c) 2	Sub point a) KB team created the milestones progress template to evaluate the projects progress internally. Sub point b) Hub's Senior Indigenous Facilitator involved through the Indigenous facilitation network in the development and implementation planning for the latest version of the Three Category Approach. Sub point b) IP1- Our report on "Inclusive urban greening in regional areas: Findings and recommendations from regional stakeholder workshops" is designed to

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No.	Performance measure	Result for reporting period (numerical only)	Explanation, if any
			inform environmental management in the form of urban greening in regional areas. IP3 - Sampling Guidance for complex waste materials and associated factsheet on Hub website.

Longer-term outcomes – qualitative measures

This is the third year of operation for the Hub and the second year where research continued to be implemented. The longer-term outcomes have been identified and are being realised. The Hub is on an impact pathway that will progress as the research matures over the life of the Hub, towards medium to longer term outcomes for our key stakeholders, namely governments, industry, community, including Indigenous communities. Many outcomes are expected and summarised below.

IP1.02.01 have developed and delivered on several co-funded, partner-led projects exploring eco-restoration and wellbeing, equitable urban greening and research-user-driven projects on nature-based solutions and the values of dark skies. As partner-led projects, these are already informing and impacting policy and practice. The Nature Connection Storytelling project has been gaining significant interest from partners in Tasmania with many partner-led, story-collecting events and activities planned for 2024. The more stories that are collected and shared through this project, the more recognition there will be of the value of nature to Australians. IP1 efforts in working with Tasmanian Aboriginal communities resulted in the initiation of an Indigenous-led project which is the first cross-Hub project to involve all four Hubs. The IP1 contribution to this project will be to support the MTWAC community to develop a wellbeing framework and then to apply that framework to understand the wellbeing benefits of on-country activities. This project supports agency and capacity building for wellbeing research for the community and, if the outcomes show a wellbeing benefit of the pilot ranger training program, will support funding applications for that program.

For **IP1.02.02**, the inputs from national survey and workshops have paved the way of envisioning a system strengthening platform enabling inter/cross regional networking and data sharing, while also responding to local contexts with sensitivity to existing needs, capacities and lived experiences. Key research questions and indicative workplans have also been developed for the piloting of anchoring institutions through living laboratories, which will be implemented through four streams over the coming years:

- Stream 1 (Anchor Institution Processes and Outcomes): To understand how a coordinating platform can strengthen the system by supporting the development of anchor institutions in these contexts.
- Stream 2 (Platform Functions): To identify the key tools, training, networks, and resources that the platform should host to support in-context outcomes and establish the institutional and structural arrangements to support their development and accessibility for anchors and partners.
- Stream 3 (Platform Operations and Administration): To identify the components required to support the development and function of a knowledge platform.
- Stream 4 (Resource Flows and Authorising Environments): To identify the economic, institutional, knowledge and skill-based resource streams to support available access and uptake at the local scale.

For **IP2.02.01**, a detailed study into synthetic grass-based microplastics will investigate the composition, prevalence and impact of the waste in our environments. The results of the study will help determine the most effective interceptions points to begin conducting pilot studies for longer term monitoring. The interception pilot trials will target tyre dust and other microplastics, with the goal of preventing further microplastic release into the environment and to increase recycling rates.

Following the scoping work conducted previously under **IP2.02.02** and the implementation of a pilot recycling solution for a remote community, the project will continue to develop the pilot trial and report on some of the knowledge gained and lessons learnt. These learnings will then inform the next set of

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demonstration case studies as the project moved to the implementation of the second and third case studies for inner and outer regional communities.

The first Annual Technology Forecast report was prepared and dedicated to the exploration and analysis of innovative recycling technologies specifically tailored for recycling facilities operating in regional and remote Australia. The Annual Technology Forecast will also see further refinement in RP 2024 and RP2025 following the feedback from stakeholders who have reviewed the report. New and emerging technologies would be incorporated into the next phase of the report and emerging waste streams would be identified, focusing on the streams deemed most problematic for regional and remote communities.

IP3 will build on the strong research foundation generated in 2023 to continue to generate high quality data and methodologies for the characterisation of risks associated with identified chemicals in EOL tyres and e-waste and determine the value for other complex waste materials. Sampling guidance has been developed and leaching guidance is planned – both to be promoted for adoption nationally. These documents are intended to be updated with feedback from our strong stakeholder network and validated with additional sampling and characterisation events both within the IP3 research program and outside. Using the co-designed sampling guidance and the method statements developed for both leaching and ecotoxicology, a coordinated approach to characterisation and risk assessment related to relevant reuse scenarios is envisaged. The generation of high-quality data and information will enable circular economy, safe waste reuse and confidence to operate for the recycling industry, while reducing risk of unintended consequences to human and environmental health.

All **IP4** projects have established key priorities and actions to support their research in later years. For **IP4.02.01**, the goal of the KTF was to establish working relationships with Indigenous researchers throughout Australia and to engage in discussions with community to understand gaps in the research and to launch new research. To date, we have been able to identify a gap in understanding smoke messaging to protect health during periods of extreme smoke. This has resulted in the application of a grant with Indigenous partners from the Djurali Centre and the University of Sydney. Members of the team have also been able to leverage salary support from SCaW and their organisations to support the MRFF Indigenous Health grant being led by Menzies Institute for Health Research. To date, a multi-institute agreement has been circulated to organisations and the primary ethics application has been submitted. Once approved, the partner organisations will obtain reciprocal ethics approvals. In the long-term, these studies will provide air quality and health findings for vulnerable Indigenous populations which will support the development of appropriate messaging and policies to protect health from smoke events. The longer-term goals are to ensure that there is capability and capacity within Indigenous communities to undertake research activities that will benefit their health and environment. The foundational work will also ensure that any future activities are co-designed with Indigenous partners.

For **IP4.02.02**, the models being generated will support the selection of appropriate climate change mitigation policies by demonstrating the benefits of applying a range of climate change policies to improve air quality. These will support the Department in selecting actions to help meet future targets.

For **IP4.02.03** the team have been able to evaluate a range of interventions that will provide information on the economic and health benefits of implementing different mitigations to reduce the impacts of wood heater emissions. These are the foundations for rolling out any national policies around wood heater change out programs. Funding has been obtained to conduct a wood heater change out in Armidale, NSW. This is supported by the local council and Asthma Australia. This will provide the evidence and methodology to conduct a larger scale rollout if funding becomes available. In partnership with Mt Barker local government, a behaviour change will be evaluated in winter 2024. This will be conducted after a year of baseline air quality data has been collected by EPA SA so it will

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be possible to quantify the benefits of this mitigation approach. Discussions are ongoing with ACT Department of Health to co-design a relevant mitigation evaluation.

For **IP4.02.04** the team have now completed their evaluation of low-cost air sensors and HEPA portable air cleaners and commenced a literature review to understand the state of both policy and science around the use of cleaner air shelters. These will be evaluated and tested in coming years to provide local governments with tools to select appropriate buildings for use as clean air shelters during extreme smoke episodes.

IP5 will realise several longer-term outcomes. For **IP5.02.01** we are committed to continue material flow analysis and expand the time-series to include environmental impacts and scenario modelling in RP2024. An online data platform is also to be developed for public access. Capacity building for the Australian Bureau of Statistics will also be undertaken to build capability for material flow accounting.

For **IP5.02.02** this study is expected to provide better information to inform decisions to overcome market barriers, to enable the reduction of stockpiling, dumping, landfilling and onsite disposal of used tyres and conveyor belts. It will also facilitate value recovery from these wastes, leading to economic benefit and reduced human and environmental risks. This will allow for science-based decision making for managing tyre and conveyor belt material flows, developing recycling capacity, and creating market potential. It will also assist in establishing regulatory and policy instruments in WA to help overcome market barriers and to enable diversion of waste from stockpiling, dumping, on-site disposal and landfilling to value recovery from used tyres and conveyor belts, especially in regional areas. The insights will inform industry, state and national strategies to improve the circular economy of tyres and conveyor belts.

For **IP5.02.03**, It is expected that peer to peer learning will occur in the online community, councils will want to participate in trials co-design and implementation; and benefit from learning (locally) and share them widely (across the population). Specific trials will have specific outputs emerging from the co design process. By 2027 it is expected that there will be widespread adoption of the resulting regional and remote network governance for CE framework. The team collaboration has increased their engagement and attention on the experiences and challenges of regional and remote LGA areas, and they are highly interested in working further with the project. Expected outcomes also includes sharing results with Australian circular economy (CE) community, opening a dedicated regional and remote LGA space on their platform, sharing learning and resources from trials. This project involved in piloting survey, sharing experiences and cases, and later, participating in online community, participating in trials and co-designing network governance approach.

For **IP5.02.04** the long-term outcomes of the Yarning Circles project, grounded in the collaborative engagement of Elders of Indigenous communities and community representatives, are poised to generate profound and enduring transformations. By delving into the cultural understanding of waste and materials within Indigenous perspectives, the project aims to preserve and integrate these insights, fostering not only cultural sustainability but also a heightened awareness of the environmental and social impacts of waste within the community. The identification of key waste management challenges serves as a catalyst for heightened community awareness, instigating a commitment to actively address these issues. As the project progresses, the proposal of circular economy solutions, intimately aligned with local needs and cultural values, will assist in empowering the community to embrace sustainable waste management practices. The ultimate long-term outcome encompasses the development and implementation of a robust circular economy model, contributing to economic resilience, job creation, and environmental conservation within the Indigenous communities. The project envisions a future where these communities lead the way in adopting a

culturally sensitive approach to waste management, thereby enhancing overall wellbeing and sustainability while generating employment for the local community.

NESP impact stories

NESP impact stories are provided at Attachment B. These stories showcase the contribution of NESP -funded research beyond contributions to academia, including to the environment, the economy, society, culture, public policy and quality of life. Impact stories provided are aligned with our key themes for the Hub.

Collaboration and partnerships

NESP encourages a collaborative, multi-disciplinary approach to environmental and climate research. Key to the success of the hub will be the capacity to foster partnerships across hubs and with a wide range of decision-makers across the Australian community, including Indigenous communities, to achieve positive environmental, social and economic outcomes.

Co-design is a fundamental pillar in how the SCaW Hub engages in research, from planning and design through to implementation. With the breath of issues covered by the Hub comes the need to engage with a wide range of stakeholders and listen and respond to their needs, working closely with our partners to ensure research-user expectations are met and the impact sought, achieved, as shown in Figure 6.

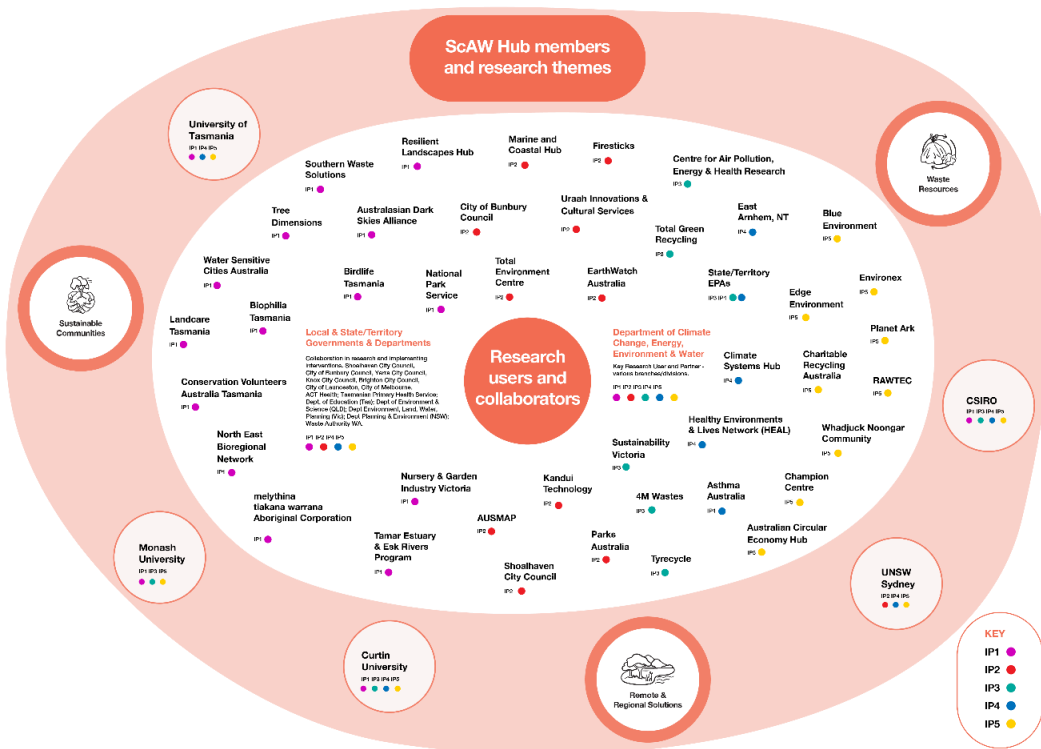


Figure 6: The 2023 SCaW Hub Stakeholder Network, which demonstrates the fluid line between hub collaborators and research-users

In 2023, Table 1 summarises cross-hub collaborations occurred for each IP in their respective projects.

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Scaw Hub Project Details	Cross Hub Project Details	Cross Hub Linkage Activities
<p>IP1.02.01: Nature connection</p> <p>Project leader: Emily Flies, UTAS</p>	<p>Project: 3.17. Improving environmental outcomes on conserved and managed lands</p> <p>Cross Hub: Resilient Landscapes</p> <p>Project leader: Vanessa Adams</p>	<ul style="list-style-type: none"> Stream 1: Not an official cross-Hub stream, though there is and will continue to be collaboration with RL Hub on this stream. Stream 3: Is an official cross-Hub, Indigenous-led project which will have co-investment of funds across all four Hubs, with a collaborative, cross-Hub codesign process led by our indigenous partners (MTWAC) with data sharing as appropriate.
	<p>Project: 4.4: An Indigenous-led approach to advance health and wellbeing of Tebrakunna Country, Coastal Plains nation, North-east Tasmania</p> <p>Cross Hub: Marine and Coastal Hub</p> <p>Project leader: Alan Jordan (and Mark Harris, as Indigenous lead at partner organisation, MTWAC)</p>	<ul style="list-style-type: none"> There will be co-investment of funds across all four Hubs, with a collaborative, cross-Hub codesign process led by our indigenous partners (MTWAC) with data sharing as appropriate.
	<p>Project: 2.5: Regional climate change guidance for local action and proposed project 4.3: Conservation Adapt' - a cross hub biodiversity adaptation knowledge platform</p> <p>Cross Hub: Climate Systems Hub</p> <p>Project leader: Jennifer Styger</p>	<ul style="list-style-type: none"> There will be co-investment of funds across all four Hubs, with a collaborative, cross-Hub codesign process led by our indigenous partners (MTWAC) with data sharing as appropriate.
	<p>Project: 2.5. Regional climate change guidance for local action</p> <p>Cross Hub: Climate Systems</p> <p>Project leader: Jason Evans</p>	<ul style="list-style-type: none"> There will be a co-investment of funds across hubs, a collaborative co-design process, appropriate data sharing and co-production of knowledge products.
<p>IP2.02.01: Understanding Microplastics</p> <p>Project Leaders: Prof. Veena Sahajwalla, and Anirban Ghose, UNSW</p>	<p>Project: 2.4. Ecological outcomes of wastewater discharges in contrasting receiving environment</p> <p>Cross Hub: Marine and Coastal</p>	<ul style="list-style-type: none"> The collaboration between these two projects will provide opportunity to undertake appropriate tests which is already occurring under IP2 to measure the ecotoxicity investigations on the consequence of contaminants in coastal marine ecosystems.

	<p>Meeting and discussions with Hub leader Alan Jordan</p> <p>Project collaborator: Bronwyn Gillanders</p>	<ul style="list-style-type: none"> • UNSW and Bronwyn Gillander's Lab at university of Adelaide (collaborator of NESP2.4) initiated working on the investigation and examination of the microplastic samples. • A set of microplastic samples which was collected by Gillander's Lab team was sent to UNSW for further analysis. The received microplastic samples will be investigated via a range of different technique including FTIR, TGA-GC/MS, SEM, UV/VIS spectroscopy and ICP.
<p>IP4.02.02: How will a changing climate and emissions reduction measures impact sources of air pollution and secondary pollutant formation?</p> <p>Project Leader: Kathryn Emmerson, CSIRO</p>	<p>Project: 2.5. Regional climate change guidance for local action</p> <p>Cross Hub: Climate Systems</p> <p>Project leader: Marcus Thatcher; Hamish Ramsey</p>	<ul style="list-style-type: none"> • Project 2.5 is providing IP4.02.02 with the climate change modelling for 2048 - 2052 so that IP4.02.02 can calculate changes in air quality. • These data will come from 4 GCMs under 2 SSPs (8 simulations in total for 5 years each).

Table 1: Cross hub collaborations with linkage activities

The SCaW Hub conducts annual reviews of its key strategies. Strategies are updated by each strategy leader and shared with other strategy leads for comment. All updated strategies are reviewed by the Hub Communication Manager for consistency and accuracy. Updated strategies are reviewed by the Operations Manager, Hub Leader and Steering Committee Chair and then sent to the Department for approval. A review of the strategies took place in early 2023 and resulted in very small modifications to the strategies. As a result, all strategies are progressing well, in line with workplans. As the need for cross-hub activities increases the work of strategy leads will expand to work with other hubs to create cross-hub products. All will be reviewed again in the 2024.

Knowledge brokering

Knowledge brokering is a key function within the Hub, guided by the Knowledge Brokering Strategy to ensure that research projects are co-designed in accordance with the Department guidelines to meet the needs of research-users and knowledge products are delivered in usable and accessible formats to generate research impact and to communicate the program level impact of the Hub. The Strategy is updated annually.

The Hub's lead Knowledge Broker (KB) guides knowledge brokering activities and functions across the Hub, in partnership with the Department, all Hub partners, Indigenous facilitators and other NESP hubs, in accordance with the Hub's KB strategy. There is an active knowledge brokering presence across the Hub, with knowledge brokering roles in all Hub research institutions (also referred to as nodes), and in all Impact Priorities, via a dedicated Hub KB group that meets regularly to coordinate function and action plans for quality outcomes. At a cross-hub level, the KB team communicates regularly with KBs in the other hubs, to align research across hubs to elevate impact and share experiences and learnings. Key progress against this strategy in 2023 has included:

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- Circulating Scaw Hub updates via a quarterly Newsletter to share information about presentations, talks, community engagement activities, publications etc. among all IPs.
- An internal hub showcase organised between all IPs to share the progress on research projects, and research findings, creating pathways to explore the collaboration opportunities between Hub IPs.
- A SCaW Hub internal Monitoring and Evaluation (M&E) template has been created and circulated among all the IP's and initial reviewing commenced.
- Knowledge product development in response to IPs research findings tailored to meet stakeholder needs and easy adoption.
- Regular meetings and discussions with each IP team to understand their needs and how best to support them.
- Recent discussions with Robert Markham, an Indigenous knowledge broker, DCCEEW who actively participated in the KB meetings with Researchers.
- Cross-hub collaboration facilitation through regular meetings with the Climate Systems, Marine and Coastal and Resilient Landscapes Hubs Knowledge Brokers to share experiences and ideas around translating research and knowledge.
- Collaborating internally to support other strategic leadership, such as Indigenous Partnerships and Data Wrangling, to enhance the ways they communicate their research and engage with research participants, research-users, and the broader public.

Communication

The Hub's communication strategy guides the communication function in conjunction with the Hub's research plans and the strategies of other hub functions. The role of the communications function is to promote and protect the activities and reputation of the Hub and its partners, while supporting the overall objectives and vision of NESP.

The Hub's Communication and Media Manager has worked closely with the Hub leadership team on various levels of stakeholder engagement, including with the Department, the Hub's Steering Committee and its Chair, and all research areas across the Hub. This includes regular and targeted engagement with researchers and collaborating with the other strategy leads. This also includes monthly meetings with the NESP hubs Communications Practice Group, which discusses and shares communications matters relating to all four hubs including publicity, events and insights. The Manager has also participated in the weekly Hub Host Leadership group meetings and interactions.

The Communications Action Plan is the workplan of activities to deliver the strategy and for 2023 key activities included:

Branding / templates / materials to support IP areas	<ul style="list-style-type: none"> • No new branding or new templates, but delivered various updates via correspondence and in meetings about branding requirements and support provided by the Communications function • Updated communications support and requirements document to V5.3 to account for various changes
Website	<ul style="list-style-type: none"> • Website maintenance and operation • Updates to operational changes (e.g. personnel changes) • A new 'Impact' webpage has been created on the website: https://www.nespsustainable.edu.au/impact

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	<ul style="list-style-type: none"> • Extensive publication of news and event posts • Published all new research reports and annual reports • Published relevant IP-related sections of research reports for each IP • After the home page, the top three visited web pages of 2023 are: <ul style="list-style-type: none"> ○ Key Thinkers Forum on Air Quality ○ Report: End-of-life tyres and conveyor belts ○ Impact Priority 1 - Sustainable people-environment interactions • Website user report analysis shows various highlights such as: <ul style="list-style-type: none"> ○ DEECCW is the second highest referral site to the website, followed by LinkedIn then Twitter ○ Top three geographic domains are Australia, the US and India ○ Desktop users are 4 times the rate of mobile users
News	<ul style="list-style-type: none"> • Wrote and published 18 news items on website • Curated on the Hub website and promoted via social media posts with relevant key news and reports, such as new pages for RP2023 and IP project reports.
Events	<ul style="list-style-type: none"> • Wrote and published 22 events items on website • Community events: The Hub leader and IP leads have spoken at more than a dozen community-based events in 2023, promoting the Hub and its work. This has led to numerous new connections for the Hub and increased exposure, including the Questacon presentations during National Science Week. • Industry events: The Hub leader has spoken at another dozen industry specific events, building awareness of and collaboration opportunities for the Hub at an industry level. This includes the Innovation Summit Sydney and the Circular Economy - More than Recycling webinar hosted by the Australasian Institute of Mining and Metallurgy. • Hub events: The Hub communications function delivered the communications support for the Hub's first major event, the Key Thinkers Forum on Air Quality, Asthma and Indigenous Health.
Media	<ul style="list-style-type: none"> • Media exposure: Various media mentions of the Hub by the Hub leader in her media work, including a recent Ocean Protect podcast and videos on plastic waste, an ABC News "Courtney Act" online and video recycling story, an ABC podcast about "waste as a resource" and an SBS story on plastic waste.
Videos	<ul style="list-style-type: none"> • No new videos produced in 2023
Social media handles (LinkedIn and Twitter)	<ul style="list-style-type: none"> • Wrote and published posts for all website news and event stories, including linking to SCaW Hub site posts and other relevant curated content (such as reposting relevant DEECCW posts) • A strong following base across both platforms • Leveraging the Hub Leader's profile and social channels of Twitter and LinkedIn to promote the Hub has helped grow our following • Thousands of post views each month • Continue to consider other social channels as the supply of content emerges
Newsletters	<ul style="list-style-type: none"> • Quarterly internal newsletter updates from KB team. • SCaW provided regular newsletter content for the Department.

<p>Knowledge product support and management of approval process with NESP</p>	<ul style="list-style-type: none"> • Working with IP leaders to identify their project’s key messages that need to be communicated to different stakeholders. • Working with other hubs to create joint communication pieces as part of cross-hub products about complimenting research topics.
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Indigenous partnerships

The Hub's Indigenous Partnerships Strategy, a live document, was endorsed by the Hub's Steering Committee and approved by the Department on 28 September 2021. It was developed by the Senior Indigenous Facilitator in consultation with the Hub leadership team and reviewed with minor administrative updates made in 2022. The Hub has continued to deliver key activities against the Indigenous Partnerships Strategy in 2023 including:

Right to Indigenous cultural and intellectual property: Several more Hub members have attended True Tracks Training to better understand Indigenous cultural and intellectual property.

Co-created research: Cultural capabilities have increased, and the Hub is seeing more engagement with Indigenous populations.

Indigenous partnership approach: The three-category approach has been revised and will be available following the release of the final toolkit from DCCEEW. It is being used for RP2024 however within SCaW Hub. DCCEEW Indigenous Knowledge Brokers have arranged training delivery of how to apply this for 2024 across all Hubs.

Facilitation and governance: The Hub remains actively engaged in the Indigenous Facilitation Network (IFN) through the Senior Indigenous Facilitator. Other key activities undertaken by the Senior Indigenous Facilitator included:

- Delivering a presentation for the DCCEEW showcase in May 2023.
- Participation in a workshop with the IFN which included her arranging a visit for the Facilitators and Indigenous Knowledge Brokers to the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS). The visit provided access to attendees to the collections within the Stanner Room and an opportunity to engage with collections management staff regarding appropriate protections and storage of Indigenous knowledge and artefacts.
- Active involvement in providing input into the revised version of the three-category approach. The input has included contributions to the design, the roll out and training in its application.
- Delivering a presentation for the NESP Reconciliation Week Showcase to DCCEEW on 31 May 2023. The presentation was pre-recorded and provided insight to ethical considerations for Indigenous Australian research.
- Continuing to work with the Indigenous Facilitation Network regarding the revised three category approach.
- Arranged for the Hub Indigenous Advisory Group to have a presentation about the three-category approach.

Arranged for an Uluru Statement from the Heart Youth Delegate to present to the Hub about the Uluru Statement ahead of the upcoming referendum to assist with informed decision making. Post the referendum outcome, DCCEEW and many other institutions (Curtin University included) implemented a week of mourning. Following this there remains some division and hurt around community. In light

of this, some relationships are now fractured and there is less willingness to 'co-design' on projects in some populations. This has been a balancing act for the Senior Indigenous Facilitator to understand the changing landscape.

Data management

In 2023, the Data Wrangler made substantial progress in the transfer of knowledge between researchers and research-users across government, industry and communities, with several workshops to discuss the requirements of individual projects within the SCaW Hub.

The Data Wrangler maintained communication and collaboration with the projects within IPs and the supporting teams including the Knowledge Broker team and the Indigenous Facilitator. Interactions with the Knowledge Broker team and the Senior Indigenous Facilitator have been critical to the development of the framework and the overall data strategy for the SCaW hub. The meetings with the Indigenous Facilitator clarified the key concepts regarding Indigenous data and identified the gaps in the current data management strategy, highlighting the importance of including the CARE principles in the plan. Regular workshops were held with the IPs, to maintain awareness of the data being generated and plan for their transfer and translation. By meeting with each group, the Wrangler could understand the requirements from both the researchers and research-users whilst also ensuring each group understood the principles of FAIR and CARE and its importance to high-quality, long-term data.

The Data Wrangler commenced regular workshops with the ARDC (Australian Research Data Commons) regarding scoping a specific project to address FAIR and persistence beyond the life of the Hub. This project is being scoped in 2024 and will be supported by the ARDC and SCaW. One of the outcomes of this project is to ensure Hub readiness for broader consultation with EIA (Environment Information Australia) which is in process of being established by DCCEEW. The meetings ensured alignment of goals across the stakeholders, drawing from their extensive experience in data management to structure the framework effectively.

The data strategy and action plan has been designed specifically for the SCaW hub and the unique data sets that are currently being created by the researchers. The range of disciplines demands flexibility in the application of data standards across the Hub. The strategy will continue to be developed into 2024.

During the year the Data Wrangler also reached out to industry experts for potential collaborations to translate research data through diagrams and interactive websites.

Hub-level risk management

All risks identified in the Hub's risk management plan are being actively managed.

A risk management framework is in place for the Hub, having been approved by the Steering Committee and the Department as a part of the RP 2021, RP2022 and RP2023 signoff. Risks are identified, managed and reviewed on a monthly basis by the Hub Host leadership team. Risks can be identified through discussions with Node and Impact Priority leads or through notification from the Department. Where new risks are identified appropriate mitigation measures are developed and communicated to Node and Impact Priority leads as required. Updates are also provided to the Hub's Steering Committee and the Department as required.

There were no new risks identified for the Hub during RP2023.