Environmental Sustainability Guidelines for Spaces and Places

2024

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SPORT NEW ZEALAND
IHI AOTEAROA

Te Kāwanatanga o Aotearoa
New Zealand Government

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Key Definitions
Tautuhi Matua

Air-tightness: is the degree to which the building envelope (the exterior shell of a building, including walls, roof, and floor) is designed and constructed to prevent unintended air leakage.

Biodiversity: refers to the variety of life forms existing in a particular ecosystem, including diversity among species, genetic diversity within species, and diversity of ecosystems. Biodiversity is essential for ecosystem stability, resilience, and productivity, as well as for providing ecosystem services such as oxygen production, pollination, soil fertility, and regulation of climate and disease.

Biophilia: the incorporation of natural elements and design features to connect building occupants with nature, promoting well-being.

Building Management System (BMS): a computerised control system for management of various building systems, such as heating, ventilation, air conditioning (HVAC), lighting, power, and security. BMS assist in optimising performance, enhancing energy efficiency, and providing occupant comfort.

Building for Climate Change programme (2020): launched by MBIE to reduce carbon emissions from buildings over their entire lifespan. In the coming years, MBIE will put caps on energy use in new buildings and the carbon that can be emitted and embodied when constructing, maintaining and demolishing buildings.

Building Information Modelling (BIM): is an advanced form of computer aided design used as a collaborative and data- rich platform for architects, engineers, contractors, and other stakeholders to work together more efficiently and effectively. Please refer to https://www.autodesk.com/solutions/aec/bim

Business As Usual (BAU): refers to the continuation of existing practices and operations within an organisation without significant changes or efforts to improve sustainability. It implies a focus on the near-term, regardless of future environmental consequences.

Carbon offsetting: counterbalancing one's own carbon emissions by supporting projects or initiatives that either decrease or absorb a comparable volume of carbon in a different location.

Carbon footprint: the total amount of greenhouse gases emitted during the production, transportation, and use of building materials and energy.

Climate Change Commission (He Pou a Rangi): provides the Government of the day with advice, monitoring and reporting that supports New Zealand's transition to a climate-resilient, low emissions future.

Climate Change Response Act (2002): the legal framework that enables New Zealand to develop policies to limit global warming to 1.5° Celsius above pre-industrial levels; and allow New Zealand to prepare and adapt to the effects of climate change.

Commissioning: the systematic process of ensuring a building's systems are designed, installed, and function correctly to meet operational needs while enhancing energy efficiency and occupant comfort.

Conditioned space: an indoor area within a building that is actively heated, cooled, or otherwise regulated to maintain specific temperature, humidity, or air quality conditions for comfort or functionality.

Cradle-to-Cradle design: an approach to design that considers the entire life cycle of a product, aiming for materials that can be fully recycled or re-purposed.

Cross Laminated Timber (CLT): is a type of engineered wood product that is used in construction as an alternative to traditional building materials like concrete, steel, and masonry. CLT is known for its sustainability, strength, and versatility in building design.

Ecosystem services: the benefits that humans obtain from ecosystems, including clean water, pollination of crops, flood mitigation, air purification, and recreational opportunities.

Embodied carbon (upfront carbon): carbon emissions from the production of building materials, transportation of materials, emissions through the construction stage through to building occupation.

Embodied carbon (use stage): carbon emissions from the maintenance of the building. (i.e., cleaning, repairing and replacing building elements).

Embodied carbon (End of Life): carbon emissions from the deconstruction/demolition, processing and disposal of building materials.

Embodied carbon (Whole of Life): all carbon emissions mentioned above.

Greenhouse gases (GHGs): gases in the Earth's atmosphere, that trap heat from the sun, leading to the greenhouse effect and contributing to global warming and climate change. Significant GHG include water vapour, CO2, methane (CH4), and nitrous oxide (N2O).

Indoor Air Quality (IAQ): strategies to maintain clean and healthy indoor air through ventilation, low-VOC (volatile organic compounds) materials, and pollutant control.

IPPC (Intergovernmental Panel on Climate Change): an international scientific body established by the United Nations to assess and provide authoritative information on climate change, its impacts, and potential adaptation and mitigation strategies.

Life Cycle Assessment (LCA): an analysis of the environmental impact of a building or product over its entire life cycle, from production to disposal.

Mass timber structure: a type of building construction using large timber load-bearing and non-load-bearing elements, such as solid wood panels or laminated timber beams,

MBIE (the Ministry of Business, Innovation and Employment): a government agency responsible for policies supporting economic growth and improving the living standards of New Zealanders. This includes building regulations.

National Adaptation Plan (2022): sets out how the Government will respond to climate risks identified in the first National Climate Change Risk Assessment, and overall objectives for climate adaptation in New Zealand.

Nature-based Solutions (NbS): refer to approaches that utilise nature and natural processes to address various societal challenges, such as climate change and biodiversity loss.

Net Zero carbon: the amount of CO2 and other greenhouse gases (GHGs) emitted into the atmosphere is balanced by the amount removed from the atmosphere by reducing emissions, sequestering carbon or offsetting emissions.

Net Zero water: a water management approach that aims to balance water use with water capture and reuse, reducing reliance on external water sources.

Operational carbon: refers to the carbon dioxide (CO2) emissions produced by the ongoing energy consumption and activities of a building or facility, typically associated with heating, cooling, lighting, and other operational aspects.

Passive solar design: using the building's orientation and materials to maximize natural heating and cooling, reducing the need for mechanical systems.

R-value: The common abbreviation for describing the values of both thermal resistance and total thermal resistance. It is a measure of a material's or building component's ability to resist the flow of heat through it.

Renewable energy: energy derived from sources that can be naturally replenished, such as solar, wind, and hydroelectric power.

Thermal bridging: refers to a situation in a building's construction where a pathway or material allows heat to flow more easily between the interior and exterior environments. This negatively impacts the building's thermal performance and leads to moisture-related issues (mould, condensation etc.).

Universal design: an approach to creating products, environments, and spaces that are usable and accessible to people of all abilities and characteristics without the need for adaptation or specialised design.

Urban cooling island effect: an ecosystem service where localised cooling of urban areas is produced by green spaces.

Zero Energy building: is a highly energy-efficient structure that is designed to produce as much energy on the building site as it consumes over the course of a year.

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Context
Horopaki

Otaki Pool, Architecture HDT(2017)

Sport NZ is a kaitiaki (steward) of the play, active recreation and sport system in Aotearoa New Zealand. As a Crown entity, Sport NZ promotes and supports quality experiences in play, active recreation and sport to improve levels of physical activity and, through this, ensure the greatest impact on wellbeing for all New Zealanders.

Sport NZ has identified the need for clear, practical guidelines to help **Territorial Authorities and** sport and recreation organisations navigate the range of issues relating to environmental sustainability that affect spaces and places for play, active recreation and sport (referred to as spaces and places) in Aotearoa New Zealand.

Sustainability is a broad and complex topic. These guidelines apply specifically to the environmentally sustainable inception, design, construction and operation of spaces and places. They have been prepared for Sport NZ by a team of consultants and a project steering group selected from industry stakeholders, including tangata whenua. They are intended to help organisations identify and adopt sustainability measures that will:

1. help to improve present operations
2. support decision-making for future investment.

Read these guidelines together with other guides and strategies on the Sport NZ Spaces & Places webpage https://sportnz.org.nz/spaces- and-places/

If the design and the work is sustainable, so too will be the outcome.

He kaitiaki a Sport NZ o te purei, te tākaro me te pūnaha hākinakina i Aotearoa. He umanga kāwanatanga a Sport NZ, ka whakatairanga, ka tautoko hoki i ngā wheako kounga i roto i te purei, te tākaro me te hākinakina hei whakapai i ngā taumata kori tinana, ā, mā roto mai i tēnei, ka whakaū i te pānga nuitanga ki te hauora mō te katoa o Aotearoa.

Kua kite a Sport NZ i te hiahia mō ngā aratohu mārama hei āwhina i ngā rōpū whakahaere hākinakina me te tākaro i roto i ā rātou whakahoahoatanga me ā rātou whakahaeretanga o ngā wāhi me ngā takiwā toitū mō te hākinakina me te tākaro. He kaupapa whānui, whāroa hoki te toitūtanga, ka whai wāhi atu ko ngā take e hāngai ana ki te toitūtanga o te taiao ka whai pānga ki ngā wāhi me ngā takiwā i Aotearoa. Kua whakaritea tahi- tia ēnei aratohu e tētahi kāhui mātanga hāpai i te taha o tētahi rōpū mahi i tohua e te hunga whaipānga nō te ahumahi, me te tangata whenua. Ko te whāinga ia mā ēnei e āhei ai ngā rōpū whakahaere ki te tohu me te whakamahi i ngā ine toitūtanga hei:

1. whakapai i ngā whakahaere o te wā nei me te
2. tautoko i te whakataunga o ngā takiwā me ngā wāhi kia rite mō tētahi āpōpō rerekē ake nei.

Kia toitū ngā whakaaro, kia toitū ngā mahi, ka toitū ngā hua.

Four key sustainability concepts are conveyed in these guidelines:

Sustainability First: considering and implementing sustainable practice is no longer a nice to have. Aside from applicable regulatory requirements, it is essential for the operational resilience, financial viability and long-term cost effectiveness of spaces and places.

Whole of Life: all projects must be considered in terms of their long-term consequences. This applies to positive and negative impacts on the community and environment that spaces and places have over the life of the asset, and also to the affordability of operating facilities in the future.

Needs Assessment: thinking and acting sustainably requires reducing excess and effectively utilising our resources. Careful consideration of needs, as opposed to wants, should guide decision making, with particular focus on the needs of potential future users of spaces and places.

Context: facilities don't operate in isolation but as parts of larger systems - social, cultural, transport, ecological and economic. Finding solutions that not only minimise negative impacts but create win- win outcomes for the wider community requires working with a wide range of stakeholders and expertise as early as possible in the project.

E whā ngā kōrero toitū matua kei roto i ēnei aratohu.

Toitūtanga tuatahi: Ehara te whai whakaaro me te whakatinana i ngā mahi toitū i tētahi moemoeā noa iho. Hāunga ētahi o ngā here whakaritenga, me mātua whai wāhi mō te roanga o te whakahaere me te hāngai o ngā utu i ngā takiwā me ngā wāhi.

Oranga katoa: me ata whai whakaaro ngā kaupapa katoa e ai ki ngā utu pae tawhiti. E hāngai ana tēnei ki ngā pānga pai, me ngā pānga kino ki te hapori me te taiao o ngā taki-wā me ngā wāhi ka whai hononga, ka mutu, te utu pai mō te whakahaere i ō mātou whare i te inamata.

Hāngai ki te mahi: ko te taha whakaaro me te taha mahi o te toitūtanga ka ū mēnā ka whaka heke i te hau, ā, ka whakanga- ko i te whakamahinga o ā mātou rauemi. Me āta whai whakaaro ki ngā hiahia, tērā i ngā manako, ka noho tērā hei ārahi i ngā whakataunga, ka kaha aro ki ngā tūpono hiahia o te hunga ka whakamahi i ngā takiwā me ngā wāhi i te inamata.

Horopaki: e kore ngā whare e whakahaer- etia takitahitia, engari ka noho hei wāhanga o ētahi pūnaha nui ake – ā-hapori, ā-hauropi hoki. E kitea ai he urupare ka whakaheke i ngā pānga kino me te whakakaha i ngā hononga ki te horopaki whānui, me whai wāhi wawe mai ko tētahi whānuitanga o ngā hunga whaipānga me ngā pūkenga i te wāhanga whakahoahoa kaupapa.

1.1
Why is sustainability important to spaces and places?
Ngā wāhi & ngā takiwā me ngā take toitūtanga

There is a need to improve the performance of spaces and places to reduce negative environmental impacts, including greenhouse gas emissions, and to create spaces and places fit for a profoundly different future.

What is sustainability?

The United Nation's Brundtland Commission (1987) provides the most widely used definition of sustainability, as a way of living which:

'Meets the needs of the present generation without compromising the needs of future generations.'

It is likely that for future generations the uses of spaces and places, and the environmental conditions in which they will operate, will be markedly different from our own.

This will likely impact our current expectations for spaces and places, and influence where capital is best spent. So, a rigorous assessment of current and future needs, with long-term thinking applied to all project decision making, is needed.

How does sustainability impact spaces and places?

In March 2023, the sixth report of the International Panel on Climate Change (IPPC- SYR, 2023), concluded that current and future generations will be living in a hotter world to the one we currently know. Globally, average climate and weather extremes will shift further and further away from what we recognise as 'normal'. From an Aotearoa New Zealand perspective, the Auckland floods (January 2023) and Cyclones Hale (January 2023) and Gabrielle (February 2023) are indicative of weather extremes exacerbated by climate change. These events caused widespread disruption to populations, livelihoods, and the environment, including impacts on physical activity resulting from damage to spaces and places.

In Aotearoa New Zealand, the Climate Change Response Act is committed to a 50% reduction of net greenhouse gas (GHG) emissions below 2005 levels by 2030. GHG emissions relate to spaces and places in terms of their operations (mainly transportation impacts and non-renewable energy use) and in the emissions embodied in the materials used to create and maintain them. It is worth noting that the MBIE's Building for Climate Change programme suggests that reporting on both operational and embodied carbon emissions may be required for new buildings as early as 2025.

In parallel, the National Adaptation Plan and the Climate Change Commission accept some level of climate change is already 'baked in' and we now need to adapt to that. Sea-level rise and extreme weather events – such as storms, heat waves and heavy rainfall - will impact where spaces and places are situated and how they are designed and operated.

But, climate change is only one aspect of planetary change driven by human activities that sustainable spaces and places needs to address. Water supply, biodiversity, pollution and land-use change are all affected by and, in turn, have an influence on various types of spaces and places. Sustainable projects explain their impact on these factors, and how these factors will impact future generations' operation and enjoyment of spaces and places.

The benefits of sustainability

A commitment to sustainability will challenge decisions made over capital costs and require wide-ranging behavioural changes. The earlier decisions are made, the greater the benefits of sustainability. These include:

- Leaving the environment no worse (preferably better) than it was found.
- Delivering higher quality and more financially efficient facilities.
- Meeting expectations of mana whenua, customers, and funders.
- Reducing Whole of Life costs.
- Greater resilience to maintaining operations under adverse conditions.
- Ensuring compliance with evolving sustainability requirements.
- Increasing the ability to meet international sustainability criteria for hosting events.
- Improved intergenerational appeal.

Alongside the benefits gained by spaces and places organisations through sustainable practices, is the positive impact on communities and society as a whole. Addressing sustainability-related challenges will see long-term positive influences on our collective health and wellbeing: physical, mental, cultural, economic, and environmental.

Your organisation's sustainability vision

Collectively our approach to sustainability is changing, but it needs be faster and more comprehensive. So, establishing a challenging but achievable sustainability vision is crucial.

All sport and recreation organisations should develop their own sustainability visions. Unique to the environmental, economic, and social context of each organisation, this vision will provide a framework for future decision making.

1.2
Four key sustainability concepts
E whā ngā kōrero toitū matua

To achieve your organisation's sustainability vision, your spaces and places approach needs to address four key sustainability concepts:

- **Sustainability First**
- **Whole of Life**
- **Needs Assessment**
- **Context**

Sustainability first

Collectively, we are coming to understand the urgency of prioritising sustainability. In general, the construction industry is making progress with this, initially with improvements in energy efficiency (which aim to reduce operational GHG emissions) and, more recently, with greater awareness of embodied carbon.

However, sustainability measures are largely seen as cost-prohibitive or actions that can be put off to a later date. So, sustainability is regarded by some as a project trade-off, to be managed alongside budget and scope. This needs to change, with project sustainability objectives becoming fundamental to decision making. Developing a clear sustainability vision, with achievable project objectives is important.

Examples of this approach include:

- Reducing GHG emissions by improving energy efficiency and making informed material choices.
- Making a step-change in water management by reducing consumption and minimising discharges.
- Reducing all waste going to landfill and developing a culture of re-use and recycling.

Very soon environmental sustainability will be mandatory for all facility developments, and also critical for the successful operation of spaces and places. Projects that get ahead and establish a sustainability-first approach will future-proof their organisations and spaces and places.

Whole of Life approach

Incorporating Whole of Life principles into your sustainability vision is an important part of long-term thinking. While this requires more up-front work (and associated cost), the results will be long-term benefits for operators and users.

Understanding the social and environmental impacts of spaces and places over their entire lifespan - from design and construction, through operations, to end-of-life and subsequent recycling and reuse is also important.

Examples of this approach include:

- Setting strategic aspirations for reducing GHG emissions.
- Accounting for operating and maintenance costs and how they will be funded over time.
- Considering the preparation needed for resilience against future extreme weather events (flooding, storms, coastal erosion, and heat waves).
- Considering material maintenance, durability and lifespan (including what happens to them at end-of-life).

Life Cycle Assessment (LCA) is a methodical process for assessing Whole of Life costs and is becoming a standard tool for design teams to use. There are several software packages and online.

Fundamentally, the most sustainable development is no development at all - in many cases a new facility should be the last option. The following Danish priority hierarchy can help you with your decision making:

1. Collaborate/co-habit with a nearby community facility
2. Refurbish the organisation's existing facility
3. Re-purpose an existing facility

   Accounting for up-front investments in, for example, greater energy efficiency, which can deliver substantial dividends over the life of a facility.
4. Build new if there are no other adequate solutions.

Excellent guidance on Life Cycle Assessment principles is available through the Building Research Association of NZ.

Needs assessment

A rigorous and critical needs assessment should feature in the early stage of each project. This will inform your decisions on whether to commit to a new facility in the first place, or develop alternative approaches, such as adapting existing facilities.

Ensure you agree to the 'why' of the project (instead of the 'what') with all stakeholders from the start. Revisit and re-emphasise the 'why' throughout the project stages to guide thinking and decision making.

Build new if there are no other adequate solutions

In certain contexts, though, a new facility may be the most sustainable option. It can provide extended service life, improvements in participant experience, significant improvements in operational running costs, and capacity for future flexibility with associated community benefits and revenue generation.

However, it is important that all other avenues are investigated before a new facility is committed to. These options are described in more detail as follows:

Collaboration

- Develop the project with early identification, engagement, and co-ordination between potential partners such as local authorities, schools, healthcare providers, local and residing iwi, and the private sector.
- Align with the key sustainability objective of meeting future needs by creating integrated multifunctional facilities.
- Investigate sharing facilities to reduce the total amount of construction activity, thus reducing overall embodied GHG emissions.
- Promote a network approach that can lead to the creation of activated, connected communities.
- Increase utilisation of a facility, which provides more revenue to operate and maintain (financial sustainability) but also means you are getting more out of the existing.

Refurbish

- Upgrade building services to reduce energy and water use can generate significant operational savings.
- Design changes to the layout of a facility to extend the life of existing facilities and provide functional flexibility, expanding the range of potential users and therefore revenue generating potential.
- For playing fields, intensive field maintenance with adequate recovery time can restore the playing quality of a natural turf playing surface.

Re-purpose

- Upgrade existing buildings to accommodate completely different activities from their original function. Consider community facilities, unused commercial or industrial premises.
- Consider compromises. Both refurbishment and re-purposing may call for more flexibility in specification by sport and recreation organisations, including compromises in court dimensions, floor finishes and the scale of spectator facilities. Refer to the Edgar Centre case study.
- When synthetic turf surfaces are removed, a single-sport surface can be replaced with a multi-sport surface to encourage a wider range of uses and user groups.

Context

Addressing the challenges of sustainability requires taking a holistic approach, encompassing the wider physical and social surroundings of the facility, both current and future. This involves developing mutually beneficial relationships with local systems (ecological, cultural, climatic, transport, and economic) to improve the resilience of the facility as conditions change in the future.

Taking account of these systems from the outset of the project also helps ensure they are not compromised by the development and become contentious issues if not addressed properly. Some examples of context include:

Ecological

The development site presently plays, or historically played, a role in an ecosystem, which may not be immediately apparent. This includes a role in providing essential natural services such as flood mitigation, shade/shelter, water purification, air filtration and provision of biodiversity. In both urban and rural contexts, biodiversity is under pressure, so it is important any opportunity to rekindle, protect and enhance biodiversity is incorporated into the project. Consultation with mana whenua and local stakeholders is an essential part of understanding the inherent ecological value of any site.

Cultural

Embedding a mātauranga Māori approach into the process for planning, developing, operating, and improving spaces and places for physical activity is a deliberate shift towards an approach grounded in cultural narrative that descends from the land.

This approach can deliver positive outcomes for the environmental biodiversity, but also elevates the priorities of mana whenua and Māori to the same status as everyone else in the community. For example, agreeing to remove a facility or not build a facility on an urupa or wahi tapu means we are giving the same importance to that land as we would to a cemetery or religious or sacred land.

Working in a cultural context, provides an opportunity for learning and development for those involved with spaces and places planning and development. If done well, it can also ensure spaces and places can support the aspirations of mana whenua for their lands and subsequently improved wellbeing outcomes for their people and communities.

Climate

The vulnerability of the facility to climate change can be better understood by studying the site in its larger geographic context. This relates to critical issues such as potential flood plains (where any new development as a rule should be avoided), locations susceptible to erosion (either impacting the site directly or indirectly), exposure to extreme wind and rain, as well as sea level rise.

Transport

The location of new facilities should support and align with local strategies to reduce fossil fuel emissions. These include current or planned public bus routes, cycle paths, walkways, as well as co-location with schools or other institutions who could utilise the facility, and proximity to residential areas and future residential areas. Aligning the location of a new facility with these strategies also contributes to creating activated, connected communities.

2

Project Stages
Hātepe o te Kaupapa

2.1 Who these guidelines are for and how to use them

Mō wai tēnei puka ārahi me pēhea te whakamahi i ēnei aratohu

These guidelines have been created to help organisations involved in play, sport and active recreation define what sustainability means to them and ensure their spaces and places projects achieve their sustainability objectives. These guidelines are structured around the key project stages of project concept and planning, design, construction and operation.

Who these guidelines are for?

These guidelines are for anyone interested in the environmentally sustainable design, construction and operation of spaces and places. You could be part of a local authority involved in long-term planning, sport and active recreation organisation – looking at upgrading facilities or constructing new ones, or a member of the public – the ultimate beneficiary of spaces and places.

To help organisations to quickly identify the information most relevant to them, the guidance is divided into the following project types:

1. New build aquatic centres
2. New build dry sport facilities
3. Outdoor recreation and play spaces (including fields, parks, golf courses)
4. Existing aquatic facilities
5. Existing dry sport facilities

How to use these guidelines

The guidelines are structured around the four key stages of most spaces and places projects:

1. Project Concept and Planning
2. Design
3. Construction
4. Operation

Because sustainability objectives should flow through all four stages, checklists for each stage are included to help guide the actions needed as a project proceeds.

You will also find supplementary information on commonly used sustainability rating tools and case studies from the five spaces and places project types. The case studies include embodied and operational carbon modelling, where applicable, which demonstrate the impact of specific sustainability approaches.

More information on Whole of Life carbon costs, potential funding sources, trends in sustainable spaces and places, and best practice building fabric standards can be found in the appendices.

Importantly, sustainability must be considered holistically - making changes in one area impacts performance in another. Eight interconnected sustainability themes run throughout the guidelines:

1. Energy
2. Materials
3. Water
4. Transport
5. Ecology
6. Wellbeing
7. Communities
8. Economy

A second set of checklists (set out as tables), which you can find in the Appendices, addresses each of these themes. These will help you quickly assess the relevance and the impact of a particular theme on your project. The actions having the greatest sustainability impact are at the top of the table, followed by preferable sustainability actions, in descending order.

Before you use the project stage checklists, see the general introduction to the context of sustainability for spaces and places. The introductory material will assist organisations to identify the sustainability issues most relevant to their activities and explain the four key sustainability concepts described in these guidelines.

Project stage checklists

to access checklists for project use, by stage

Sustainability theme checklists

to target particular aspects of sustainability

Project concept and planning
Tīmata kaupapa

Needs assessment

Establish the 'why' of the project (instead of the 'what')

Needs assessment can significantly affect the sustainability outcomes of a project by ensuring options other than a new facility are considered first. Options include:

1. Collaborate/co-habit with nearby community facilities
2. Refurbish the organisation's existing facility
3. Re-purpose another existing facility
4. Build new if there are no other adequate solutions

Site selection

For projects considering new-build or re-purposing of an existing building

Points to check when selecting a site include:

- Climate change risk - flood, sea level rise, erosion, storm exposure
- Previous uses - check for site contamination, land fill, extraction activities, liquefaction risk, etc
- Cultural issues - consult mana whenua* for any cultural significance or constraints attached to the land
- Biophysical properties - sensitive habitat, opportunities for renewable energy (solar, wind)
- Highly Productive Land - avoid conversion of fertile agricultural land
- Space for future expansion
- Ground source heat recovery
- Compatibility with neighbouring land-use activities
- Present land zoning and possible re-zoning
- Integration with public transport routes (bus, cycle, pedestrian)
- Integration with potential partner organisations for facility share and community connectivity

* Mana whenua are Māori who have historic and territorial rights over the project area

Sustainable transport

Reduce the organisation's carbon footprint

Sustainable transport includes vehicles delivering supplies, transportation of teams and spectators to venues, as well as everyday use of spaces and places. Consider:

- Site selection/layout that encourages active modes of transport like walking and cycling
- Provision for low-carbon alternatives:
  - public transport
  - ride-sharing, car pooling, mini-bus provision
  - EV parking/charging

Sustainability vision

Develop a holistic sustainability vision to support all future decision making

Key concepts for developing a sustainability vision:

- Sustainability first
- Needs assessment
- Whole of Life approach
- Context

Sustainability champion

Essential to the implementation of organisation's sustainability vision

Appoint a sustainability champion for your organisation with the following qualities and objectives:

- A passion for sustainability
- Existing sustainability knowledge or a desire to learn
- Authority to influence decision making and develop teamwork
- Communicate sustainability goals and performance to the organisation and to stakeholders and receive feedback
- Implement initiatives, ensure adherence to vision and track progress

Energy · Materials · Water · Transport · Ecology · Wellbeing · Community · Economy

Sustainability audit

Establish where you are at present in terms of sustainable performance

Carry out baseline assessments of:

- Energy - a useful tool for establishing your carbon footprint is the NZ government's Climate Action Toolbox https:// www.tools.business.govt.nz/climate/
- Water consumption
- Waste production

Sustainable rating tools

Provide a framework and set of criteria to assess the sustainability performance of a project

A variety of tools available to rate the sustainable performance of facilities are available.

- Determine the appropriate tool for the project - refer to Sections 2.2 and 4.3 for additional guidance.
- Decide if the project wants to comply with standards set by the tool or to actually achieve certification
- Will help set ambitious yet achievable targets across key sustainability indicators, whether certification is pursued or not

Stakeholder consultation

Consult the wider community to ensure long term viability of the project

Suggested groups to include:

- Mana whenua
- End-users
- Neighbours
- Community groups
- Local authorities
- National bodies and affiliates
- Existing and potential funding bodies

Project brief

The guiding document for the project, identifying function, budget and timeline

Points to include in the project brief include:

- Set out the context of the project
- Details the functional and spatial requirements of the proposed
- project as they respond to an identified need
- Site requirements (if not already selected)
- Project team - establish the project team with representatives from the organisation's different interests
- Mana whenua and other stakeholders
- Targeted end-users
- Project budget - including consultants' and regulatory fees
- Delivery timeline - divide into design, tendering, construction and intended operational date
- Expected sustainability outcomes - including overall energy strategy
- Key project risks

Design team

Key expert advice is recommended from project inception through to an agreed period of operation

The following factors should be considered when appointing a project design team:

- Key consultants (for a building project) - architect, landscape architect, structural and civil engineers, MEP (mechanical, electrical and plumbing) engineers, fire consultant, quantity surveyor (for cost control expertise) and planning consultant
- Experience - look for experience not only in delivering projects but in delivering sustainability focused projects
- Communication and reporting - appoint a lead consultant who will be the point of contact between the organisation and design team
- Interdisciplinary - delivering sustainable projects requires a diverse set of expertise - it is critical that all the various skills and disciplines work in synergy with each other and not in isolation
- Timing - the lead consultant (typically the architect for building projects) should be engaged as early as possible; a quantity surveyor should also be engaged as early as possible so that project expectations remain in line with affordability

● Energy ● Materials ● Water ● Transport ● Ecology ● Wellbeing ● Community ● Economy

Design
Whakahoahoa Whare

Site

Sustainable transport All transportation associated with spaces and places	Consider the following in terms of regular use of spaces and places: • Provision of parking/charging spaces for EVs, including e-bikes • Provision of sheltered and secure bike parking, close to main entrance • Provision of accessible parking close to entrance and sheltered ramps • Links to active transport routes beyond the site boundaries
Habitat integration Understanding the project's place in the wider ecological context	Determine existing ecology and pre-development ecology through stakeholder and expert consultation. Develop site layout to respect existing biodiversity and restore, protect and enhance habitat. Develop an ecological management plan that documents: • Site ecology and context • Strategy and actions taken • Measures of success • Required maintenance
Biophysical site conditions Understanding the project's specific climate and environmental context	Determine climate characteristics: • Prevailing wind and storm directions • Solar orientation • Site microclimate (wind shelter, urban cooling island effect) Determine environmental characteristics: • Check previous land use for possible contamination • Ground bearing, subsidence risk • Flooding risk (riverine flooding and increased risk due to sea level rise) • Consider site drainage needs and how that fits into the catchment outside the site • Erosion / landslide risk (including neighbouring and upstream properties) • Topsoil - minimise earthworks through smart facility layout, store and protect all excavated topsoil • Site topography - determines exposure to weather, flood paths, slope stability; consider design options that are sympathetic to existing landforms
On-site renewables Consider the feasibility of on-site renewable energy generation	The range of potential renewable energy options in New Zealand include: • Solar photovoltaics (PV) - either on roof or on ground-mounted stands • Solar thermal - usually a roof-mounted solar water heater • Wind - depends on location's wind resource • Ground-sourced heat pump - uses stable underground temperature for heating / cooling. • Geothermal - extraction of hot water is limited but in areas with geothermal activity pre-heating solutions may be feasible • Collaboration and integration with neighbours and community renewable energy systems should also be investigated

Energy · Materials · Water · Transport · Ecology · Wellbeing · Community · Economy

Nature based solutions (NBS)

Using nature and natural processes as a solution to project challenges

NBS can be applied to a wide range of project challenges, including:

- Stormwater systems integrated with artificial wetland systems, swales and green roofs
- Wastewater (grey and black) treatment integrated with artificial wetlands
- Cooling provided by evapotranspiration from woody vegetation groupings and evaporation from water
- Shelter from prevailing winds and storms with strategically located tree planting

Regard for neighbours

Identify neighbours likely to be affected by construction works and subsequent usage

Measures to mitigate impact on neighbours include:

- Carry out a noise assessment (maybe required by a consent) to inform local residents of the impact of new or extended playing/ use hours
- Ensure floodlights meet obtrusive spill guidelines to minimise im- pact on neighbours
- Be flexible with target/preferred lux levels of floodlights
- Physical works (such as retaining and earthworks) close to residential and/or commercial boundaries should be brought to the attention of relevant parties

Building Envelope

Building form

The shape and orientation of the building

Aspects of building form to consider include:

- Minimising the amount of earthworks and foundation design through the design of the building
- Positioning the building in an east-west orientation, aligning the longer side of the structure towards the north to maximise use of sunlight and solar heating
- Design the building's mass to reduce the ratio between the external surface area (envelope) and the overall building volume to reduce energy use
- Locate building and consider form in relation to site topography to reduce exposure to extreme weather
- Be mindful of the impact of building form on neighbours - obstruction of views and funneling of wind

Passive ventilation

Natural or non-mechanical ventilation using the principles of convection and pressure differentials

The building design should consider the following points to optimise natural ventilation:

- Building orientation - understand prevailing winds and external factors (such as trees, pollution sources) affecting air flow
- Cross-ventilation/natural ventilation paths - ensuring flow of air is essential to natural ventilation
- Openings - it is critical that opening sizes and locations are calculated specifically to meet the natural ventilation strategy
- Shading and solar control - coordinate with the passive solar design of the building form to ensure windows used for ventilation don't lead to overheating
- Seasonal adjustments - account for different requirements for ventilation throughout the year
- Airtightness - when openings are closed building airtightness may need to be strictly controlled, depending on the mechanical systems used to heat and cool the building

Highly insulated and airtight

For better building interior performance in winter and summer

Aspects of insulation and airtightness to consider include:

- High levels of insulation - to future-proof against changing building regulations and to reduce energy use. Good insulation is more effective in controlling cold/hot extremes than expensive HVAC systems
- An airtight building shell reduces energy required to heat and cool interior spaces
- Pay close attention to thermal bridges - parts of structure that bridge between building exterior and interior - as areas particularly susceptible to condensation damage

Energy · Materials · Water · Transport · Ecology · Wellbeing · Community · Economy

Natural light Provision of daylight to interior spaces reduces dependence on artificial lighting and improves comfort	Glazing, orientation, and building form should be designed to: • Optimise natural light influx while minimising unwanted solar heat gains and glare (for example, reflections in pool halls) • Locate spaces needing optimal daylight on external walls • Explore opportunities such as light-wells, light pipes and roof-lights to bring daylight to the centre of the building
Materials Embodied carbon	The emissions embodied in the materials used to create and refurbish facilities. • The carbon used in the supply of materials to a project is called 'upfront' carbon; during the building operational life embodied carbon is categorised as 'use stage' carbon; 'end of life' carbon accounts for demolition disposal of building materials • Measured using Life Cycle Analysis (refer 1.3) • Clear understanding of embodied energy implications of the building design (refer 4.4) • MBIE's Building for Climate Change program suggests that reporting on embodied carbon emissions may be required for new buildings as early as 2025
Materials Re-use & local supply	Consider all opportunities for using: • Recovered and recycled materials • New Zealand produced sustainable materials, which reduce travel distances and help support local suppliers
Materials Hazardous	Consider the entire supply chain of materials used: • Avoid the use of materials such as paints, adhesives and coverings that release volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs) during construction and also into operations • All hazardous and toxic material use should be minimised - it will eventually need to be disposed of • Bear in mind the non-toxicity of the end-product doesn't mean there has been no exposure to toxins during the manufacturing process • Natural materials, sourced from responsible supply chains, should be used where appropriate • Green labeling initiatives (such as Declare, Environmental Choice New Zealand (ECNZ) and GreenTag) can assist with identifying potentially harmful products
Materials Composting	Implement on-site composting and compost use for all organic waste generated during construction (food waste, removed vegetation) and operations.
Materials Natural turf	• Choose turf types and specifications suitable for the climate and intended use • If using an irrigated turf, consider drainage water capture and on-site treatment for re-use • Choose turf types suitable for the sport field construction type proposed • Consider maintenance requirements • Consider major renovation works and periods to revitalise the turf surface and how that interacts with sport seasons
Materials Artificial turf	Artificial turf technology is moving quickly with a high degree of differentiation between suppliers. Issues to consider include: • Whether governing body certification is required • Whether removing micro-plastics and rubber from the surface is important • Whether alternative/natural infill materials are acceptable or if no-infill systems are preferred • Determine whether the turf surface needs to be suitable for multiple sports • Decide if an unlimited-use warranty is important • Decide if a surface type that can be supplied by multiple manufacturers is important • For hockey, consider dry surfaces given the recent decision by the International Hockey Federation to stop using irrigated surfaces at international level

Energy · Materials · Water · Transport · Ecology · Wellbeing · Community · Economy

Materials

Hard-court surfaces

- As the options are really asphalt or concrete, LCA/Whole of Life costs is an important consideration
- Alternative materials need to be carefully selected to avoid negative interactions with acrylic surfaces, such as fly ash and fibrecrete
- Recycled aggregates are highly suitable as sub-base material, but for top layers each load will require testing
- Consider drainage water interception and treatment if intended for use as irrigation

Materials

End-of-life

Take responsibility for the entire supply chain of materials used:

- For components needing replacement over the lifetime of the facility, the materials should be chosen on the basis that they can be recycled at the end of their useful life, reducing waste going to landfill
- Use construction methods that allow for deconstruction

Playgrounds

In this highly competitive market, most suppliers provide sustainability credentials, for example, products made from recycled materials and/or products that are easily recyclable at the end of product life

- Use locally sourced products with locally sourced materials
- Building play spaces that are future proofed and can be changed as play trends change
- Maximise use of existing landforms and features to minimise earthworks
- Maximise potential to integrate or enhance local ecology
- Consider an approach to nature play - using trees, fallen trees etc. as the basis for play, rather than plastic and steel structures

Services

Energy strategy

An overall energy and GHG reduction strategy should be developed for the facility

This strategy includes the following components:

- Energy audit and baseline assessment
- Operational energy efficiency measures
- Clear understanding of embodied energy implications of building services design (refer 4.4)
- Renewable energy opportunities
- Battery storage systems
- Building Management Systems (BMS)
- Passive design measures (high levels of insulation, airtightness, solar orientation, integration with landscaping etc)
- Low-carbon transportation strategies
- Education, monitoring and reporting measures

Zoning

Co-locate heat producing areas to enhance energy efficiency

To optimize temperature control, it is advisable to cluster rooms with high temperatures, while utilizing areas with lower temperatures as buffers to minimize heat dissipation to the outside. Additionally, it is essential to insulate adjacent walls and/or provide adequate ventilation for to reduce the unintended exchange of heat and moisture.

Waste heat recovery

Utilising energy given off by equipment that would ordinarily be wasted

Identify heat sources and sinks such as:

- Heat recovery opportunities from high temperature exhaust air from the pool hall. Heat can be recovered with heat exchangers or heat pump systems
- Simultaneous heating and cooling loads can be served highly efficiently within the same facility, or between nearby sites

Plant location

Location of building services equipment

Locations of plant should consider the following:

- Maintenance access - placement of plant areas for ease of access, minimal disruption of activities, and public safety
- Minimising of ductwork and pipework runs, thus reducing material use and energy use
- Minimising the adverse effects of pollution and noise on the well- being of occupants or users

Energy · Materials · Water · Transport · Ecology · Wellbeing · Community · Economy

Greywater Water that has been used for activities such as showering, washing hands, dishwashing, and laundry	The feasibility of greywater re-use involves: • Collection normally requires a parallel pipework system (which incurs extra cost) • Filtration and/or treatment (to local authority standards) • Storage • Re-use - typically for irrigation systems and/or toilet flushing
Rainwater harvesting Rainwater that falls on rooftops and other surfaces	The feasibility of rainwater re-use involves: • Collection - ensure roof material and gutter design is adequate • Filtration and/or treatment (to local authority standards) • Storage - match tank capacity to the intended use (e.g., irrigation, toilet flushing, and/or drinking water) or stormwater attenuation • Maintenance - gutters, filters and tanks require regular cleaning • and, depending on end use, water quality will need to be tested • Re-use - typically for irrigation systems and/or toilet flushing
Building Management Systems (BMS) A computerised system for monitoring and controlling various building operations and equipment	A BMS can be applied to projects of all sizes, and can include the following systems: • Lighting linked to motion sensors • Automated lighting and heating, ventilation & air conditioning (HVAC) systems to maintain comfort and reduce energy use • Security and access • Data analysis - can provided key feedback on building performance and sustainability efforts • Fire safety BMS should not be overly complicated and should suit the level of management skills available.
HVAC Heating, ventilation and air conditioning	HVAC systems should be designed considering energy usage and occupant comfort. In terms of specific facility types: Indoor aquatic facilities: • Require HVAC systems that provide humidity control as well as temperature control. This is essential to control energy usage and prevent damage from condensation on the building • Heat recovery systems should be used to minimise energy usage Indoor sport facilities: • Should carefully consider the intended range of activities before HVAC systems are designed • Some community courts facilities can be naturally ventilated and unheated (or heated to low levels) and provide a suitably comfortable environment for their use • Others may require more energy intensive space heating and cooling
Irrigation	• Determine water use requirements and water balance model • Identify if irrigation water can be sourced from on-site harvesting, storage and treatment • Consider sub-surface irrigation to maximise water use efficiency • Consider water retentive materials being incorporated into growing media to decrease irrigation demand • Include rain sensors to ensure irrigation system do not operate after or during rainfall events • For water-based turfs, ensure uniformity is optimised and the most efficient water cannons/ sprinklers are used to reduce water waste

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Drainage	• Consider appropriate drainage for the local climate and intended use • Determine if existing drainage catchment devices (ie, dams on golf courses) have the capacity for more drainage water • The more free-draining the surface, the greater the irrigation and nutritional demand • Soil-based fields with overland drainage offer low levels of use • Sand-based fields with sub-soil drains and sand slits (or equivalent) enable all-weather use • Consider alternatives to sand, such as recycled glass • Unless locally sourced, sand comes at a high embodied carbon cost • Artificial turf drainage systems can vary widely. Ensure it is designed to the local conditions and will operate effectively under high rainfall events • Consider field drainage water capture options for re-use on the same field or ancillary areas (eg, garden beds)
Lighting Artificial lighting systems, indoors and outdoors	The lighting design should consider: • Space usage – competition facilities often have higher lighting requirements to host events, whereas community facilities may not require the same investment in lighting • Consider modern lighting control systems that can save energy, like daylight harvesting, occupancy sensing, and automatic lighting scheduling • Utilise the most energy efficient options (such as LEDs) and control systems that minimise the activation of floodlights • Design to the most stringent obtrusive light (light spill) regulations to minimise adverse effects on neighbours • Consider ease of maintenance (for example, base-hinged poles for external lights) to ensure maintenance is carried out appropriately and regularly, keeping the lights in their optimum working condition • For flood resilience, place electronics higher up the light pole
Refrigerants Substances or compounds used in refrigeration and air conditioning systems to facilitate the trans- fer of heat	Commonly available heat pump refrigerants often have high global warming potential (GWP). Issues to be aware of include: • Some refrigerants have lower global warming potential but require more refrigerant for an equivalent heat output compared to other refrigerants, so the total refrigerant liability of the system should be considered, not the GWP in isolation • Consider using heat pumps with very low GWP, reducing total heating/cooling demands to reduce plant size, sharing heat pump systems between combined heating and cooling loads • Consider a rigorous maintenance regime for any heat pump systems • Note that refrigerants also contribute to the operational carbon footprint for the facility

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Construction
Waihanga

Site waste management plans (SWMP)

Sets out strategy and actions to reduce waste generated, and to recycle and reuse waste that is created

A SWMP has the following key features:

- Specifies who is responsible for managing waste on site
- Records and monitors targets, including highlighting the amount of waste sent to landfill
- Describes recycling/reuse methods for each material type
- Describe special measures and precautions for material use and handling

Earthworks minimisation

Topsoil is a valuable, irreplaceable resource

All possible efforts should be made to:

- Reduce the amount of cut and fill on site
- Re-use site-won materials to limit off-site disposal and associated vehicle movements
- Protect, retain and re-use existing topsoil, including conservation of biological properties (cover rather than expose to UV light and rain/wind, which reduces organic matter)

Construction nuisance

Reduce impacts of construction activities on the surrounding community and ecology

Strategies and actions include:

- Dust control
- Control sediment run-off, which can cause waterway/public drainage issues, by providing appropriate silt fences, earth bunds, and stabilized site entry points to prevent vehicles tracking soil onto roadways
- Manage all emissions, including noise, smoke, and odours

Commissioning

Effective commissioning is vital to ensure building services are operating efficiently and are delivering expected performance

Commissioning should be carried out by an experienced and qualified consultant. It is recommended that an Independent Commissioning Agent (ICA) is appointed. Elements that need commissioning include:

- Mechanical and electrical systems
- BMS systems and trending/reporting systems that provide support for maintenance and long term troubleshooting of the mechanical and electrical systems
- Fire protection and suppression systems
- Lifts
- Automatic opening windows
- Solar shading devices
- Renewable energy systems

Commissioning should also confirm that the project's Operation and Maintenance (O&M) manual is complete and accurate.

● Energy ● Materials ● Water ● Transport ● Ecology ● Wellbeing ● Community ● Economy

Operations
Whakahaere Whare

Operation and Maintenance (O&M) Manual

A manual compiled by the design team to provide a summary overview of the facility and how to operate and maintain it over its lifetime

The O&M manual should include:

- Operational and maintenance instructions for all building, infrastructure, utilities and equipment components of the project
- Instructions on how to achieve the sustainable performance goals targeted by the project
- Records specifications and supplier contact details of all significant items of plant and equipment, including commissioning reports
- An ecological management plan for the site should be included so that guidelines for the management and maintenance of biodiversity features are embedded in the facility's operation
- Development of a comprehensive maintenance plan for the facility, which enables clear understanding of cost implications of keeping the facility in top condition

Staff training and checklists

Sustainability training for the facility's building systems and sustainability practices is included at staff inductions and regularly updated

Staff sustainability documentation should consider:

- Integration with general staff training material so that sustainability practices are seen as integral to facility operation, not a nice to have extra
- Walk-round check lists to ensure straightforward monitoring and recording of sustainability features and targets

CIBSE Soft Landings

Extended facility handover phase developed by Chartered Institution of Building Services Engineers (CIBSE)

Carry out CIBSE Soft Landings to improve the transition from the design and construction phase to the operation of a facility. This has the objectives to:

- Optimise the facility systems performance
- Familiarise end-users with facility systems
- Develop a clear understanding of performance expectations and how to monitor performance

Monitoring

Ensuring the facility meets the sustainability aspirations it was designed for

Monitoring activities may include:

- Developing a routine for reading meters regularly for analysing energy and water use
- Ensure that meter data is regularly backed up and stored in a separate location/system to the facility's BMS system, and that as much historic metering data is protected/recorded as possible – a minimum of 12 continuous months of data should be easily accessible by facility management staff
- Recording agreed metrics to measure waste management and site biodiversity
- Benchmarking against similar facilities
- Identifying unexpected changes in consumption patterns or environmental impact

Education and engagement

Utilise the place of play, active recreation and sport in Aotearoa New Zealand to influence the wider community

Staff and facility users communications should promote sustainability practices:

- Placards, information panels and/or touch-screen panels should be placed around the facility to demonstrate the importance of collective action in operating a sustainable facility and to educate the public on environmental impacts
- Display sustainability goals and performance (in real time, if possible)
- Provide interface for public inquiries and suggestions in relation to sustainability practices
- Promote and market the sustainability success stories to provide case examples of what is working well

Energy · Materials · Water · Transport · Ecology · Wellbeing · Community · Economy

Pool covers

Consider the use of pool covers during the nighttime to mitigate heat and water loss while enabling a reduction in nighttime ventilation rates. When choosing pool cover materials, it's important to exercise caution to prevent the release of Semi-Volatile Organic Compounds (SVOCs).

Landscape management

Sprays and mowing

- Utilise energy-efficient vehicles (electric and hybrid electric) to limit fossil fuel use
- Plan maintenance operations to ensure efficiency of vehicle traffic routes and movement
- Utilise organic and environmentally recognised consumables such as fertilizers and sprays
- Minimise use of chemical sprays, especially near sensitive receiving environments (this may impact on plant and turf species selection)
- Carry out regular agronomy checks for the early identification of disease pressure and nutrient deficiency
- Consider reducing regularity of mowing or not mowing some areas

Supply chain

The impact of purchasing upstream to downstream

Sports and recreation organisations are significant consumers of mass-produced goods such as sporting equipment, and via spectator events generate significant amounts of organic and inorganic waste.

Consideration should be given to:

- Upstream impacts - the environmental and social impact of where and how consumable goods are made
- Downstream impacts: limit the use of single use items/packaging, and consider the toxicity and environmental impacts of cleaning products etc
- Green labeling initiatives (such as Declare, Environmental Choice New Zealand (ECNZ) and GreenTag) can be used to assist both upstream and downstream decision-making
- On-site water fountains to reduce plastic water-bottles
- On-site recycling bins and -site composting
- Swap programmes for shoes, uniforms and equipment

Transport

Ongoing facilitation of sustainable transport options

Keep staff and users of spaces and places informed of opportunities for low-carbon transport options by:

- Displaying and keeping updated public transport routes/timetables
- Managing car-pooling or minibus options
- Ensuring pedestrian and cycle paths are well maintained, including lighting as appropriate

Facility operators

Include in the contracts with facility operators some sustainability clauses and reduction targets.

End of Life

What happens to the facility at its end of life

Spaces and places should be designed with their End of Life in mind. Some areas worth considering include:

- Design for disassembly, incorporating modular and easily detachable components to facilitate disassembly
- Choose materials that are durable, recyclable, and environmentally friendly
- Identify opportunities to provide reusable or salvageable materials from the building
- Design the building with flexibility and adaptability to support future changes in use or occupancy
- Integrate with the LCA strategy for the project, including a system to track building materials, components, and maintenance records

Energy Materials Water Transport Ecology Wellbeing Community Economy

2.2
Sustainability theme tables

Energy
Rārangi Ngao

Energy / Rārangi Ngao	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	Cost	Benefit
1. Measure operational carbon							
• Measure or estimate baseline operational carbon	●	●	●	●	●	$	✔✔✔
2. Reduce energy use							
• Energy strategy (including clear target setting)	●	●	●	●	●	$	✔✔✔
• Review the impact of existing behaviour on energy use	●	●	●	●	●	$	✔✔✔
3. Prioritise re-purpose and refurbishment of existing assets							
• Re-purpose or adapt existing building to satisfy need	●	●	●	N/A	N/A	$$+	✔✔✔
• Refurbish or modify existing building fabric	N/A	N/A	0[1]	●	0[2]	$$+	✔✔
• Replace fossil fuel consumption with electric and/or renewables	N/A	N/A	0[1]	●	0[2]	$$	✔✔✔
4. Passive principles first							
• Use building orientation, form, fabric and landscape to optimise lighting, heating, cool and ventilation	●	0[2]	0[1]	0[3]	0[3]	$$+	✔✔✔
• Pools covers	●	N/A	N/A	●	N/A	$$	✔✔
5. Provide monitoring and control of existing building services							
• Improve monitoring and control of lighting, ventilation and heating to reduce energy use	●	●	0[1]	●	●	$	✔✔
• Building Management Systems (BMS)	●	●	0[1]	●	●	$$	✔✔✔
• Heat and electrical energy metering systems	●	0[2]	0[1]	●	0[2]	$	✔✔
6. Fine tune with easily controlled, efficient building services							
• LED lighting and controls (including floodlights), solar pedestrian lights	●	●	0[1]	●	●	$+	✔
• Natural and mechanical ventilation systems	●	●	0[1]	●	0[2]	$$	✔✔

● Applicable
0[1] Associated buildings only
0[2] Lower energy profile, therefore less relevant
0[3] Existing building, therefore reduced opportunity for significant change
0[4] To be considered alongside lighting requirements of particular sports

Energy **Rārangi Ngao**	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	**Cost**	**Benefit**
7. Incorporate on-site renewables appropriate to site							
• PV and solar hot water panels	●	●	0[1]	●	●	$$+	✔✔
• Ground/air/water source heat pump and heat recovery	●	0[2]	0[1]	●	0[2]	$$+	✔✔✔
• Wind power	●	0[2]	●	●	0[2]	$$$	✔✔
8. Use off-site renewables							
• Investigate shared energy use with other facilities	●	●	●	●	●	$$$	✔✔+
9. Offset Carbon (last resort)							
• Offset remaining carbon with recognised scheme	●	●	●	●	●	$$$	✔
10. Verification and Advocacy							
• Publicly disclose/display of facility's operational carbon	●	●	●	●	●	$	✔✔✔
• Comprehensive O&M manual covering energy use strategies, equipment, and monitoring	●	●	●	●	●	$	✔✔✔

● Applicable
0[1] Associated buildings only
0[2] Lower energy profile, therefore less relevant
0[3] Existing building, therefore reduced opportunity for significant change
0[4] To be considered alongside lighting requirements of particular sports

Materials
Rārangi Rawa

Materials / Rārangi Rawa	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	Cost	Benefit
1. Measure embodied carbon							
• Measure or estimate baseline embodied carbon	●	●	●	●	●	$	✔✔✔
2. Prioritise re-purpose and refurbishment of existing buildings							
• Re-purpose or adapt existing building to satisfy need	●	●	●	N/A	N/A	$$+	✔✔✔
• Refurbish or modify existing building fabric	N/A	N/A	0[1]	●	0[2]	$$+	✔✔
3. LCA							
• Undertake LCA from early stages of project to drive better long term decision making	●	●	●	●	●	$	✔✔✔
4. Material use							
• Prioritise materials with low embodied carbon	●	●	●	●	●	$$	✔✔✔
• Use ethically sourced, re-cycled and/or locally sourced materials	●	●	●	●	●	$$	✔✔✔
• Consider durability and the end of life impact of materials used	●	●	●	●	●	$$	✔✔✔
• Avoid hazardous materials (including coatings)	●	●	●	●	●	$$	✔✔✔
5. Facility design							
• Robust facility design for long- life (exceed code minimum)	●	●	●	0[3]	0[3]	$$	✔✔✔
• Design multifunctional facilities, adaptable to different uses	●	●	●	0[3]	0[3]	$$	✔✔✔
6. Waste minimisation							
• Target zero construction waste diverted to landfill	●	●	0[1]	●	●	$$	✔✔
• Consider modular, off-site construction systems	●	●	0[1]	●	●	$$	✔✔✔
• Design buildings for disassembly and re-use	●	●	0[1]	●	●	$$	✔✔✔
7. Verification and advocacy							
• Publicly disclose embodied carbon of facility	●	●	●	●	●	$	✔✔✔
• Comprehensive O&M manual covering materials and components maintenance	●	●	●	●	●	$	✔✔✔

● Applicable
0[1] Associated buildings only
0[2] Lower energy profile, therefore less relevant
0[3] Existing building, therefore reduced opportunity for significant change
0[4] To be considered alongside lighting requirements of particular sports

Water
Rārangi Wai

	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	Cost	Benefit
1. Measure water use							
• Measure or estimate baseline water consumption	●	●	●	●	●	$	✔✔✔
• Provide metering to monitor, assess and set targets	●	●	●	●	●	$	✔✔✔
2. Reduce water required							
• Consider higher water efficiency pool filtration systems	●	N/A	N/A	●	N/A	$	✔✔✔
• Consider pool backwash system capture and reuse	●	N/A	N/A	●	N/A	$	✔✔✔
• Optimise water/air temperature (minimize evaporation)	●	N/A	N/A	●	N/A	$	✔✔✔
• Water based heat rejection systems (i.e. no cooling towers)	●	●	0[1]	●	●	$$	✔✔✔
• Provide low flow sink and WC fixtures and timer-based showers	●	●	●	●	●	$	✔✔✔
• Consider landscape/ turf design to minimise irrigation	●	●	●	●	●	$	✔✔✔
• Provide leak detection	●	●	●	●	●	$	✔✔✔
3. Capture							
• Capture and reuse sprinkler test water	●	●	0[1]	●	●	$$	✔✔
• Capture and reuse rainwater for irrigation	●	●	●	●	●	$$	✔✔
4. Stormwater / Wastewater							
• Maximise on site stormwater retention	●	●	●	0[3]	0[3]	$$	✔✔✔
• Consider a networked approach to flood mitigation	●	●	●	0[3]	0[3]	$	✔✔✔
• Provide on-site grey or black water treatment and recycling	●	●	●	0[3]	0[3]	$$$	✔✔
5. Verification and Advocacy							
• Publicly disclose/display potable water use of facility	●	●	●	●	●	$	✔✔✔
• Comprehensive O&M manual covering water use strategies, equipment, and monitoring	●	●	●	●	●	$	✔✔✔

● Applicable
0[1] Associated buildings only
0[2] Lower energy profile, therefore less relevant
0[3] Existing building, therefore reduced opportunity for significant change
0[4] To be considered alongside lighting requirements of particular sports

Transport **Rārangi Waka**	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	**Cost**	**Benefit**
1. Network							
• Consider network approach to provision of spaces and places	●	●	●	N/A	N/A	$	✔✔✔
2. Site							
• Prioritise site selection with good proximity to complementary functions, public transport, user base, schools and cycle networks	●	●	●	●	●	$	✔✔✔
• Leverage opportunities of adjacent sites for car parking overflow	●	●	●	●	●	$	✔✔✔
3. Amenities							
• Provide end of travel facilities for users and staff (showers, lockers and secure cycle parking)	●	●	●	●	●	$	✔✔✔
4. Electric vehicles							
• Provide infrastructure for electric vehicles	●	●	●	●	●	$$	✔✔✔
5. Pedestrians and cycleway							
• Provide high quality and safe pedestrian and cycleway links	●	●	●	●	●	$	✔✔
6. Verification and advocacy							
• Complete post occupancy evaluation survey and publicly disclose	●	●	●	●	●	$	✔✔✔
• Comprehensive O&M manual covering transport strategies, equipment, and monitoring	●	●	●	●	●	$	✔✔✔

● Applicable
O[1] Associated buildings only
O[2] Lower energy profile, therefore less relevant
O[3] Existing building, therefore reduced opportunity for significant change
O[4] To be considered alongside lighting requirements of particular sports

Ecology
Rārangi Hauropi

	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	Cost	Benefit
1. Site							
• Prioritise site re-use (brownfield)	●	●	●	●	●	$	✔✔✔
• Account for site microclimate in location of facilities and functions	●	●	●	0^3	0^3	$	✔✔✔
• Integrate the facility with site topography to reduce cut/fill and minimise topsoil disturbance	●	●	●	0^3	0^3	$	✔✔✔
• Carry out sustainable remediation of site pollution	●	●	●	0^3	0^3	$$+	✔✔✔
• Select eco-friendly chemical sprays/ fertilisers and minimise leaching to groundwater	●	●	●	●	●	$	✔✔✔
• Engage with mana whenua and other stakeholders to understand historic ecological value of site	●	●	●	●	●	$	✔✔✔
2. LCA							
• LCA used to inform landscape design for best Whole of Life concept	●	●	●	●	●	$	✔✔✔
3. Biodiversity							
• Aim to leave site in better ecological condition than pre- development	●	●	●	0^3	●	$$	✔✔✔
• Undertake ecological assessment of site, noting ecosystem services provided by the site to local community	●	●	●	●	●	$$	✔✔✔
• Ecological management plan, promoting enduring synergies with local ecosystems & biodiversity strategies	●	●	●	●	0^3	$$	✔✔✔
4. Landscaping							
• Create a range of easy to maintain green spaces, coordinated with biodiversity strategies	●	●	●	0^3	0^3	$$	✔✔✔
• Composting and/or food production integrated with landscaping	●	●	●	0^3	0^3	$$	✔✔✔
• Integrate nature based solutions with on-site wastewater and stormwater management	●	●	●	0^3	0^3	$	✔✔✔
• Select species for resilience and adaptation to climate change	●	●	●	0^3	0^3	$	✔✔✔
5. Verification and advocacy							
• Comprehensive O&M manual incorporating ecological management plan	●	●	●	●	●	$	✔✔✔

● Applicable
0^1 Associated buildings only
0^2 Lower energy profile, therefore less relevant
0^3 Existing building, therefore reduced opportunity for significant change
0^4 To be considered alongside lighting requirements of particular sports

Wellbeing
Rārangi Hauora

	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	Cost	Benefit
1. Creating active environments							
• Integrate / collaborate with or linking to other local active spaces	●	●	●	●	●	$	✓✓✓
• Design spaces that are inclusive and universally accessible	●	●	●	●	●	$	✓✓✓
• Place cycle parking closest to the entry	●	●	●	●	●	$	✓✓
• Design welcoming and visible staircases and ramps	●	●	0[1]	0[3]	0[3]	$	✓✓
2. Nature-connected design (Biophilia)							
• Design spaces featuring natural materials such as timber and stone	●	●	0[1]	●	●	$	✓✓✓
• Provide indoor daylighting to connect users to changing time of day and weather	●	0[4]	0[1]	●	0[4]	$	✓✓✓
• Incorporate views of natural elements like greenery, water bodies, or landscapes	●	●	0[1]	0[3]	0[3]	$$	✓✓
3. Comfort							
• Provide spaces with simple controls for ease of use and maintenance that can expand and contract to provide flexible uses	●	●	0[1]	●	●	$	✓✓✓
• Design spaces with excellent indoor air quality	●	●	0[1]	●	●	$	✓✓
• Design spaces to adaptive thermal comfort standards	●	●	0[1]	●	●	$	✓✓✓
• Design spaces with good acoustics	●	●	0[1]	●	●	$$	✓✓
• Provide places for pedestrians and spectators to sit, incorporating rain and shade structures/elements	●	●	●	0[3]	0[3]	$$	✓✓
4. Verify							
• Provide clear user feedback mechanisms to continuously improve the facility's features and publicly disclose this	●	●	●	●	●	$	✓✓✓

● Applicable
0[1] Associated buildings only
0[2] Lower energy profile, therefore less relevant
0[3] Existing building, therefore reduced opportunity for significant change
0[4] To be considered alongside lighting requirements of particular sports

Communitiy
Rārangi Hapori

	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	Cost	Benefit
1. Community Connection							
• Enhance local identity and sense of place though mana whenua, stakeholder engagement and design which reflects the wider community	●	●	0[1]	●	●	$	✓✓✓
• Consider synergies with schools and other community centres (existing & proposed)	●	●	●	●	●	$	✓✓✓
• Carry out a needs assessment to ensure the facility is well used and meets the needs of its community	●	●	●	●	●	$	✓✓✓
2. Social							
• Create shared spaces & places that encourage people – often from diverse backgrounds – to meet naturally	●	●	●	●	●	$	✓✓✓
• Provide multifunctional facilities that will adapt to changing community demands	●	●	●	●	●	$	✓✓✓
• Create a high quality public realm at arrival and entrance to the facility	●	●	●	●	●	$$	✓✓✓
3. Safety							
• Ensure personal security outside and inside the facility with adequate lighting and good passive surveillance	●	●	●	●	●	$	✓✓✓
• Create secure places for privacy, respecting genders and cultural needs	●	●	●	●	●	$	✓✓✓
4. Verify							
• Provide clear user feedback mechanisms to continuously improve the facility's features and publicly disclose this feedback	●	●	●	●	●	$	✓✓✓

● Applicable
0[1] Associated buildings only
0[2] Lower energy profile, therefore less relevant
0[3] Existing building, therefore reduced opportunity for significant change
0[4] To be considered alongside lighting requirements of particular sports

Economy
Rārangi Ōhanga

	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility	Cost	Benefit
1. Whole of Life							
• Consider future escalation of running costs in all decision making	●	●	●	0[3]	0[3]	$	✔✔✔
• Use LCA to assess cost / benefit of capital investments	●	●	●	●	●	$	✔✔✔
• Carrt out operation modelling to account for depreciation and to create a sinking fund for future asset renewals	●	●	●	●	●	$	✔✔✔
• Provide multifunctional facilities with flexibility to accommodate alternative revenue streams	●	●	0[1]	0[3]	0[3]	$	✔✔✔
2. Completion							
• Measure the operational and embodied carbon of the completed facility and publicly disclose	●	●	●	●	●	$	✔✔✔
• Measure energy, management and maintenance costs and publicly disclose	●	●	●	●	●	$	✔✔✔
• Measure occupant satisfaction and impact of the facility on their health and wellbeing	●	●	●	●	●	$	✔✔✔
• Measure added value of sustainable outcomes of building	●	●	●	●	●	$	✔✔✔

● Applicable
0[1] Associated buildings only
0[2] Lower energy profile, therefore less relevant
0[3] Existing building, therefore reduced opportunity for significant change
0[4] To be considered alongside lighting requirements of particular sports

3

Case Studies
Tauira Rangahau

The following projects have been selected as case studies due to the range of sustainability solutions they offer.

Naenae Aquatic Centre

St Sidwells Leisure Centre

Typical Community Aquatic Centre

Edgar Centre Indoor Courts

Te Kori Scott Point

Remuera Golf Club

3.1
Naenae Aquatic Centre

The Naenae Aquatic and Fitness Centre will be New Zealand's first Greenstar 5 rated aquatic centre. This case study and associated modelling compares the benefits of Greenstar and Passive House rating systems with typical aquatic facility building fabric and design (the Passive House option was not selected in the eventual building). Passive House highlights a Whole of Life approach, where slight uplift in construction cost results in significant cost savings and reduced environmental impact over the life of the project.

Client/Location:

Hutt City Council
Naenae, Lower Hutt

Case Study Stage:

Concept Design Study

Project Value:

Approx. $68M (Greenstar 5)

Features:

- 50-metre 10-lane pool
- Learners' pool
- Leisure pool
- Fitness centre

Key Metrics:

Climate Zone: 3

Floor Area: 4,680 m^2

Water surface area: 1,680 m^2

Occupants: 660

The key differences between the Greenstar 5 Base Case and the Passive House case are given in the table below:

	Greenstar 5 Base Case	**Passive House**
Mechanical Plant	Externally located within service yard - 8 no. air handling units required	Mechanical plant located within the building envelope - 5 no. air handling units required
Hydroslide	Fully external to the building	Slide tubes 50% internal, 50% external
Services Undercroft	Partially insulated	Fully insulated High performance windows, doors and skylights

Insulation R values (m2K/W):

Windows	1.1	1.25
Walls	5.00	7.15
Roofs	5.00	10.00
Air tightness	not required for Greenstar	0.4 m^{3}h/m^2 @ 50 Pa
Design EUI	900-1000 kWh/m^2 yr	600-700 kWh/m^2 yr
Leisure Pool Temperatures	Pool water: 32°C Pool hall air: 27°C	Pool water: 32°C Pool hall air: 29°C

Key Information

Key information when compared with a typical aquatic facility of the same size:

	Greenstar 5 Base Case	Passive House
Capital Cost Increase over typical	3.75%	7.26%
% Energy cost savings per annum over typical	24%	60%

The comparative Energy Use Intensity (EUI) is given on the adjacent graph. The increased efficiency of the Passive House model means that it is cheaper to own and operate over a whole 50-year building life span. Financial analysis shows implementing the Passive House approach provides cumulative cash saving of $23,900,000 (or $6,900,000 NPV) compared to the Greenstar 5 model over 50 years.

Compared to the Greenstar model, up to the year 2050 the Passive House scheme saves 20,000 tonnes of CO2e emissions from purchased electricity. This equates to needing to plant a 1000 hectare forest to offset the additional carbon of the Greenstar base case over the next 30 years. (Passive House forest shown in green outline, base case shown in red outline).

Existing Passive House aquatic centres typically operate with the air temperature two degrees warmer than the water temperature. The reason is twofold:

- It minimises the amount of pool water evaporation and therefore heat loss within the space (and also reduces water use). Reduced evaporation also leads to reduced ventilation air change rates, therefore reduced air handling requirements and energy use.
- It maximises user (children and supervising parents in the water) comfort by eliminating the evaporative cooling effect that is commonplace in New Zealand leisure pools.

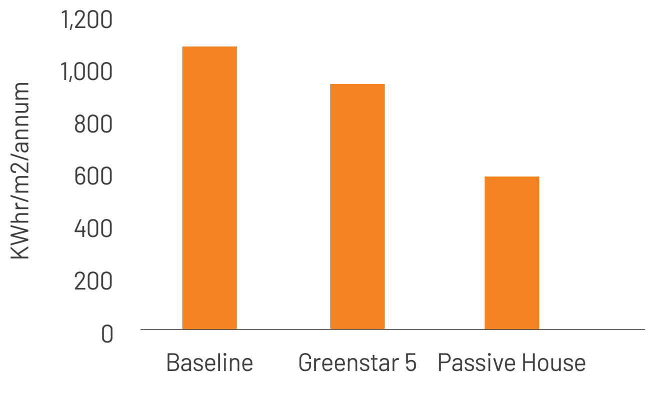
New Zealand aquatic centres typically have a greater number of casual spectators than European facilities. The operation of a facility with an air temperature at 2 degrees higher than the water temperature will therefore be a paradigm shift for pool operators as it would be likely to adversely affect lifeguard and clothed spectator comfort levels. The modelling undertaken assumes the pool and air temperatures given on the previous page.

Energy loss associated with hydroslides is significant due to their large surface area.

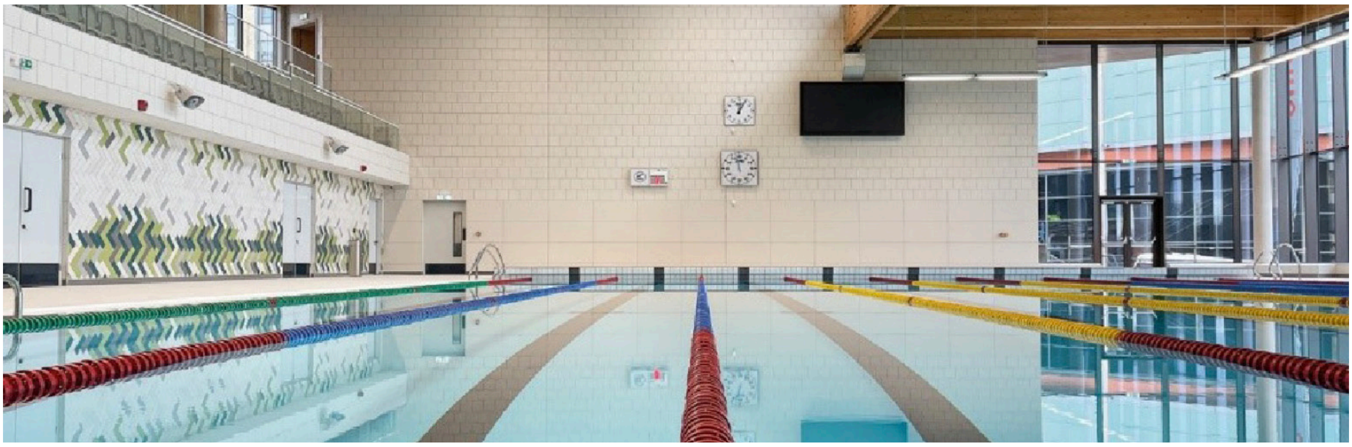
Considerable energy savings can be made by accommodating the slides within the insulated building fabric, or insulating the slides where these are outdoors.

The following graph below provides a quick summary of the energy savings for a new aquatic centre project. Annual energy use is reduced by achieving a Green Star 5-star rating, - a very high level of sustainability certification available in New Zealand. By investing further than required by Green Star in terms of building insulation and air-tightness (among other factors) to achieve Passive House certification, energy use is even further reduced. Refer to Section 2.2 for more information about these sustainability rating systems.

Comparative energy use for a proposed aquatic centre



3.2
St Sidwells Leisure Centre



St Sidwells is a recently completed aquatic and fitness centre designed to Passive House standards. Modelling undertaken by the consultant team is useful to compare with that undertaken on the Naenae Aquatic Centre to demonstrate the benefits of a Passive House approach to aquatic facility design. This case study highlights the importance of a high -quality building envelope.

Client/Location:

Exeter City Council
Exeter, England

Case Study Stage:

Opened 2022

Construction Value:

$73M (£35M)

Features:

- 8-lane 25 m main pool
- 20 m learners' pool
- Splash pool
- 175 spectator seating area
- Café
- Wellness centre / 150 station gym

Sustainability:

- Designed to Passive House standards to minimise Whole of Life operating costs.
- Designed to modelled climate change data up to 2080.
- Extremely high levels of thermal insulation were continuously detailed to avoid thermal bridging.
- Reduced evaporation led to reduced ventilation air change rates.
- Polyvalent heat pump (heats and cools simultaneously) – heat rejected from the gym used to heat pool area.
- Water source heat pump backwash water recycled to flush WCs.

Key Metrics:

Climate Zone: N/A

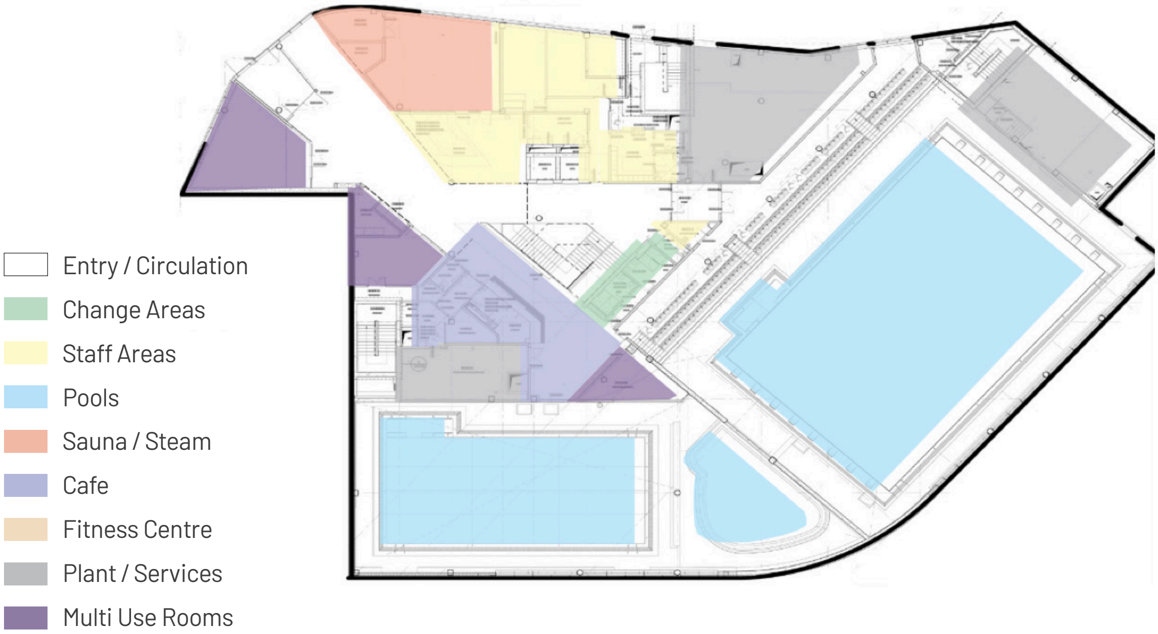
Floor Area: 4,900 m^2

Water surface area: 675 m^2

Occupants: 500-600

Insulation R values (m2K/W):

Windows	0.95
Skylights	0.95
Walls	7.1
Roofs	11.0
Air tightness	0.2 m^3h/m^2 @ 50 Pa Tested to 0.3 m^3h/m^2 @ 50 Pa
Energy Use Intensity (EUI)	375 kWh/m^2 yr Design EUI (operational EUI not available)
Temperature settings	Main pool water 28°C Learners / leisure water 30°C Air temp set 1-2°C above pool temps



Key Information

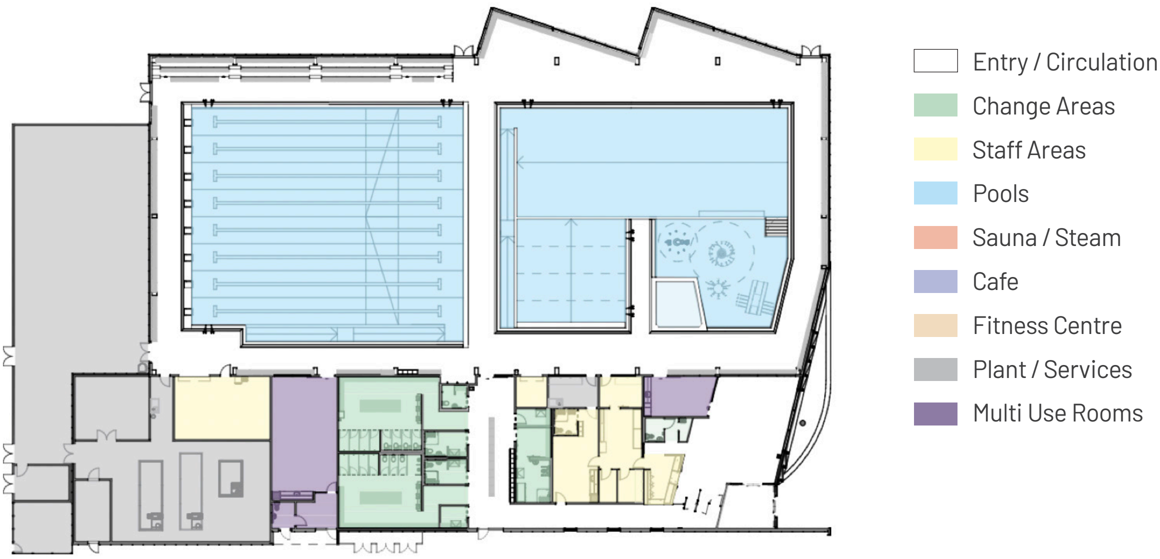
The St Sidwells facility was estimated to reduce energy costs by 60% when compared with a typical facility. The same as forecast for the Naenae Aquatic Centre.

At St Sidwells, the payback on the additional capital cost of achieving Passive House standards was forecast to be 10 years. This compares with 17 years in the case of Naenae. The forecast energy use intensity (EUI) is also significantly lower for St Sidwells (375 kWh/m2 yr compared with 600-700 kWh/m2 yr for Naenae). Key reasons for these differences are likely to be:

- As noted in the Naenae case study, the difference between air and water temperatures is significant. St Sidwells allows for the air temperature to be 2 degrees warmer than the pool water temperature. The higher temperature and relative humidity on poolside is more acceptable in European facilities.
- The St Sidwells facility has significantly less water area than Naenae (675m2 for St Sidwells, compared with 1680m2 for Naenae)
- The mix of water space at St Sidwells is predominantly structured water space. Leisure water which is warmer and is activated by water features increases energy demand and decreases the payback period. As the pool water temperature is less (typically 26-28 degrees), a higher air temperature is easier to accommodate without affecting patron comfort.

A Passive House approach requires a compact building form and solar orientation of the building to maximise solar gains. It requires careful design of the building envelope, in particular, attention to minimising cold bridging in the building fabric. This allows higher internal surface temperatures with minimised condensation risk at a higher internal relative humidity. The higher internal humidity reduces evaporation rates from pool water and the required ventilation rates are reduced (ventilation rate of 1-1.5 air changes/hour with no re-circulation), which contribute to both water and energy savings.

3.3
Typical Community Aquatic Centre



This case study uses a recently completed aquatic centre to allow calculation of the following:

- The carbon emissions profile of a typical community sized aquatic facility.
- The relative contribution of different building elements to the embodied carbon.

This case study demonstrates the relative benefit of upgrades to existing building fabric for an older facility, as well as the reduction in operational carbon expected from changing the heating source from a gas boiler to an electric heat pump.

An aquatic facility was modelled based on the Stratford Aquatic Centre as representative of a medium-scale community aquatic facility. It was modelled with weather from the Lower North Island and a fresh air dehumidification system to be representative of the most common HVAC configuration.

Construction Value:

Approx. $24M

Features:

- 25 m, 8-lane pool
- Learners' pool
- Programmes pool
- Toddler pool

Key Metrics:

Floor Area: 2,700 m^2

Water surface area: 1,000 m^2

Occupants: 600

Insulation R values (m2K/W):

Windows	0.31
Walls	5.1
Roofs	4.4
Energy Use Intensity (EUI)	600-700 kWh/m^2 yr
Temperature settings	Main Pool water: 27.5°C Programmes/ Learners/Leisure Pools: 31°C Pool hall air temp. : 24°C Relative humidity 65 %

Key Information

The below table indicates the carbon emissions impact of a typical community aquatic centre over its life time (assumed to be 50 years).

Life Cycle Stage	$kgCO_2e$ / m^2
A1-A3 Materials	774
A4 Transport	11
A5 Construction	64
B1 Use phase	526
B4-B5 Replacement	173
B6 Energy	3,244
C1-C4 End of Life	15
Total	**4807**

The carbon emissions from operating the building (3244 $kgCO_2e$ /m^2) account for 67% of the total emissions over the 50-year building life, assuming the use of an electric heat pump.

For a new build facility, modelling was undertaken to understand the difference in life cycle carbon between a gas boiler and a heat pump central energy system over a 50-year design life. The life cycle carbon for a gas boiler system was modelled at 14,610 $kgCO_2e$ /m^2, compared with 4,807 $kgCO_2e$ /m^2 for a heat pump system as given above. A significant proportion of the carbon emissions relating to a gas boiler lies in the operation of the facility - 13,531 $kgCO_2e$ /m^2 for the gas boiler, compared with 3,244 $kgCO_2e$ /m^2 for the heat pump.

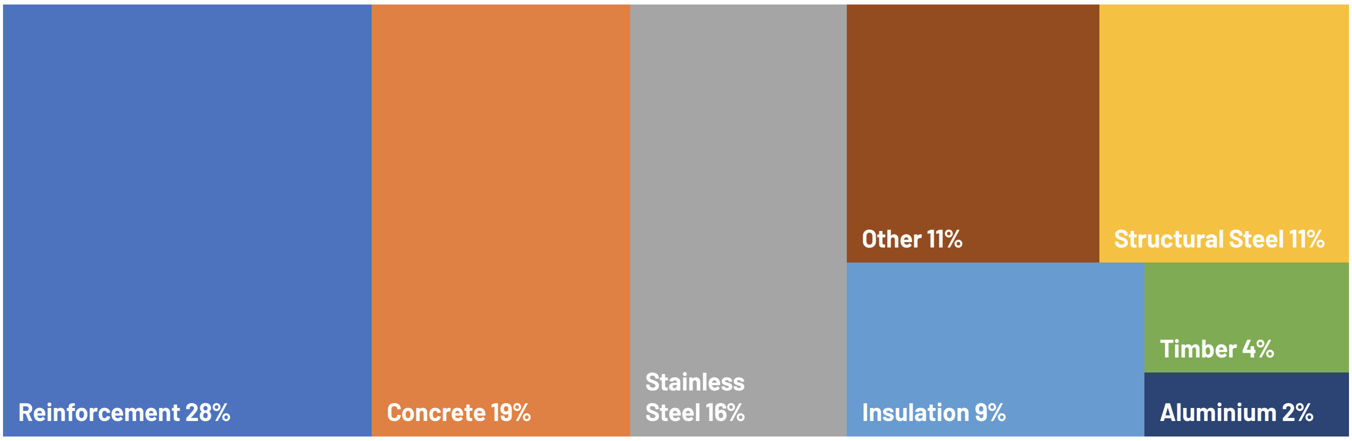
The carbon payback period for a heat pump system (i.e., the length of time required to pay back the embodied carbon associated with the change in system with the operational carbon savings it offers) is estimated to be **2.79 years.**

Older aquatic facilities (25+ years old) typically employed a foil vapour barrier and insulation batts for the roof and wall construction. The insulation values associated with this construction are significantly lower than what is obtained by the insulated panel construction more commonly used in modern aquatic centres (approximately R1.8 for foil and batts compared with R5 for insulated panels). The carbon payback period for replacing an old roof and wall fabric with new is modelled at **16.66 years**.

For owners and operators of existing facilities who are looking to improve the performance and/or carbon profile of their facility, the easy sustainability win is therefore to replace gas boilers with a heat pump system.

With older facilities (25+ years), it is likely that other factors such as the seismic resilience and condition of the primary structure, and how well the facility is meeting existing needs will affect decisions on whether to upgrade or build new. An upgrade to a heat pump energy system is likely to be considerably less intrusive than the replacement of building fabric.

The diagram below provides a breakdown of the upfront embodied within a new facility by material type.



A significant proportion (58%) of the upfront embodied carbon is associated with the primary structure (concrete, structural steel and reinforcement). The modelling assumes the base build has structural steel portals for the primary structure.

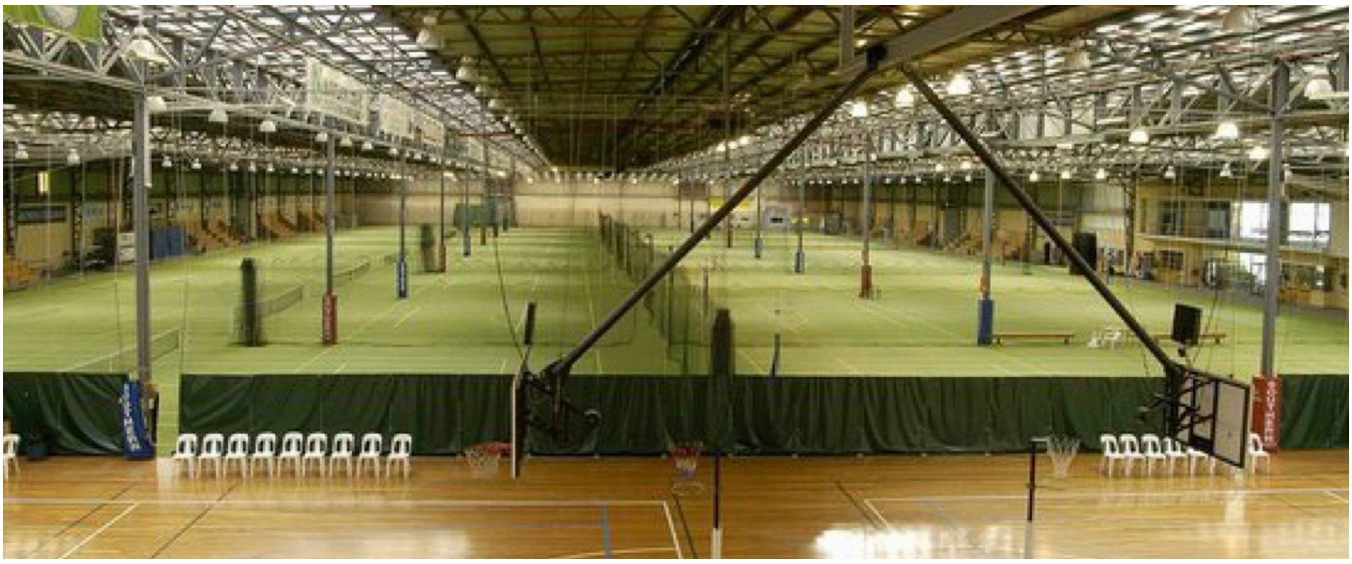
Reductions in upfront embodied carbon are therefore best targeted at primary structure, where significant savings can be made:

- **20% reduction** in upfront embodied carbon, associated with procurement of steel reinforcement from suppliers who use electric arc furnaces instead of gas boilers.
- **4% reduction** in the upfront embodied carbon associated with primary steel are achieved in the same way as reinforcing steel, by carefully considered procurement.
- **10% reduction** in upfront embodied carbon offered by the replacement of structural steel with mass timber structure. While there is a small cost premium to go to glue laminated primary structure, the Whole of Life cost is less due to the reduced maintenance requirements of timber in an aquatic environment.
- **3% reduction** in upfront embodied carbon offered by the use of low carbon concrete.

Modelling and Assumptions

- Life cycle modelling has been undertaken using One Click Life Cycle Assessment software.
- Emissions factors for materials and elements have been taken from the One Click LCA database. Where available, NZ-specific environmental product declaration (EPD) data has been used. In the absence of NZ-specific data, generic global data has been used which has been regionalized to NZ.
- Product and element service life times (that is, replacement cycles) have used One Click LCA built-in assumptions.
- Emissions factors for purchased electricity and building gas usage have been taken from 2022 Ministry for the Environment published guidelines.
- No allowance for future decarbonisation of the grid has been included.
- Refrigerant emissions are highly variable between sites. For the comparative modelling above, a high-level assumption was made for gas boiler systems as being ~20% of the refrigerant emissions from an equivalent heat pump system, to allow for equipment required to condition gym and office spaces.
- Building electricity consumption (beyond pool heating/HVAC) has been assumed to be 1.5GWh/yr. Although expected to be typical for a community aquatic facility, it is likely to vary between sites depending on design decisions.
- A coefficient of performance of 3.0 was assumed for the air source heat pumps, and an efficiency of 0.85 for a gas boiler. These are likely to be slightly conservative assumptions.
- The carbon figures and findings presented above have been calculated using specific past project examples and should not be taken to be predictive of any future project performance.

3.4
Edgar Centre Indoor Courts



The Edgar Centre is a 1970's wool store converted to a sport centre in 1996. This case study highlights the significant environmental benefits resulting from the adaptive re-use of existing buildings.

In order to demonstrate the potential scale of carbon emissions avoided through the re-use and re- purposing of an existing building, the impact of the Edgar Centre conversion was estimated and compared against an equivalent new building of the same size and function.

Client/Location:

Dunedin City Council
Dunedin

Construction Value:

N/A

Features:

- 7 basketball courts, or
- 10 volleyball courts, or
- 21 netball courts, or
- 14 tennis courts
- 16 football/futsal courts, or
- Serves as a multifunctional sport and events facility, accommodating community events, weddings, conferences as well as indoor sport.
- 14 'Tiger Turf' synthetic grass courts allow the space to be reconfigured.
- Each has markings for tennis and indoor football/futsal.
- Well-connected to public transport and active transport options.

Key Metrics:

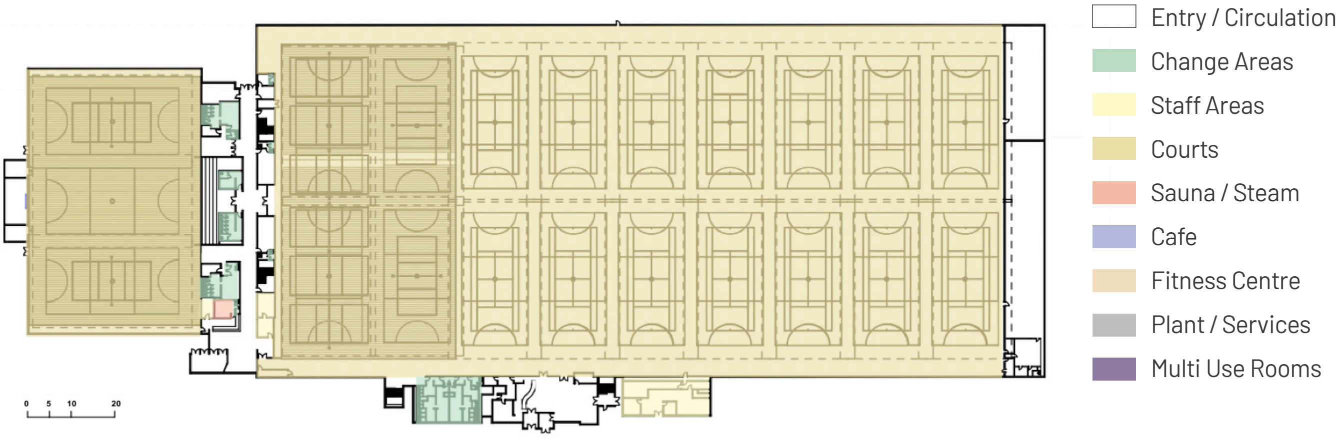
Climate Zone: 5

Floor Area: 19,350 m^2 / 14,400 m^2 usable court space

Occupants: Up to 1,600

Modelling and Assumptions:

- The new materials required to undertake the conversion and refurbishment were taken from historic project drawings, and assumed to largely comprise of minor structural strengthening, re-clad (roof and walls), and the addition of some sprung timber flooring for the courts.
- The building is assumed to be an unconditioned space, with the majority of energy consumption being from lighting. This is assumed to be the same between the new build and refurbished options so has not been incorporated into the Whole of Life comparisons.



Key Information

The table below compares the carbon impacts from building reuse when compared with an equivalent new build over a 50-year lifespan. Re-purposing buildings generally results in significant carbon emissions reductions associated with new materials and transportation.

	Adaptive Re-use	Equivalent New Build	Avoided carbon emissions
Demolition emissions	6t CO_2e	30t CO_2e	24t CO_2e
New materials and construction	2,000t CO_2e	3,600t CO_2e	1,600t CO_2e
Replacement and refurbishment over the building life	30t CO_2e	30t CO_2e	-
End of Life	30t CO_2e	30t CO_2e	-
Total	**2,066t CO_2e**	**3,690t CO_2e**	**1,624t CO_2e**

The saving in carbon emissions are significant. An adaptive re-use strategy is estimated in this case to save 1,642 tonnes of CO_2e when compared with an equivalent new build facility of the same size.

When considering the re-use of an existing facility, careful attention should be paid to the condition of the existing building. For modelling purposes, the above assumes that replacement and refurbishment over the life of the building is equivalent between a new and re-used building. The reality is that older building fabric is likely to require additional maintenance.

Adaptive re-use is more applicable to indoor dry sport facilities. It is not considered applicable for aquatic facilities due to the particular envelope and servicing requirements of these buildings.

In many cases, adaptive re-use significantly reduces the programme time associated with bringing facilities into service. It is typically better suited to community facilities where there can be greater discretion given to such things as court run-off requirements, lighting and seating capacities when compared with a competition facility.

Adaptive reuse avoids the disruption / degradation of existing ecosystems.

3.5
Te Kori Scott Point

New Zealand's first fully sustainable sport park, Te Kori Scott Point is designed to meet the needs of an Auckland community of around 20,000 new residents. It provides facilities for sport and active recreation, informal recreation as well as ecological restoration and conservation. This case study highlights the value of integrating spaces and places with the fabric of place, as well as using nature-based solutions to reduce environmental impact and operating costs.

Client/Location:

Auckland Council
Hobsonville, Auckland

Case Study Stage:

Site clearance and forward earthworks completed May 2022

Project due for completion April 2025

Construction Value:

Approx. $35M

Features:

- New Zealand's first sustainable sport park
- 2 baseball diamonds
- Footpaths / cycleways
- Infrastructure Sustainable Council's 'Leading' rating
- Ecological restoration
- Play area and hard courts
- Natural and artificial turf sport fields
- Provision for a multi-functional building

Sustainability:

Water:

- 36% reduction in water use by implementing a site-wide drainage water capture, treatment, storage and re-use methodology.
- 100% self-sufficient for non-potable water.
- Use of alternative turf types, reducing depth of sub-surface irrigation.

Energy:

- 23% reduction in direct emissions during sport field construction.
- 7% reduction in direct emissions for park maintenance.
- Total project operational GHG emission reduction of 14%.

Materials:

- 5% reduction in embodied GHG emissions.
- Use of drainage cells under No. 1 field to remove aggregate layer.
- Reduce sand carpet thickness on fields 2 and 3.
- Timber bollards instead of aluminium.
- 521m less kerb and channel due to carpark redesign.
- Mulching and hay used to stabilise ground in place of geotextiles.

All data reproduced with the permission of Auckland Council.

For more information, read the ISC reports and Auckland Council reports throughout construction: https://www.aucklandcouncil.govt.nz/plans- projects-policies-reports-bylaws/our-projects/projects-north-Auckland/ Pages/scott-point-sustainable-sports-park.aspx

Key Metrics:

Climate Zone: 1

Floor Area: N/A 16.4 ha site area

Occupants: N/A

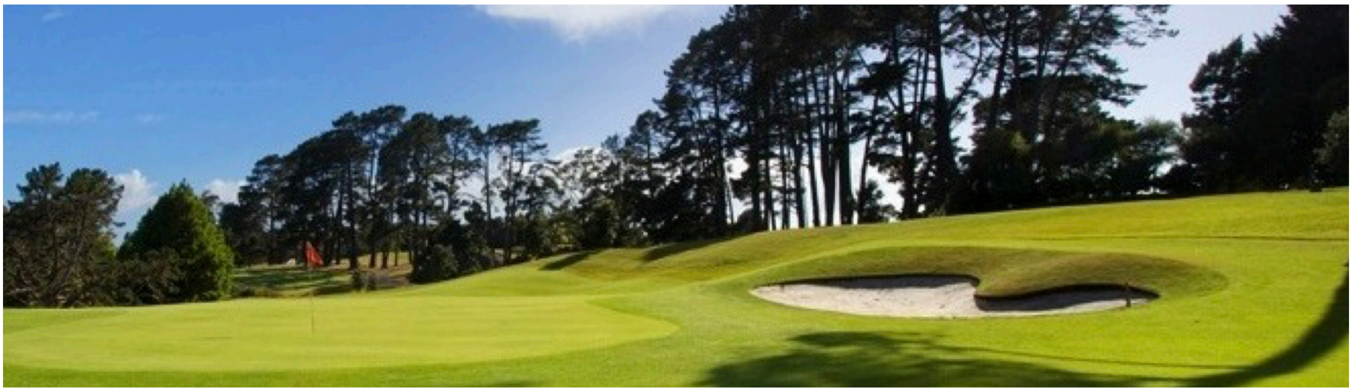
Key Information

The site-wide water capture and re-use strategy is a significant feature of Te Kori Scott Point. Following analysis of water use and potential water sources on site, a system was devised that would require zero supplementation from the town supply. This was achieved with stormwater capture and holding tanks beneath the artificial turf fields, which can be emptied on-demand into a main holding tank. Water capture from hardstand areas also feed into the main holding tank. The main turf field features its own below ground water storage and sub-surface irrigation system, reducing the need for additional irrigation water.

Biodiversity enhancement and carbon offsets were achieved by significant planting around the site. The trees provide habitat for local species while also offsetting the carbon lost when removing trees from the sport field areas. Additionally, the ‘at risk’ Epilobium hirtigerum plant species was transplanted within the site and native copper skink were provided with a safe area on-site. Since works began, the New Zealand dotterel/tūturiwhatu, an endangered shorebird, has nested and successfully reared chicks on the site.

A 90% reduction in construction and demolition waste going to landfill was achieved by completing a thorough inventory of what was existing on-site and identifying alternative waste streams and re-use possibilities for site-won material prior to works commencing. The first phase of construction works achieved 87% diversion with additional efforts being made to further analyse and identify diversion possibilities in subsequent phases to achieve the initial target.

3.6
Remuera Golf Club



Remuera Golf Club was established in 1934 and was the first golf club in New Zealand to achieve GEO Certification. This case study illustrates the opportunities for incorporating nature-based solutions to enhance the overall amenity of spaces and places, but also to provide positive impacts for the surrounding community.

Client/Location:

Remuera Golf Club
Auckland

Case Study Stage:

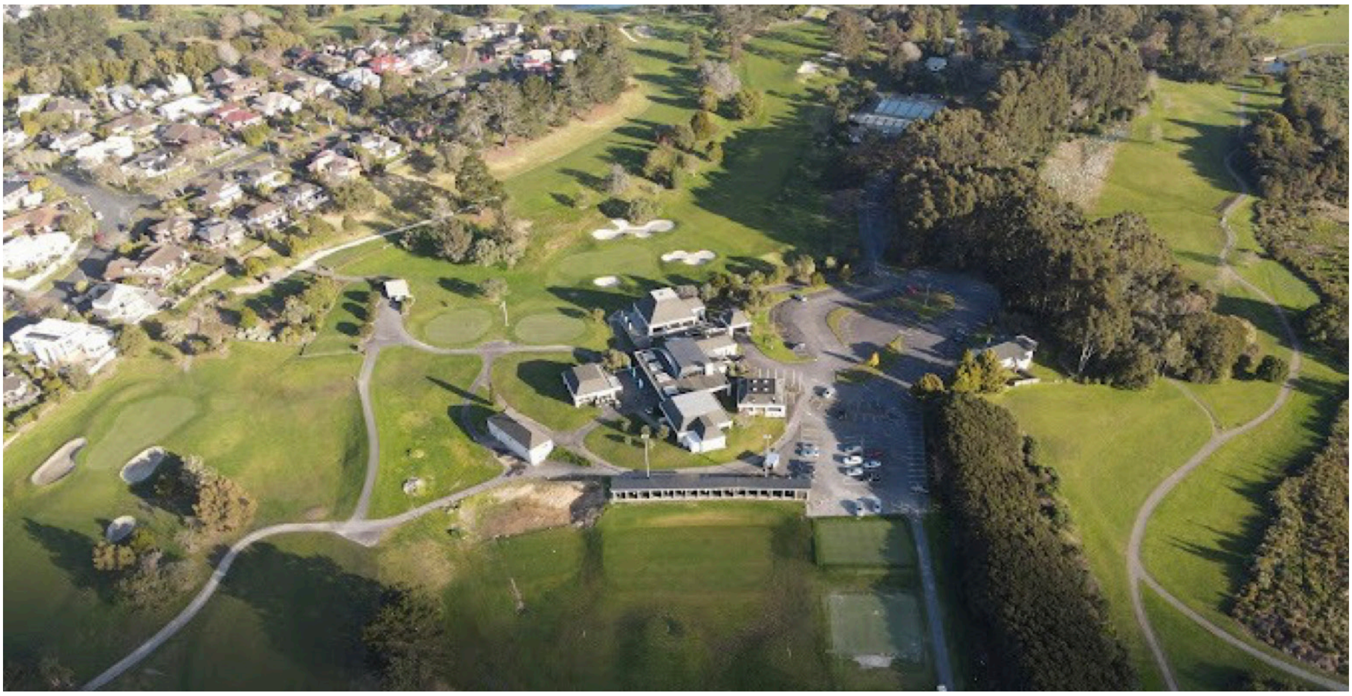
GEO certified 2016, renewed 2019 & 2022

Construction Value:

Approx. N/A

Features:

- 18-hole, par 72 course
- 200 car parking spaces
- Clubhouse facilities
- 72 ha woodland park reserve



Sustainability:

Biodiversity:

- Native tree planting & removal of exotics.
- Pest trapping carried out (for unwanted animals, plants and insects).
- Bee hives on course (harvest and sell honey produced on-site).
- Nesting boxes installed around the course.
- Use of specific fish species to control aquatic weeds.

Water:

- Change of turf plant species to low irrigation and high disease tolerance.
- Regular water quality testing (1-2 x per yr).
- Use of recycled water from Stonelands (nearby development).
- Use of Nano-bubble oxygenated water.
- Use of locally sourced organic fertilisers.

Energy:

- EVs replacing petrol and/or diesel vehicles.
- Changed to renewable power suppliers (carbon zero).
- PV panels installed late 2023 to cover 100% electricity needs.
- 14T reduction in carbon emissions between 2018 and 2021.

Community:

- Workshops to upskill and inform other courses, with involvement from
- Auckland Council and DOC.
- Neighbours engaged on planting days and pest trapping.
- School children visit site with formal outdoor classrooms to learn about sustainability.
- Locals invited to walk the course during Covid-19 lock-downs.

Key metrics:

Climate Zone: 1

Floor Area: 72 ha total site area

Key Information

The holistic approach to turf management resulted in benefits spread across a range of golf course elements. For example, the change in turf species meant that fertiliser demands were lower. An efficient irrigation system that altered the pH of the water to ensure neutrality, means that soil conditions are optimised for plant growth and nutrient uptake. The use of slow-release organic fertilisers means that fertiliser applications are less frequent, resulting in carbon savings through the use of less fuel; fuel use dropped by 4,000 litres between 2018 and 2021.

Biodiversity improvements have resulted in sightings of native kākā on the course; a bird typically found only in native forests. The bellbird/korimako has been spotted on the course for first time in 100 years. The brown teal/pāteke is now nesting on site and throughout the period of GEO certification, over 1 ha of new woodland habitat has been created and over 6 ha of unmanaged rough created.

Since the first GEO certification, alterations at the course now means that all drainage water is being diverted to on-site storage ponds. The holistic turf management approach has resulted in improved water quality, as evidenced by ongoing water tests. The tests show lower pH, reduced e-coli coliforms and reduced bacterial load. Testing of the downstream catchment shows that the water quality of nearby wetlands has also improved. This capture of all drainage water and improved water quality means that no town supply water is used for course management.

4

Appendices
Āpitihanga

4.1 Sustainability rating tools
Rauemi arotake toitūtanga

There are several sustainability certification tools available, with the most relevant summarised below. While there are other sustainability certification tools like Nabers and Homestar available in New Zealand, these are generally not relevant to sport and active recreation projects. A more comprehensive assessment of these tools and their applicability is found in the Appendices.

Green Star is a sustainability rating system managed by the Green Building Council of New Zealand (GBCNZ). It evaluates the environmental performance of new and existing buildings and communities based on energy efficiency, water conservation, materials selection, indoor environmental quality, and innovation.

Passive House certification focuses on energy efficiency and comfort in building design and construction. It sets stringent standards for insulation, airtightness, ventilation, and heat recovery, resulting in buildings with minimal energy consumption and superior thermal comfort.

The IS Rating Scheme (IS) is managed by the Infrastructure Sustainability Council of Australia (ISCA) and is Australia and New Zealand's only comprehensive rating system for evaluating economic, social and environmental performance of infrastructure across the planning, design, construction and operational phases of infrastructure assets.

The Golf Environment Organisation (GEO) is an international non-profit organization that promotes sustainability in the golf industry. Their certification program assesses golf courses' environmental and social performance, covering areas such as nature protection, water conservation, energy efficiency, and community engagement.

The International Living Future Institute (ILFI) offers a range of certification tools for sustainable projects including the Living Building Challenge (LBC), the world's most stringent sustainability certification program promoting holistic regenerative practices in buildings. LBC focuses on site, water, energy, health & happiness, materials, equity and beauty. A range of more focussed certification tools include Zero Carbon and Zero Energy Certification.

4.2
Sustainability rating tools comparison
Puka ārahi rauemi toitūtanga

Sustainability Rating Tool:	New Aquatic Facility	New Indoor Sport Facility	Outdoor Sport, Rec. & Golf	Existing Aquatic Facility	Existing Indoor Sport Facility
GREEN STAR - Design and As Built	0[1]	0[1]	-	-	-
GREEN STAR - Interiors	0[1]	0[1]	-	0[1]	0[2]
GREEN STAR - Performance	-	-	-	0[1]	0[2]
PASSIVE HOUSE	●	-	-	0[3]	-
ILFI - LIVING BUILDING CHALLENGE	●	●	●	●	●
ILFI - CORE WITH PETAL CERTIFICATION	●	●	●	●	●
ILFI - CORE CERTIFICATION	●	●	●	●	●
ILFI - ZERO ENERGY CERTIFICATION	●	●	●	●	●
ILFI - ZERO CARBON CERTIFICATION	●	●	●	●	●
GEO	-	-	●	-	-
IS RATING SCHEME	-	-	●	-	-

1 Limited relevance. Greenstar is developing a pilot tool for Aquatic Projects. A Standard tool does not currently exist. The tool is not flexible with sporting type buildings

2. Limited relevance. The tool is not flexible with sporting type buildings

3. Limited relevance. Passive House has no tools available for certifying existing buildings. This would only be relevant to a facility that is undergoing a full major refurbishment of all systems.

4. Limited Relevance. Only relevant at an organisational level.

greenstar

Green Star is Australasia's largest voluntary sustainability rating system for buildings, fit- outs and communities. Green Star ratings are available to a wide variety of commercial projects.

Green Star Design & As Built is the most commonly used Green Star rating helps guide the sustainable design and construction of any new commercial build or major refurbishment.

Green Star Performance assesses the operational performance of all types of existing buildings across nine holistic impact categories. This certification system aims at improving the existing building fabric.

Capital Cost Implications over Whole of Life:

1. Additional cost to certify.
2. Additional specialist consultant fees required for input and certification.
3. Additional cost of implementing requirements varies depending on the credits targeted and whether targeting a 4,5 or 6 Star Green Star certification.

Operational Cost Implications over Whole of Life:

Varies depending on the credits targeted.

Advantages

- High adoption in New Zealand.
- Well recognised tool for typical commercial building types.
- Holistic tool that covers many areas of sustainability.

Disadvantages:

- Expensive certification system to apply to smaller projects under $20M.
- Limited flexibility. System is based on a very prescribed set of credits so is not easily tailored to bespoke sport and aquatic projects.
- Credit structure results in a shopping list approach based on lowest cost for implementation.

PASSIVEHOUSEINSTITUTE

Passive House is a fabric-first approach to achieving healthy and comfortable buildings. It provides a clearly defined standard and a quality management system that produces buildings that deliver on all aspects of occupant wellbeing while consuming little energy.

Capital Cost Implications over Whole of Life:

1. Additional cost to certify.
2. Additional specialist consultant fees required for input and certification.
3. Additional cost of implementing requirements.

Operational Cost Implications over Whole of Life:

Significant potential operational savings over Whole of Life for the right project type. Refer to Naenae Case Study.

Advantages

- Internationally recognised certification system.
- Improved comfort of building occupants.
- Large potential operational savings in high energy use buildings.
- Greater emphasis on quality assurance during construction

Disadvantages:

- Limited expertise of this certification system within NZ.
- Initially more expensive capital cost to implement.

INTERNATIONAL LIVING FUTURE INSTITUTE℠

ILFI is a US-based green building certification body with a growing list of certified projects around the world. ILFI takes a holistic approach to projects and also allows a degree of flexibility certification requirements to specific local conditions.

Three are five ILFI certification systems that are incrementally more comprehensive and challenging to achieve:

1. Zero Carbon - 100% of building energy offset with on-site or off-site renewables.
2. Zero Energy - 100% of building energy provided by on-site renewables.
3. Core - a holistic sustainability rating across ten sustainability themes, or 'Petals': Place, Water, Energy, Health + Happiness, Materials, Equity and Beauty.
4. Core with Petals - Core achieved plus specialisation in the Water, Energy or Materials petals.
5. Living Building Challenge (LBC) - this is currently the summit of holistic green building sustainability certification; LBC certification requires a project to score comprehensively high performance across all Petals.

Advantages

- Internationally recognised as the most stringent green building certification system.
- Project team can target tools relevant to project type and budget.
- Core and LBC requirements offer some pragmatic flexibility, which can be discussed on a case-by-case basis.
- ILFI's holistic approach encompasses education, advocacy as well as certification, ensuring sustainability is deeply embedded in the project and project team.
- Awarded only after 1 year's operation to ensure this is not just a 'tick-box' exercise.

Disadvantages:

- Presently ILFI certification systems have low adoption and recognition in NZ. At time of writing, there is one Living Building Challenge certified project, with two in progress, and two Core with Petal certified projects, in New Zealand.
- Programme implications - adds additional time to the design and documentation phase.
- Capital cost implications - additional cost to certify, additional specialist consultant fees required for input and certification.

ISCA

ISC is a member-based purpose-led organisation that supports sustainability outcomes in infrastructure. The new IS Essentials tool is applicable for sport projects where capital cost is between $5m and $100. ISC promotes sustainable thinking and the embedding of sustainable practices into projects in a number of ways, including its Rating Tools, learning and training courses, events such as conferences and forums, member networking, advocacy and through the management of a ISupply directory of suppliers that meet certain sustainability criteria.

Advantages

- The ISC Essentials rating schemes provides a standardised framework for assessing sustainability, enabling benchmarking against industry best practices and facilitating comparisons between different projects.
- Using the ISC rating tools promotes the adoption of best practices in sustainability, fostering innovation and promoting the use of environmentally friendly materials and processes in construction projects.
- The IS Essentials rating schemes involves multiple stakeholders, including local government, industry experts & consultants, and communities fostering collaboration.
- The intent of the IS Essentials rating schemes is that long-term cost savings by reducing energy consumption, minimising waste, and promoting the efficient use of resources over the entire life cycle of the asset will be realised.

Disadvantages:

- Compliance with the rating scheme can be complex and costly, especially for smaller projects just within the capital cost criteria. A base case (standard approach) needs to be designed and then an alternative case designed so that sustainability savings against a selection of different credits can be used to gain points. The total number of points gained results in a rating.
- The IS Essential rating scheme might not accommodate unique project constraints which may lead to limited flexibility in implementation and potentially discouraging innovative approaches that do not fit within the predefined criteria.
- As a general disadvantage to rating schemes, the emphasis on meeting the criteria for a certain rating might overshadow the actual performance and impact of the project, leading to a focus on achieving the rating rather than making a substantial difference in sustainability.

Geo Foundation for Sustainable Golf ("GEO") is a not-for-profit organisation that aims to inspire and reward sustainable action and promote the social and environmental value of golf. Golf is a global sport, usually set in nature and deeply embedded with local communities. GEO certifications were developed to support the industry in its measures to protect and enhance local ecosystems, promotion of well- being, providing jobs and economic value through supply chains and demonstrating credible commitments through a number of certification options.

The GEO certification process is based on showing commitment to, and adherence to, various standards, with standards identified as those that 'must' be met, and those that

'should' be met. Upon achieving certification, the course or facility then commits to ongoing improvement and advancement in each area.

Advantages

- GEO is the most widely recognised sustainability distinction in golf and has been awarded to facilities around the world.
- GEO certification uses universal standards that are benchmarked and can be compared.
- GEO certification provides marketing and communications materials to assist with promotional activities.
- GEO certification covers all management areas including legal compliance.
- Short, medium and long-term goals are built into the certification process.
- GEO certification is carried out by independent certifiers to maintain credibility.

Disadvantages:

- The certification process is often self- assessed and/or contains voluntary standards and guidelines adopted by the developer. This is understandable given the wide range of scope and complexity in development projects, but makes benchmarking and comparison between developments difficult.

4.3
Changing trends in development and use of spaces and places
Ngā āhuatanga rerekē i te whanaketanga me te whakamahinga o ngā wāhi me ngā takiwā

The development of spaces and places in the recreation sector is experiencing significant changes and trends in recent years. The following list summarises some key changes.

Multifunctional facilities:

There is a growing emphasis on multifunctional facilities that cater to a variety of sport, recreational and community activities. These facilities are designed to accommodate diverse user groups and offer flexible spaces that can be adapted for different purposes, such as hosting sporting events, fitness classes, casual play, community gatherings, and cultural activities. This trend promotes inclusivity and maximises the utilisation of space and the resilience of the facility to future changing demands.

Technology integration:

The integration of technology has transformed the provision of spaces and places in the sport and recreation sector. From advanced audiovisual systems and digital signage to smart lighting, sales and integrated wireless solutions, to interactive recreation and gamified experiences using touch screen technology, and wearable health trackers.

Technology is enhancing the user experience, enabling access, promoting safety, wellbeing, and enabling efficient facility management.

Additionally, virtual reality and augmented reality technologies are being utilised to enhance training, entertainment, and spectator experiences. It can also assist with promoting the multifunctional and flexibility of spaces.

Inclusive and accessible design:

Facilities are being designed and renovated to ensure everybody has access and opportunity to participate. This includes promoting and championing the importance of diversity and inclusion, including all genders and ages, abilities and all ethnicities.

Active recreation:

There is a trend for increasing demand and participation in active recreation and sport activities in a non-competitive sense. This includes activities like walking, swimming, cycling, equipment-based exercise, fishing, running and yoga which can occur independently or with the involvement of a 'provider' group or organisation.

Active outdoor spaces:

There is a shift towards creating more active outdoor spaces that encourage and promote physical activity and outdoor recreation.

Parks, trails, and outdoor fitness areas are being developed to provide opportunities for sport, recreation and play activities in natural settings. These spaces often integrate elements of nature, such as greenery, water features, and natural play areas to enhance the overall experience.

Community engagement:

The provision of spaces and places in the sport and recreation sector is increasingly focused on fostering community engagement and social interaction. Facilities are designed to accommodate social gatherings, events, and programs that encourage community involvement and connection. This includes the integration of multifunctional community rooms, gathering spaces, and amenities that support socialisation and community-building activities.

Health and wellness:

There has been an increase in the provision of sport and recreation spaces that prioritise wellbeing, and holistic health. Facilities are incorporating wellness studios, mindfulness spaces, and specialised areas for yoga and meditation. Complimentary health consulting spaces are increasingly being provided within sport facilities to create a one stop shop to wellness. Outdoor spaces and infrastructure are increasingly responding to the growth in non-traditional sport and informal outdoor recreation activities.

Adaptive re-use (or re-purposing):

Adapting existing facilities to provide flexible recreation opportunities close to communities and prioritising this over rigidly focusing on traditional sport code spatial requirements Refer to the Edgar Centre case study.

Network approach:

Facilities, sport fields and parks are being considered as interconnected components within a broader network. Instead of viewing individual facilities in isolation, this approach emphasises collaboration and coordination among various stakeholders, including local governments, sport organisations, iwi and hapū, schools, private organisations and community groups. The network approach aims to optimise the use of existing spaces, share resources, to create more integrated and efficient facilities, and minimise duplication. It supports participation and utilisation across a range of facilities. This paradigm shift covers site selection, transport impacts, stormwater, energy, waste alongside the spaces and places. Refer to the Te Kori Scott Point case study.

Sport field ecological practices:

Biochar, a form of charcoal produced from organic waste materials, is increasingly being used in sport field management. Biochar has several benefits, including improved soil fertility, enhanced water retention capacity, and increased carbon sequestration. Its incorporation into a sport field can help promote healthy turf growth, reduce the need for synthetic fertilisers, and enhance the overall sustainability of sport field management practices. Artificial turf has gained popularity as an alternative to natural grass in sport fields. To make artificial turf more environmentally friendly, eco-friendly infill materials made from recycled materials, incorporating organic or recycled rubber infill, and implementing efficient irrigation systems to conserve water usage can be considered. Additionally, eco- conscious maintenance practices, such as minimising chemical usage and implementing eco-friendly cleaning methods, are being emphasised.

Carbon accounting:

Carbon accounting is an emerging practice in the sport sector, aimed at quantifying and reducing carbon emissions associated with a facilities embodied and operational carbon. Carbon accounting involves measuring and tracking greenhouse gas emissions and identifying carbon reduction strategies.

Energy:

Swimming pool facilities are high energy consumers. Internationally, aquatic centre facilities are recognising their high cost of operation. Recently, some organisations have been adopting the Passive House design and certification approach to drastically reduce the energy use of the these highly energy intensive facilities. Refer to the Naenae Aquatic Centre and St Sidwells case studies.

Hub centralisation:

Historically there has been a trend to cluster multiple aquatic and sport/recreation functions under one roof to create super hubs. This creates synergies between the different spaces and provides efficiencies in staffing and operation, but can be at the expense of increased transportation volumes. There is a tension between the distribution of community facilities, sustainable transport goals and maximising facility use. Having facilities close is convenient and can mean fewer people travel by car. However, small facilities that individually lack the space to provide a range of activities can mean some people will travel further or to multiple facilities to access what they desire. This can result in more car travel and lower facility use, as demand is spread across multiple facilities. Conversely, a large facility can attract people from a wide area due to the greater range of activities on offer. This can result in more car travel, but higher facility use. Therefore, this centralised approach must be evaluated on a case by case basis at a network level to ensure it provides the best cost, carbon and community benefit.

4.4
Potential funding sources
He tūpono puna pūtea

Sustainability initiatives may be eligible for funding from various bodies. Many funders are interested in projects that will deliver strong environmental sustainability outcomes. In approaching any funder for support, it is important to clearly articulate what is proposed, why and the anticipated impact. While all funders have different objectives and geographic areas, some suggested starting points are outlined below.

NZ Lotteries Commission

Lotto NZ's profits are used to help build strong, sustainable communities around New Zealand. Enquiries for funding can be directed to the NZ Lottery Grants Board.

Community Renewable Energy Fund

The government has committed $46 million to support community-based renewable energy projects and secure the energy they need. This new fund further supports the government's effort to enhance resiliency in communities and trial innovative ways to store and distribute locally generated electricity. https://www.mbie.govt.nz/building-and- energy/energy-and-natural-resources/low-emissions-economy/energy-efficiency-in-new- Zealand/community-renewable-energy-fund/

Local Government funds

Your local government may have sustainability funds available.

Crown Energy Efficiency Loans

Public sector organisations can use Crown loans to fully or partially fund energy efficient equipment, including electric vehicles https://www.eeca.govt.nz/co-funding/public-sector-decarbonisation/crown-loans/

Gaming and Community Trust funding

A range of Gaming and Community Trust funding is available for projects. For further information, refer to the Sport New Zealand website https://sportnz.org.nz/funding/external-funding/ or refer to Generosity NZ https:// generosity.org.nz/

Additionally, private funding from power/energy companies, banks etc. may be investigated, possibly in return for naming rights.

4.5
Minimum standards for sport facility building fabric
Ngā paerewa iti mō ngā papanga hanga whare hākinakina

Aquatic Centres:

Component:	Sport England targets	NZ Building Code (H1) Climate Zone 1*	Sport NZ targets Climate Zone 1*	NZ Building Code (H1) Climate Zone 6*	Sport NZ targets Climate Zone 6*
Airtightness (q50 or @ 50 Pa)	3 $m^3/h/m^2$	N/A	3 $m^3/h/m^2$	N/A	3 $m^3/h/m^2$
External windows (R-value, m2·K/W)	0.67	0.33	0.4	0.42	0.5
Skylights	0.67	0.42	0.5	0.51	0.6
External walls	5.0	2.2	2.64	3.2	3.8
External roof	10.0	3.5	4.0	7.0	7.0
External floor	N/A	2.2	2.2	2.6	2.6
Internal windows (between pool hall and adjacent spaces)	0.67	N/A	Ensure windows are air and vapour tight; double glazing between pool halls and spaces with high temp. difference i.e.. offices, gym etc.)	N/A	Ensure windows are air and vapour tight; double glazing between pool halls and spaces with high temp. difference i.e. offices, gym etc.)
Internal walls (between pool hall and adjacent spaces)	5.0	N/A	Ensure windows are air and vapour tight; double glazing between pool halls and spaces with high temp. difference i.e.. offices, gym etc.)	N/A	Ensure windows are air and vapour tight; double glazing between pool halls and spaces with high temp. difference i.e.. offices, gym etc.)

*refer to map on page 63 for Climate Zone

Considerations for aquatic facilities:

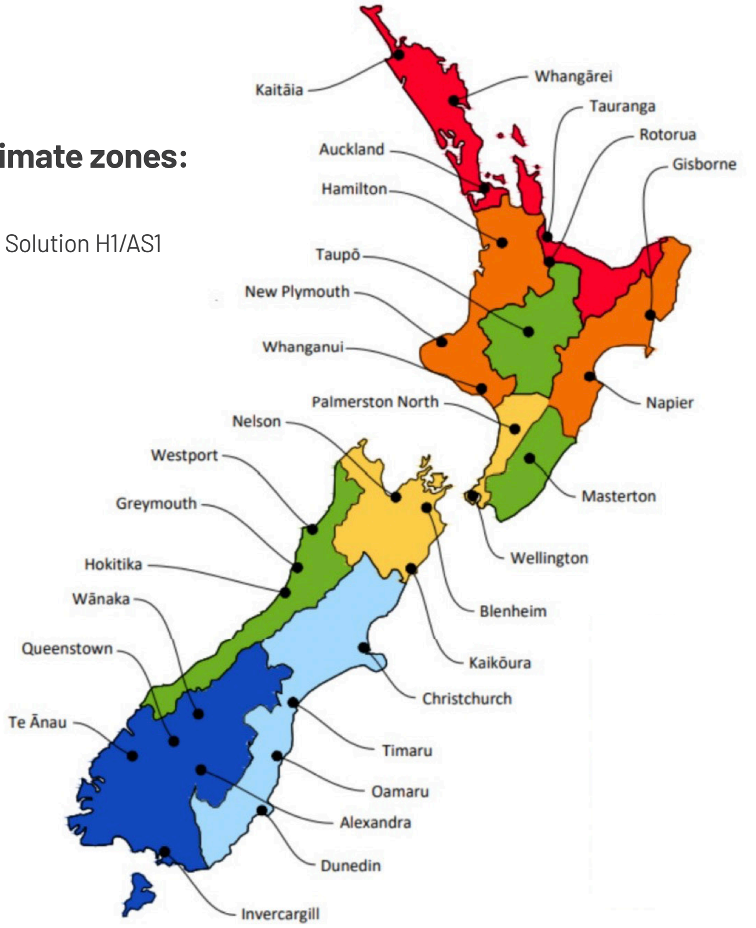
- General minimum insulation requirements are set out under the NZ Building Code (Section H1).
- Consider all cold bridging details carefully – bulk construction R values for building elements can overlook some of these details where they are relatively small compared to the size of the building envelope, but these areas are at particular risk of condensation.
- Consider all individual window construction R values (not an average across the building). Careful attention to detail around window framing construction and curtain walling construction is required.
- The pool tank walls are often part of the external envelope of the building, and would require insulation to meet minimum insulation standards for the building.
- Building envelope R-values exclude elements with embedded heating elements. If these are used, for example within aquatic changing room floors, then the respective values from H1/AS2, Table 2.1.2.2A should be used.
- Airtightness is critical to the performance of an indoor aquatic centre and therefore it is recommended that a mandatory airtightness criteria is set as part of the project brief. It is recommended that this be verified by an independent agent using a blower door test during the commissioning phase of the project.
- Aquatic facilities have multiple levels of floor slabs which need to be considered as part of the thermal envelope of the building. In typical aquatic facility construction where the concourse has backfill under it, the concourse would be considered a separate external floor to the pool tank floor.
- Consider running pool water pipework inside the building thermal envelope where possible. Where pool water pipework is outside the thermal envelope, consider pipework insulation.
- Hydroslides can be the source of large thermal losses due to high surface areas and low insulation values. Consider insulated slides, planning the slide to reticulate inside the building, planning of the run-out area to allow for demand control on ventilation and heating systems.
- Although the minimum requirements listed refer to external building envelope elements, consider instances where insulation may be required in internal separations to reduce condensation risk. For example, internal separations between the pool hall and fitness areas, or cold plant rooms, may require insulation levels similar to external building envelope elements depending on space conditions.
- Indoor aquatic facilities generally have features that meet the requirements for commercial buildings, and therefore the building services design must also meet the relevant H1 standards for commercial buildings.
- Existing aquatic facilities undergoing renovation should target the same building fabric requirements

Indoor Dry:

Component:	Sport England targets	NZ Building Code (H1) Climate Zone 1	NZ Building Code (H1) Climate Zone 6	Sport NZ targets
Airtightness (@ 50 Pa)	5 $m^3/h/m^2$	N/A	N/A	5 $m^3/h/m^2$
Windows (R-value, m2·K/W)	0.67	0.33	0.42	As per NZ Building Code (H1)
Skylights	0.67	0.42	0.51	As per NZ Building Code (H1)
Walls	4.55	2.2	3.2	As per NZ Building Code (H1)
Roof	7.15	3.5	7.0	As per NZ Building Code (H1)
Floor	5.0	2.2	2.6	As per NZ Building Code (H1)

Map of New Zealand climate zones:

Source: MBIE, 2022,
H1 Energy Efficiency Acceptable Solution H1/AS1



Considerations for indoor sport facilities:

- Indoor sport facilities cover a variety of uses, some of which may not technically have minimum insulation requirements under the NZ Building Code (Section H1), for example unconditioned community courts. The above table does not include fitness centres.
- Indoor dry sport facilities are less energy intensive that aquatic centres and therefore the associated cost benefit of providing improvements over code minimum H1 values is outweighed by considering other environmental factors for these building types when considered over the Whole of Life. Sport NZ therefore recommend focusing on other key metrics as below before considering enhancing indoor sport facility building fabric:
  - Red List free products (https://living-future.org/red-list/)
  - Minimisation of embodied carbon
  - Site selection to minimise transport affects of indoor sport facilities.
- The minimum standards recommended in this guide recognise the importance of a quality building envelope for sustainable, robust facilities. Typically, attempts to avoid NZ Building Code requirements for some areas of these facilities result in difficult construction and insulation details for interior areas of the building that normally do not require insulation.
- Permanent natural ventilation openings in indoor sport facilities (for example, louvres) should be closable by facility operators.
- Sport field facilities often have changing room facilities associated with the development. These should target the same building envelope R-values as a new build indoor court facility if they are designed to be heated.
- Unheated and naturally ventilated sport halls are common in New Zealand. They offer an economical solution to providing internal recreation and sport space but at the expense of spectator and staff comfort, particularly through winter and the shoulder seasons in colder climate zones. Where these spaces are being provided, consideration should be given to the correct building fabric design to minimise the diurnal temperature fluctuations and also be provided with appropriate ventilation to control humidity to within acceptable limits.
- Timber sport flooring suppliers often have specific temperature and humidity ranges for maintaining warranty of their flooring system which must be considered in the design process.
- Consideration should also be made for change of use of the space and allowances should therefore be provided for infrastructure to allow for retrofit of features such as electric radiant heating panels in the electrical loading. The use of fossil fuel radiant heating panels is discouraged.

References and further reading

Title	Author
Building for the Next Generation Journey to Zero for Sports and entertainment Venues https://www.greensportsalliance.org/resources/playbooks	Green Sports Alliance
Future Proofing Community Sport & Recreation Facilities A Roadmap for Climate Change Management for the Sports and Recreation Facilities Sector	Sports Environment Alliance & Victoria State Government
Environmental Sustainability Pack For Sport and Recreation Associations in Western Australia https://www.dlgsc.wa.gov.au/department/publications/publication/ environmental-sustainability-pack	Government of Western Australia Department of Sport and Recreation.
Guidelines for Sustainable Sports Facility Construction	Natalie Essig, Sara Lindner, Simone Magdolen, Loni Siegmund for the Federal Institute of Sport Science
Kainga Ora Sustainability Framework https://kaingaora.govt.nz/assets/About-us/Kainga-Ora-Sustainability-Framework.pdf	Kainga Ora Homes and Communities
Whole of Life Embodied Carbon Emissions Reduction framework https://www.mbie.govt.nz/dmsdocument/11794-whole-of-life-embodied-carbon-emissions-reduction-framework	Ministry of Business, innovation and Employment
Aspects of Sustainability that Inspire https://hallbaraidrottsevenemang.se/wp-content/uploads/2020/06/Aspects-of-Sustainability.pdf	The Swedish Sports Federation
Development and Use of BREEAM for Olympic Park Venues https://webarchive.nationalarchives.gov.uk/ukgwa/20130228091633/ https://learninglegacy.london2012.com/publications/lessons-learned-from-the-london-2012-olympic-and-paralym.php?stylesheet=normal	Neil Paterson, BRE
Environmental Sustainability Checklist for Sport and Physical Activity Facilities https://www.sportengland.org/guidance-and-support/facilities-and-planning/sustainable-facilities-and-planning?section=sports_facilities	Sport England
Playing Against the Clock Global Sport, the Climate emergency and the Case for Rapid Change https://rapidtransition.org/wp-content/uploads/2020/06/Playing_Against_The_Clock_FINAL.pdf	David Goldblatt Rapid Transition Alliance
Game Changer How climate change is impacting sports in the UK https://static1.squarespace.com/static/58b40fe1be65940cc4889d33/t/5a85c91e9140b71180ba91e0/1518717218061/The+Climate+ Coalition_Game+Changer.pdf	Climate Coalition
Sports for Climate Action Framework https://unfccc.int/sites/default/files/resource/Sports_for_Climate_Action_ Declaration_and_Framework.pdf	United Nations Climate Change Commission
Sustainable Golf Development Guidelines https://sustainable.golf/assets/media/files/Developments/Standards/SGD_ Handbook_2nd%20Edition%20.pdf	Golf Environment Organisation

Building for Climate Change Work Programme https://www.building.govt.nz/assets/Uploads/getting-started/building-for-climate-change/work-programme-building-for-climate-change.pdf	Ministry of Business, innovation and Employment
Accelerated Electrification www.iccc.mfe.govt.nz	Interim Climate Change Committee
Low Carbon Parks Stage One: Creating a Carbon Inventory for a Sports Park A Case Study of Seddon Fields Auckland	Hannah Chapman-Carr for Auckland Council
Climate Scenarios for the Construction and Property Sector Ngā Horopaki Āhuarangi mō te Rāngai Hanganga me ngā Whare https://23159811.fs1.hubspotusercontent-na1.net/hubfs/23159811/NZGBC%20-%20Climate%20Scenarios%20for%20the%20Property%20and%20Construction %20Sector.pdf	New Zealand Green Building Council
RIBA Sustainable Outcomes Guide https://www.architecture.com/knowledge-and-resources/resources-landing-page/sustainable-outcomes-guide	Royal Institute of British Architects
Sports Environment Alliance https://www.sportsenvironmentalliance.org	
Passivhaus Institute https://passivehouse.com/	
New Zealand Green Building Council https://nzgbc.org.nz/	
Infrastructure Sustainability Council https://www.iscouncil.org	
National Australian Built Environment Rating System https://www.nabers.gov.au/	
International Living Future Institute-Living Building Challenge https://living-future.org/	

4.6
Explanatory notes and assumptions to carbon modelling

Benefits of building re-use

To demonstrate the potential scale of carbon emissions avoided through the reuse and re-purposing of existing buildings, the impact of the Edgar Centre conversion was estimated and compared against an equivalent new building of the same size and function. The new materials required to undertake the conversion and refurbishment was extrapolated from historic project drawings, and assumed to largely comprise of minor structural strengthening, re-clad (roof and walls), and the addition of sprung timber flooring for the courts.

Note the building is assumed to be an unconditioned space, with the majority of energy consumption being from lighting. This is assumed to be the same between the new build and refurbished options so has not been incorporated into the whole-life comparisons.

The embodied carbon impacts from the building re-use are compared in the table below with the equivalent new-build, over an assumed 50 year design life.

	Adaptive re-use	Equivalent new-build	Avoided emissions
		tCO_2e	
Demolition emissions	~6	~30	~24
New materials and construction	~1,000	~3,600	~2,600
Replacement and refurbishment over life	~1,000	~1,000	0
End of life	~30	~30	0
Total Embodied	~2,100	~4,700	~2,600 (55% reduction

Aquatic facility carbon reduction

An aquatic facility was modeled based on the Stratford Aquatic Centre as representative of a medium-scale community aquatic facility. It was modelled with weather from the Lower North Island and a fresh air dehumidification system to be representative of the most common HVAC configuration.

The table below indicates the carbon emissions impact of the Stratford Aquatic Centre over its life time (assumed to be 50 years).

Life cycle stage	$kgCO_2e/m^2$
A1-A3 Materials	774
A4 Transport	11
A5 Construction	64
B1 Use phase	526
B4-B5 Replacement	173
B6 Energy	3,244
C1-C4 (End of Life)	15

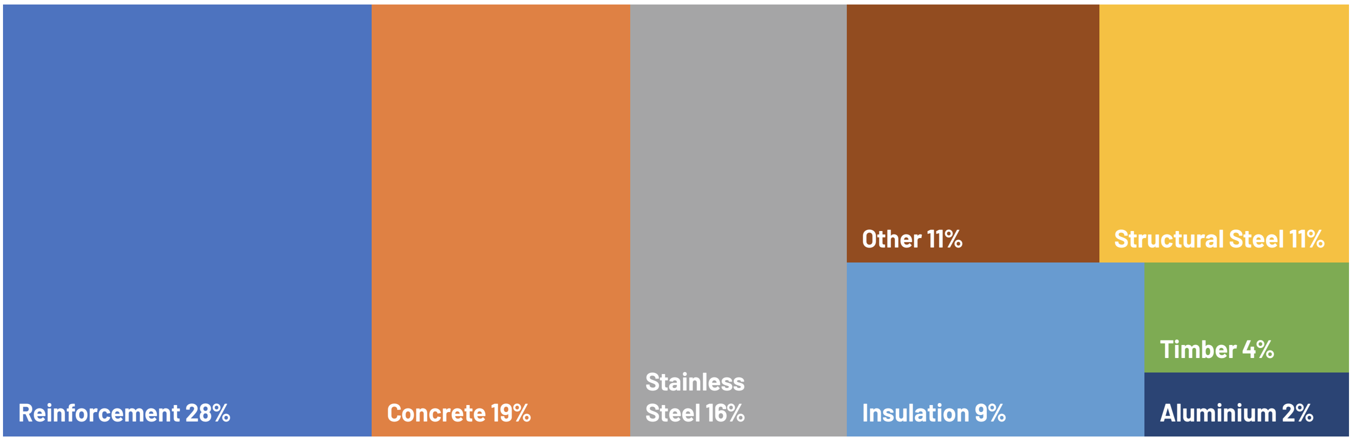
New build aquatic centre – gas boiler vs heat pumps

For a new-build facility, modeling was undertaken to understand the difference in life cycle carbon between a gas boiler and a heat pump central energy system over a 50-year design life. Assumptions related to the modeling are listed below.

Life cycle stages	Gas boiler	Heat pump
	$kgCO_2e/m^2$	
A1-C4 (whole-life carbon)	14,610	4,807
A1-C4 (embodied only)	979	1,037
B1 (refrigerant)	100	526
B6 (energy)	13,531	3,244

New build aquatic centre – upfront carbon reduction strategies

The graph below indicates the approximate breakdown of upfront embodied carbon by material type.



The table below indicates upfront carbon savings available through different low-carbon design and procurement strategies.

Low carbon design strategy	% reduction (up-front embodied)
Low carbon concrete	3
Low carbon reinforcing	20
Low carbon steel	4
Timber structure	10
C1-C4 (End of Life)	15

Existing aquatic centre (gas boiler, 25-year-old fabric) – life cycle decarbonisation

The following table indicates, for an existing asset, what the relative impacts are for different possible life cycle decarbonisation strategies, and the trade-offs between upfront carbon and operational carbon.

The existing centre with gas boiler was modeled with HVAC systems with moderate heat recovery effectiveness as is typical for these buildings. The scenarios covering an upgrade to heat pump heating were all modeled including improved HVAC systems, as a change in central energy scheme is usually aligned with a modification of HVAC equipment.

	Carbon impact	**Life cycle stages**
Building upgrade	**kgCO_2e/m^2**	
Change to heat pumps & upgrade HVAC	~60	A1-A5 (upfront embodied)
	~526	B1 (refrigerant) – 50 years
	~ - 210	B6 (operational) - saving
Upgrade envelope	~100	A1-A5 (upfront embodied)
	~ - 6	B6 (operational) - saving
Change to heat pumps & upgrade HVAC, and upgrade envelope	~160	A1-A5 (upfront embodied)
	~526	B1 (refrigerant) – 50 years
	~ - 212	B6 (operational) - saving

Envelope comparison – upfront embodied

Note the below calculations assume the primary structural wall girts and roof purlins are consistent between each option. The embodied carbon impacts of the envelope as a whole should be offset against likely operational carbon savings.

Envelope type	**kgCO_2e for 1m^2 of wall or roof (A1-A3)**
Roof – new (Kingspan)	~50
Roof – old (foil batts)	~125
Wall – new (Kingspan)	~55
Wall – old (foil batts)	~60

Assumptions and limitations

- Life cycle modeling has been undertaken using One Click LCA software.
- Emissions factors for materials and elements have been taken from the One Click LCA database. Where available, NZ specific environmental product declaration (EPD) data has been used. In the absence of NZ-specific data, generic global data has been used which has been regionalised to NZ.
- Product and element service life times (that is, replacement cycles) have used the One Click LCA in-built assumptions.
- Emissions factors for purchased electricity and building gas usage have been taken from the 2022 Ministry for the Environment published factors.
- No allowance for future decarbonisation of the grid has been included.
- Refrigerant emissions are highly variable between sites. For the comparative modeling above, a high-level assumption was made for gas boiler systems as being ~20% of the refrigerant emissions from an equivalent heat pump system, to allow for equipment required to condition gym and office spaces.
- Building electricity consumption (beyond pool heating / HVAC) has been assumed to be 1.5 GWh/yr. Although expected to be typical for a community aquatic facility, it is likely to vary between sites depending on design decisions.
- A coefficient of performance of 3.0 was assumed for the air source heat pumps, and an efficiency of 0.85 for a gas boiler. These are likely to be slightly conservative assumptions.
- The carbon figures and findings presented above have been calculated using specific past project examples, and should not be taken to be predictive of any future project performance.

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