APPENDIX 28

SPECIALIST CLIMATE CHANGE IMPACT ASSESSMENT

JULY 2025

BRUNDTLAND

CAPE WINELANDS AIRPORT

Specialist Climate Change Impact Assessment

Final CCIA report for the proposed Cape Winelands Airport expansion

February 2025 – Update 2

EXECUTIVE SUMMARY

The Cape Winelands Airport (CWA) situated 40 kilometres from the City of Cape Town currently serves as a general flying field for general aviation. The CWA proposed to expand its operations to accommodate long-haul, wide-body flights for airlines and unscheduled operators in a phased development approach. The expansion project consists of runways, landside and airside infrastructure developments. The primary runway will be realigned to an orientation of 01-19 and 3 kilometres. Airside and landside infrastructure developments include but are not limited to the development of runways, taxiways, passenger and cargo terminals, aircraft hangers and facilities, fuel storage and other basic utility infrastructure such as stormwater management, electrical supply from a biodigester and solar PV farms and passengers services such as parking, roads and hotel. The expansion project (the 'Project') envisions that the new CWA would operate scheduled domestic and international aviation, stimulate the general aviation sector due to increased service availability and assist as an alternate planning airport for redundancy and diversion planning.

The Project requires environmental authorisation under the Environmental Impact Assessment (EIA) Regulation (2017) as per the National Environmental Management Act (Act No 107 of 1998). Brundtland Consulting has been appointed to undertake the specialist climate change impact assessment (CCIA) of the project as inputs to the EIA. The CCIA involves an assessment of the potential contribution of the airport to climate change through the production of greenhouse gas (GHG) emissions from its direct and indirect activities and considers the impact that climate change could have on the project's operation, value chain and environment. The CCIA considers both the construction and operation of the CWA expansion project. As the airport lifetime is undefined, emissions have been determined up to 2050 to coincide with the South Africa's net zero emissions scenario.

To assess the impact of the Project on climate change, a carbon footprint for the construction and operation of the airport was developed using the GHG Protocol's Corporate and Accounting reporting standard and the Department of Forestry, Fisheries and Environment's Methodological Guidelines for the Quantification of Greenhouse gas emissions. The carbon footprint includes Scope 1 direct and Scope 2 indirect GHG emissions largely related to the combustion of fuels and the use of electricity by the airport itself, as well as Scope 3 value chain emissions largely related to fuel usage by road transport and flights to and from the airport. The magnitude of the Project's emissions on the South Africa carbon budget under the NDC 1.5˚C aligned emission scenario was assessed. The overall impact or significance of the Project emissions was assessed by determining the extent, duration, magnitude and probability of climate change-related impacts.

The impact of climate change on the Project was assessed through a physical risk assessment. Historical climate data and future climate projections of environmental parameters in the Western Cape such as temperature, precipitation, and extreme weather events were analysed. The risk assessment tools used include the World Resources Institute (WRI) Aqueduct Tool, The Council for Scientific and Industrial Research (CSIR) GreenBook Municipal Risk Tool and The Global Facility for Disaster Reduction and Recovery (GFDRR) Think Hazard Tool. Climate hazards were identified and the potential impacts on health and safety, operations and value chain were assessed.

The total emissions of the project up to 2050 is estimated at approximately 5.3 million tCO_2e. The construction phase is estimated to last two years and produce 362 226 tCO_2e of indirect Scope 3 emissions. Emissions accounted for in the construction phase include fuel and electricity use in construction, transportation of materials, embedded emissions of building materials, waste generated and employee commuting. The operations phase is estimated to produce 1.02 million tCO_2e of Scope 1 & 2 emissions which account for fuel use in mobile vehicles, back up-generators, grid electricity usage and from the on-site wastewater treatment plant. Scope 3 value chain emissions are estimated at 4 million tCO_2e and include emissions from purchase of capital goods, upstream emissions from fuel and energy items, waste generated by operation of airport, business travel, employee commute and downstream emissions from the operation of the airport which includes passenger commute, cargo movements, domestic and international passenger flights. Emissions from flights make the largest contribution to Scope 3.

When the effect of emissions on the South African carbon budget is estimated, emissions from international flights are excluded as emissions do not occur within the boundaries of the country. This is in line with international practice and the National GHG Inventory Report (DFFE, 2022). It is expected that 3.68 million tCO_2e will be emitted within the borders of South Africa, representing 0.097% of the South African Carbon Budget of 3,780 $MtCO_2e$ up to 2050. The regulatory context was considered when determining the impact of Scope 3 emissions due the 40% contribution of domestic aviation to the Project's carbon footprint (carbon footprint excluding international aviation). Domestic aviation emissions will be controlled by government through the envisaged allocation of carbon budgets to airlines under the future Climate Change Act and penalised under the Carbon Tax Act, which could reduce the projected GHG emissions impact. The magnitude of the Project emissions can be considered as low-medium when only considering Scope 1 and 2 emissions by the airport operation, and medium when considering all emissions including domestic flights. The overall significance of climate change impact of the emissions from the CWA expansion project is deemed to be medium.

The impact of climate change on the Project was considered by reviewing the historical average annual surface temperatures and precipitation in the Western Cape region. The Westen Cape has Mediterranean climate i.e., cold-wet winters and warm-dry summers. Modelled projections for the impact of climate change in the regions shows that there will be an increase in temperatures and an increase in the number of hot days where temperature exceeds 30˚C. There is high uncertainty in the modelled projections regarding precipitation, however a reduction in rainfall can be expected. Using the risk tools mentioned, the physical risk assessment was conducted and potential hazards that could affect the Project were ranked. Risks considered include wildfires, landslides, water scarcity, extreme heat and flooding events. The CWA faces increased risk from climate hazards such as wildfires and water scarcity which have a high-risk ranking. Landslides and extreme heat have a medium ranking and flooding events were ranked low.

The CWA is at high risk from wildfires due to the increased temperatures and rainfall variability as well proximity to fire-prone vegetation. Winds, debris and smoke from fires could negatively affect the operation of the airport and reduce aircraft visibility. Climate change is expected to increase the frequency and duration of droughts which could increase water scarcity in the region. As CWA will be reliant on groundwater sources in the medium term, appropriate management of the aqueduct is crucial. Developing early warning systems for extreme weather events will be essential for proactive risk management. Site plans should be developed to withstand climate-related impacts to help mitigate potential damages and disruptions.

The project itself considers several mitigation and adaptation options such as the use of renewable energy to meet a portion of its electricity demands, the design of zero emissions buildings and water saving technologies associated with the operation of its water and wastewater treatment plants. In addition, the CCIA considers possible mitigation and adaptation measures that could be implemented by the project developer to reduce GHG emissions and improve the projects resilience to climate change. To further reduce GHG emissions the following items should be considered. CWA should consider installing sufficient renewable energy capacity to reduce its reliance on grid electricity. A waste management plan should be developed to effectively recycle and/or compost waste, and the design of the wastewater treatment plant should incorporate mitigation measures appropriate to the chosen technology. To improve the project’s resilience to climate change, it is recommended that a water scarcity management plan be developed to mitigate water scarcity risks and that wildfire risks be considered when designing fuel storage facilities.

The CCIA emphasises the project's minimal emissions from activities controlled by the airport, substantial value chain emissions and highlights significant physical risks affecting the project site. In addition, consideration was given to additional benefits of expanding the CWA. The airport expansion would stimulate economic opportunities in the region. Organic growth in tourism is expected in the region and an additional airport would reduce road congestion. The operational efficiencies for airlines would increase by decongesting aviation space in the region, reducing reserve fuel requirements and shorter rerouting distances in case of safety concerns.

It is our opinion that the Project can align with national and global climate goals while ensuring resilience against evolving climate challenges by implementing the planned mitigation and adaptation strategies. In this respect, we considered that the emissions controlled by the airport are low when compared to the emissions related to fuels burnt by incoming and outgoing flights which will be managed through future carbon budgets imposed on airlines under the Climate Change Act. Furthermore, the additional benefits in terms of decongestion and enhanced operational efficiencies that come with the role of the Project in the region may facilitate sustainable growth.

We do not propose any special conditions with respect to the authorisation of this Project.

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ACRONYMS & ABBREVIATIONS

CWA – Cape Winelands Airport

GA – General Aviation

NEMA – National Environmental Management Act

DEA&DP – Department of Environmental Affairs and Development Planning

EIA – Environmental Impact Assessment

CCIA – Climate Change Impact Assessment

CO_2 – Carbon dioxide

CH_4 - Methane

N_2O – Nitrous Oxide

GHG – Greenhouse gas

MAP – Million Annual Passengers

NDC – Nationally Determined Contributions

LTAS – Long Term Adaptation Strategy

WCCCRS – Western Cape Climate Change Response Strategy

CoCT – City of Cape Town

IPCC – Intergovernmental Panel on Climate Change

UNFCCC - United Nations Framework Convention on Climate Change

ACA – Airport Carbon Accreditation

ICOA – International Civil Aviation Organization

CORSIA – Carbon Offsetting and Reduction Scheme for International Aviation

AFOLU – Agriculture Forests and Other Land Use

PPP – Pollution Prevention Plans

$MtCO_2e$ – metric tonnes carbon dioxide equivalent

SET – Sectoral Emissions Target

ACERT – Airport Carbon and Emissions Reporting Tool

DEFRA – Environment Food and Rural Affairs

EAP – Environmental Assessment Practitioner

UoM – Unit of measure

GWP – Global Warming Potential

DFFE – Department of Forestry Fishery and Environment

EF – Emission factor

DECLARATION OF INDEPENDENCE

We hereby declare our independence as consultants for Cape Winelands Airport (CWA) in conducting a Climate Change Impact Assessment for the CWA Expansion Projects as part of the Environmental Impact Assessment process led by PHS Consulting. Aside from personal remuneration, we hold no personal, financial, or other interests in the project activities. Our objectivity remains uncompromised, and the views expressed in this report are solely our own.

Lodewijk Nel

Partner - Brundtland Consulting

Date: 04/03/2025

Jan Willem Timmer

Principal Consultant – Brundtland Consulting

Date: 28/02/2025

Clive Wray

Operations Director – Rayten Engineering Solutions

Date: 04/03/2025

DETAILS OF SPECIALIST

The following experts from Brundtland Consulting and Rayten Environmental have been involved in the assessment of the climate change impact of the proposed Cape Winelands Airport expansion:

- **Lodewijk Nell - Project Manager and Carbon Expert** has more than 15 years of experience in climate change mitigation. Lodewijk and his team completed the Greenhouse Gas Reporting Guidelines for DFFE, which included an in-depth analysis of the main industrial sectors and their GHG performance, including the power and aviation sectors. Moreover, Lodewijk supported various organisations for many years in the area of GHG reporting and supported clients in Climate Change Impact Assessment (CCIA) studies about gas to power, gas storage, solar PV and solar PV/battery storage hybrid solutions.

  Lodewijk holds an MSc in Chemical Engineering, complemented by a business economics programme at the Rotterdam School of Management.

- **Jan Willem Timmer - Carbon Expert** has more than ten years of experience consulting on policy and climate change. Among other things, he advised the South African Department of Environmental Affairs on various climate change-related topics including carbon intensities and the determination of carbon budgets pertaining to various sectors among which the power, manufacturing and aviation sector, the Department of Trade and Industry on green transport technologies and the City of Johannesburg on devising its climate change strategic framework.

  Jan Willem holds an MSc in Finance from the University of Oxford and LLM from Harvard University.

- **Clive Wray - Physical Risk Expert** has over two decades of experience accumulating a wealth of knowledge and a profound understanding of the intricate physical risks inherent in impact assessments. Through years of hands-on involvement and continuous learning, he has honed his expertise in evaluating and mitigating potential impacts on various physical environments. This extensive background enables Clive to navigate complexities with precision, identifying potential hazards and crafting comprehensive assessments. His journey through the evolving landscape of impact assessments has provided him with a nuanced perspective, allowing him to understand challenges and implement effective strategies.

  Clive holds a BSc (Eng) Honors Mechanical Engineering and is a Professional Engineer (Pr. Eng.) registered with the Engineering Council of South Africa (ECSA).

ADHERENCE TO NEMA REGULATIONS (2014) (AS AMENDED)

NEMA Regulations (2014) (as amended) – Appendix 6	Relevant Section in this report
Details of the specialist who prepared this report	Details of Specialist on page 2
The expertise of that person to compile a specialist report including a Curriculum Vitae	See Specialist CV's
A declaration that the person is independent in a form as may be specified by the competent authority	Declaration of Independence on page 11
An indication of the scope of and the purpose for which the report was prepared	Section 2 on page 1717
An indication of the quality and age of base data used for the specialist report	Section 4 on page 32
The duration date and season of the site investigation and the relevance of the season to the outcome of the assessment	Not applicable to climate change impact assessment
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 4 on page 32
Details of an assessment of the specified identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternative	Not applicable to climate change impact assessment
An identification of any areas to be avoided including buffers	Not applicable to climate change impact assessment
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Not applicable to climate change impact assessment
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 5 on page 46 & Section 6 on page 58
Any mitigation measures for inclusion in the EMPr	Section 7 on page 64
Any conditions for inclusion in the environmental authorisation	Section 7 on page 64 & Section 8 on page 67
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and regarding the acceptability of the proposed activity or activities	Section 8 on page 67
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 8 on page 67
A description of any consultation process that was undertaken during the course of preparing the specialist report	Not applicable to climate change impact assessment
A summary and copies of any comments received during any consultation process and where applicable all responses thereto	Not applicable to climate change impact assessment

1 INTRODUCTION

The Cape Winelands Airport (CWA) was formerly known as the Fisantekraal Airfield, a South African Air Force aerodrome used during World War II. In November 2020, it was purchased by Cape Winelands Airport Ltd and serves as a general flying field for the general aviation (GA) sector and facilitates unscheduled operations. The current site consists of four concrete runways each 90 m wide with varying lengths between 700 m to 1500 m. The CWA is situated approximately 10.5 km northeast of Durbanville and 25 km northeast of Cape Town International Airport (CTIA). The site is located about 40 km from Cape Town's city centre, with access routes from Drakenstein, Wellington, Paarl, and Stellenbosch. This positioning would enable excellent connectivity and the development of new tourism nodes within the region.

The current 150 ha site spans two cadastral and falls within the Cape Town urban edge, surrounded by cultivated land, livestock, and poultry farms, with a wastewater treatment facility to the northwest. The proposed expansion will extend across five additional surrounding cadastral, totalling 885 ha. The area of study will only comprise 470 ha of the total. The development aims to upgrade the CWA from a general flying airfield to a commercial airport capable of accommodating long-haul, wide-body flights by airlines and unscheduled operators. It will serve multiple aviation roles, including scheduled airline services for domestic and international passenger flights and cargo operations, general aviation for domestic and international unscheduled and private operations, and serve as an alternate airport for fuel planning purposes. Additionally, it will function as a reliever airport, providing redundancy and diversion capability for aircraft in the region.

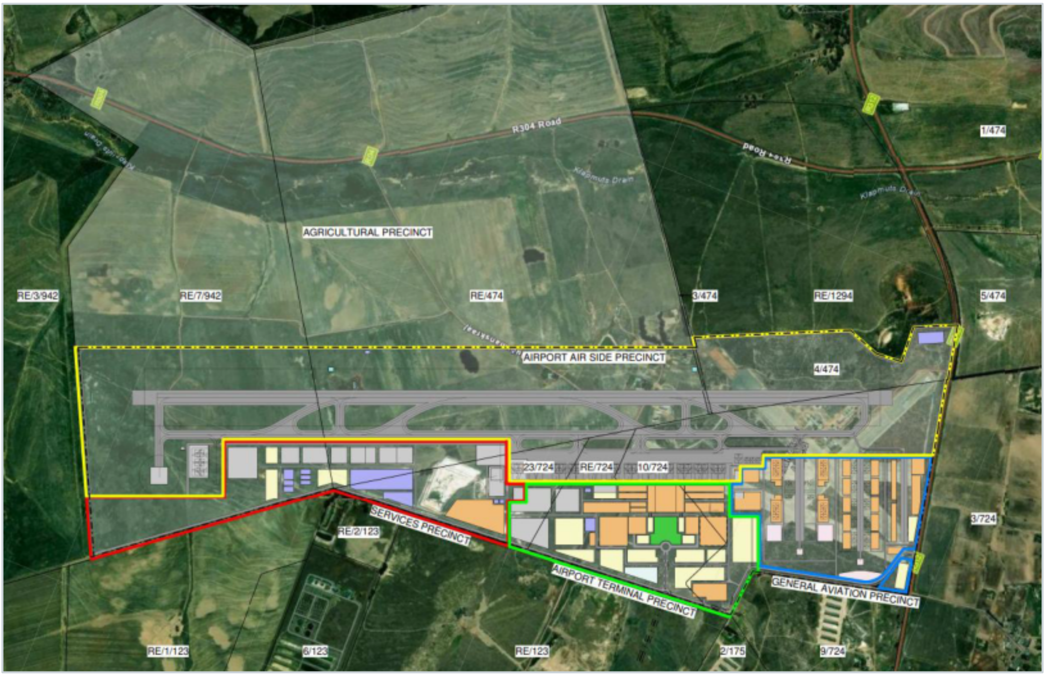

Figure 1 – Site locality and proposed layout of the Cape Winelands Airport

The services rendered by the airport will stimulate various industries and commercial activities, including fixed-based operations, private charter, recreational flying, flight training, aircraft maintenance, refurbishment, and overhaul, as well as hotel, conferencing, events, retail, food, beverage, warehousing, logistics, and freight services. The expanded airport will also serve as a significant multi-modal transport hub with excellent road, rail, and air connectivity.

The proposed expansion of the existing airport is planned to be carried out in five phases based on the 'Anchor Scenario' air traffic forecast results for the defined Planning Activity levels (PALS) 1A,1B, 2, 3, and 4. This includes realigning the primary runway to an orientation of 01-19 with a length of 3.5km. Infrastructure development on both landside and airside will also be phased in according to market demand.

Environmental authorization for the expansion project will be sought under the National Environmental Management Act (No. 107 of 1998) (NEMA) from the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP). The application will be supported by an Environmental Impact Assessment (EIA) as per the EIA Regulations of December 2017. Brundtland Consulting (Pty) Ltd was appointed by PHS Consulting to perform the Climate Change Impact Assessment (CCIA) of the proposed CWA expansion as inputs to the EIA. The CCIA involves assessing the contribution of the project to climate change through the emission of greenhouse gases (GHG's) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) as well as determining the physical risks faced by the project due to climate change.

This CCIA will cover the contribution of emissions from the airport's construction, core operation and associated value chain and investigate the consequent climate change impacts through the value chain. Climate change is a global phenomenon, and the environmental impacts experienced cannot be directly linked to the GHG emissions from an individual source, activity, or project. In other words, the GHG emissions related to the operation of the CWA cannot be attributed to any specific climate change effects. However, there is a collective responsibility to address climate change, and the CWA has an individual responsibility to minimise its contribution to climate change and manage climate-related risks within its area of influence.

2 PROJECT BACKGROUND

The operational scope for this CCIA concerns the proposed Cape Winelands Airport Expansion Project. The assessment will consider both the construction and operation phases of the Project. The scope of this assessment includes an assessment of the climate change impact, the physical climate risks, and mitigation and adaptation measures over the aforementioned project phases.

2.1 Project Description

The CWA aims to develop into an international commercial airport and multimodal logistics hub with excellent rail, road, and air connectivity. The planned developments will expand the airport's capacity to 5.2 million annual passengers (MAP) at PAL 4 under the anchor airline scenario (Naco – Master Plan Report, 2023). The anchor airline scenario represents the highest growth scenario and defines the demand or sizing for all airport facilities. Five developmental phases referred to as the Planning Activity Levels (PALs) and the corresponding capacity have been identified and shown in Figure 2. The first two phases, Pal 1A & 1B are for the first phase of the EIA (EIA Phase 1). The remaining PALS (Pal 2, 3 & 4) is for the second phase of the EIA (EIA Phase 2). The expected construction timeline for the airport is two years for the initial build, with the first flights expected in the year 2027, with continued construction and expansion up to 2060

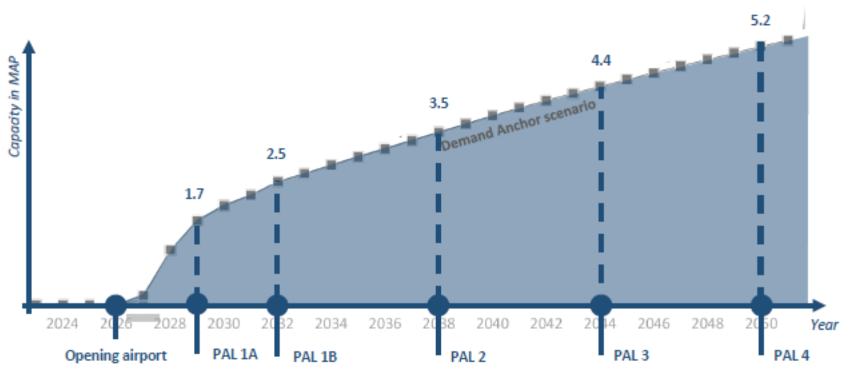

Figure 2 – Planning activity levels for the CWA

The CWA aims to be self-sustainable in terms of electricity by commissioning a Solar PV farm and Biodigester to meet its electricity needs. To further lower its carbon footprint, airport buildings will be designed efficiently to reduce heating and cooling needs and the use of electric vehicles for ground operations will be promoted. The CWA site will also focus on effective water management and recycling aiming to minimise abstraction from the borehole or groundwater sources by using wastewater in the biodigester and for irrigation.

Infrastructure development at the site is classified into four precincts i.e. the airport airside precinct, airport landside precinct, services precinct, and general aviation precinct. The infrastructure developments expected to take place include:

- **Runways, taxiways and associated airside infrastructure** development which will include a 3500 m Code 4F Runway, parallel code 4F taxiway, link taxiways, apron and apron taxiways, an isolation stand, Code 1 link taxiways, airside perimeter fence, equipment roads, stormwater drainage, pavement structures, earthworks.
- **Other aeronautical infrastructure** such as air traffic control facilities, visual and navigational aids, aircraft rescue and firefighting facilities, fuel storage facilities, heliport, advanced air mobility infrastructure.
- **Terminal Infrastructure and facilities** which includes the scheduled passenger terminal, cargo terminal facilities, landside infrastructure and facilities, access roads, vehicle parking, public transport facilities, car rental facilities, drop-and-go facilities, and plaza.
- **Lettable area** (in excess of 350 000 m^2) for hangarage, logistics and warehousing facilities, food processing, education and commercial office space, retail, events and conferencing, hotel and guesthouse accommodation, bulk aviation fuel farm, and public filling stations.
- **Other key services infrastructure** such as the biodigester plant, solar panels, renewable electricity battery storage system and non-renewable diesel backup power system, wastewater treatment, borehole system and water purification, electricity infrastructure i.e. substations, heating and cooling systems.

These developments will ensure that CWA evolves into a leading international commercial airport and logistics hub, supporting sustainable growth and regional development.

2.2 PROJECT SCOPE

The EIA process for the CWA expansion project is being conducted per the National Environmental Management Act (NEMA Act No 107 of 1998). The CCIA analysis presented in this report aligns with the NEMA regulations and the EIA regulations of 2017, which govern activities that impact the environment within South Africa. During the operational phase of the CWA, GHG emissions from various combustion activities will be released into the atmosphere, contributing to climate change. In the EIA scoping phase, a CCIA was recommended to quantify and incorporate the effects of climate change. The objective of the CCIA is to assess the current effects of climate change and determine the impact of the airport's construction and operation on the climate, as well as how the project would be affected by climate change.

The following items will be investigated and presented in this report:

- **Review of the Regulatory Context** – a review of the international, national and provincial regulatory climate change context, to inform the specialist opinion for this CCIA.
- **Impact of the Project on Climate Change** – assess the impact on the climate compared to the baseline in the absence of the Project. This will be done by:
  - Describing the existing greenhouse gasses (GHGs) emitted by the current CWA site.
  - Determining the GHG emissions pertaining to the construction and operational phases of the airport.
  - An analysis of the GHG emissions (carbon footprint) of the Project and its impact on climate change by considering its cumulative impact on the national inventory.
- **Physical impacts of climate on the project and associated risks** – assess the projected climate change impacts in the absence of, and with the Project implemented. This will be done by:
  - Determining the impacts on core operations due to the exposure to climate change, the sensitivity and vulnerability to such.
  - Determining the impacts of climate change on the value chain and the services provided.
  - Assessment of climate change-related impacts on the local natural environment, surrounding communities, local ambient air quality and human health
- **Mitigation and adaptation measures** – determine mitigation and adaptation measures to reduce the impact on the climate and improve the Project's resilience to climate change.

The CCIA will assess emissions resulting from both the construction and operation phases of the Project. For the construction phase, emissions are likely to occur from fuel consumption (i.e., during stationary combustion and mobile combustion) and electricity use. Additionally, the embodied carbon in construction materials such as cement, concrete, glass, and plastics will also be considered. The majority of the Project's GHG emissions would occur during the operational phase. The GHG emissions controlled by the airport expected during this phase include emissions from fuel consumption by backup generators and on-site vehicles as well as fugitive emissions related to fuel storage and refuelling activities. Value chain emissions from passenger and flight movements will also be considered. Due to the long-term nature of the project, the decommissioning of the airport will not be assessed. Therefore, emissions will be calculated up to 2050, aligning with a net zero emissions by 2050 scenario. Furthermore, the CCIA will not evaluate alternative scenarios as none were identified in the draft Environmental Impact Assessment (EIA).

3 CLIMATE CHANGE CONTEXT

This section provides a comprehensive overview of climate change, examining its global implications and how it is addressed at national, provincial, and regional levels. Key legislative documents are considered, including South Africa's Nationally Determined Contribution (NDC), the Long-Term Adaptation Strategy (LTAS), the Western Cape Climate Change Response Strategy (WCCCRS) 2050, and the City of Cape Town Climate Action Plan. These documents outline the anticipated impacts of climate change on various levels and identify key risks and hazards, particularly at the municipal level. Specific focus is given to those climate change risks, such as temperature and rainfall, that have direct implications for airport operations.

3.1 Global Context of Climate Change

The increase in greenhouse gas emissions from anthropogenic activities have been scientifically determined as the cause of discernible changes seen in Earth's atmospheric conditions, known as climate change. Greenhouse gases such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have driven the changes seen in the Earth's atmosphere. While the greenhouse effect is a natural process that traps heat from the atmosphere and regulates the Earth's temperatures, excessive quantities OF GHGS act as a blanket, trapping excess heat. Over the past two centuries, human activities have escalated atmospheric CO_2 levels by 50%, The natural processes on land and ocean absorb about half of the emitted CO_2 annually, however human emissions surpass the capacity of these sinks. This causes a yearly increase in atmospheric CO_2. The increased CO_2 causes the atmospheric temperature to rise, resulting in global warming, and ultimately contributing to climate change.

The pace at which global temperatures are rising exceeds any recorded instance in history, altering weather patterns and disrupting ecosystems faster than ever. As a consequence of climate change, higher temperatures, extreme weather events, increase in the severity of storms, drought and environmental issues such as rising sea levels, loss of biodiversity, and socio-economic concerns such as food shortages, health risks, poverty, and displacement have become more prevalent. Amid these escalating climate change impacts, stakeholders worldwide recognize the urgent need for robust adaptation and mitigation measures. Internationally, organizations like the World Economic Forum and the Intergovernmental Panel on Climate Change (IPCC) highlight climate change as a key global risk. They warn that the current global efforts to reduce the effects of climate change, fall short of preventing a 1.5-degree Celsius temperature increase. (IPCC – Sixth Assessment Report, 2023) Scientists warn that this increase would lead to catastrophic consequences such as intensified heatwaves, rising sea levels, and irreversible damage to ecosystems.

The Paris Agreement, adopted by 196 countries at the UN Climate Change Conference in 2015, underscores the importance of both adaptation and mitigation. The Paris Agreement calls for the submission of Nationally Determined Contributions (NDCs) from the signatory nations every five years. These action plans commit countries to reducing emissions and enhancing resilience and are meant to reflect an increase in ambition for climate action. South Africa, as a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), is committed to stabilizing greenhouse gas concentrations and developing adaptation strategies outlined in its NDCs. Under the Paris Agreement - a framework for financial, technological and capacity building support is outlined. This is in place for countries that need additional support to achieve their set goals under their NDCs. This is both for vulnerable countries that have been disproportionately affected by the effects of climate change and to encourage voluntary contributions to build better resilience to climate change.

The operation of airport bodies can be accredited for their carbon management through the Airport Carbon Accreditation (ACA) program. This is the only institutionally endorsed global carbon management certification program for airports. The ACA independently assesses and recognizes the efforts of airports to manage and reduce their carbon emissions, offering seven levels of certification. This acknowledges that airports are at different stages in their journey towards comprehensive carbon management. The program is owned and governed by Airports Council International Europe. The ACA requires airports to map both their direct and indirect emissions and work towards achieving a net zero goal. For indirect emissions, emphasis is placed on those emissions that the airport can control, such as employee commuting and staff business travel.

A significant portion of value chain emissions by airports are associated with civil aviation operations by airlines or aircraft operators. The International Civil Aviation Organization (ICAO) coordinates the international air transport sector. As a United Nations agency, ICAO aims to promote the growth of the global civil aviation system. Under ICAO, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) has been established. CORSIA is the first global market-based measure designed to reduce emissions from international aviation. CORSIA allows for the offsetting of carbon emissions that cannot be reduced through technological improvements, operational enhancements, and the use of sustainable aviation fuels, using carbon market measures. From 2027, CORSIA will be mandatory for all international flights and airlines and other aircraft operators are required offset any growth in carbon emissions above 2020 levels.

3.2 Local Context of Climate Change

South Africa, as a developing nation, faces unique challenges in dealing with climate change. To address these challenges, commitments to reduce emissions while also emphasizing the importance of continued economic and social development is crucial. The effects of climate change are already observable across the country. Over the last five decades, South Africa's temperature has increased

1.5 times more than the global average of 0.65°C, leading to more extreme daily and seasonal temperature variations (Long Term Adaption Scenario, 2013). Figure 3 below shows the annual increase in temperature in South Africa over the past century. Rainfall patterns have become more erratic, with fewer days of intense rain and more dry spells. Projections suggest continued warming by the end of the century, particularly in the interior, with wetter conditions in the west.

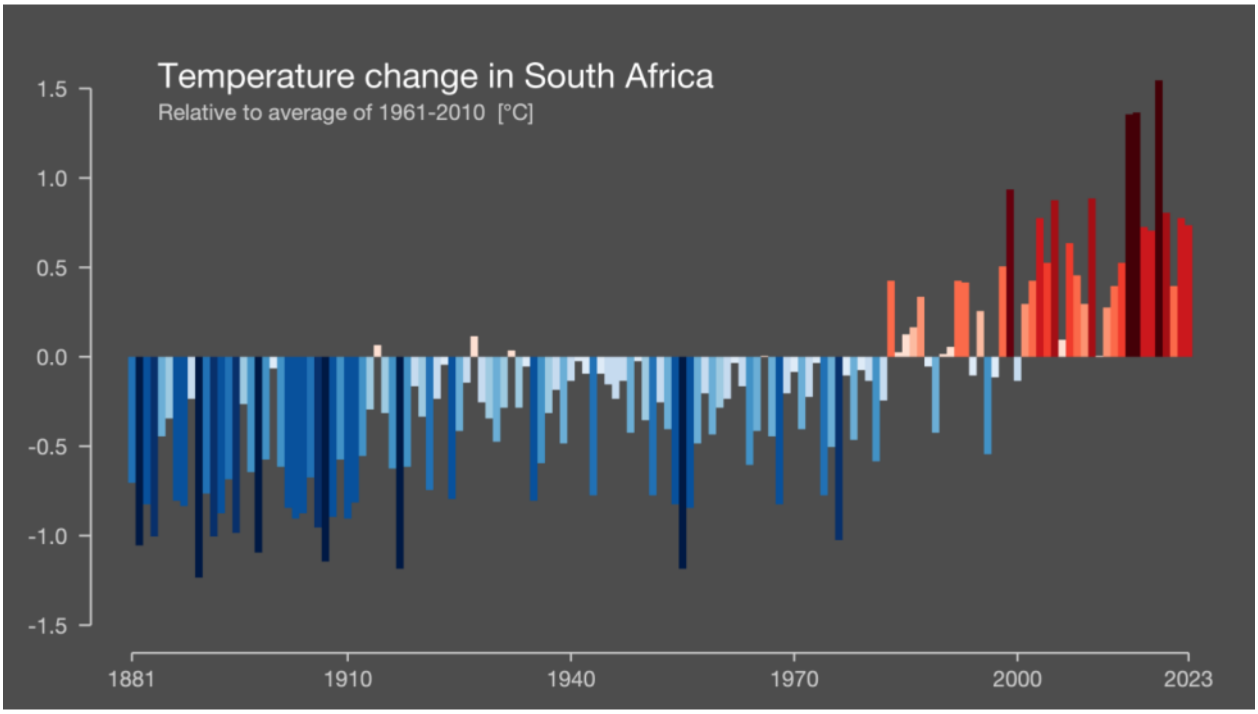

Figure 3 – Coloured bars showing the progression of increased temperatures in South Africa, relative to South Africa's average temperature between 1961 and 2010 (Show Your Stripes)

South Africa's response to the Paris Agreement involves a transition to a green economy. Initiatives such as the Carbon Tax Act of 2019 (which prices emissions from in all sectors except waste and Agriculture Forests and other land use (AFOLU)) aims to reduce sectoral emissions. The threshold for combustion emissions under the Carbon Tax Act is set at 10 megawatt thermal. Since ratifying the Paris Agreement in 2015, SA has made significant progress in developing its response to climate change and the mitigation system continues to be developed. In 2017, the GHG reporting regulations were gazetted together with the requirement that large emitters submit annual Pollution Prevention Plans (PPP). South Africa is in the process of implementing a climate change bill which is a legislative framework to provide firm legal basis for further action including a mandatory carbon budget programme per sector and sectoral emission targets.

South Africa's Nationally Determined Contributions (NDC) outline sectoral responses, adaptation investments, and support requirements, emphasising the need for finance, technology transfer, and capacity-building. The NDC takes the form of a peak, plateau and decline GHG emissions trajectory range as depicted in Figure 4. South Africa has stated the NDC up to 2030 and released an update on the progress made in achieving mitigation efforts. As per the updated NDC, between 2025 to 2030 South Africa's emissions will range between 398 and 614 Mt CO_2e as defined in the national policy and mitigation targets for 2025 and 2030 are set. South Africa's updated mitigation targets aim to reduce emissions in the implementation period from 2021 to 2025, to a level in a range of 398-510 Mt CO_2e and in the period from 2026 to 2030 to a level between 350 and 420 Mt CO_2e (NDC, 2021).

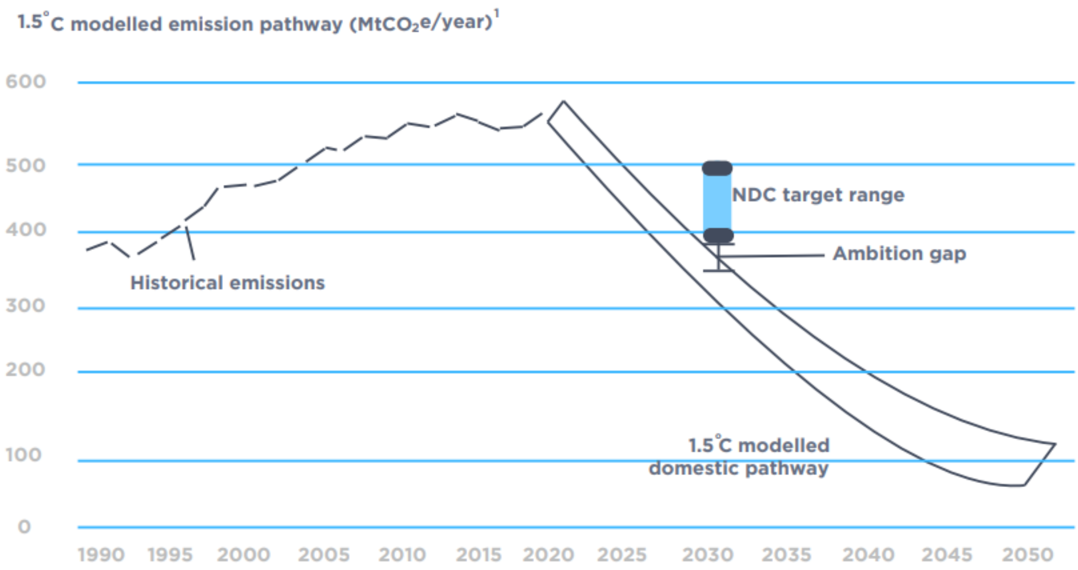

Figure 4 – South Africa's Emissions (Adapted from Climate Transparency Report, 2021)

According to the draft Sectoral Emissions Targets (SET) report, released in April 2024, the national GHG inventory is estimated at 435.7 metric tonnes of carbon dioxide equivalents ($MtCO_2e$). The transport sector is responsible for approximately 12% of the national GHG emissions. Road transportation accounts for 51.2 $MtCO_2e$, while other transport modes contribute 1.6 $MtCO_2e$. Civil aviation, identified by the IPCC code 1A3, encompasses both international and domestic aviation (Sectoral Emission Target, 2021). The draft National GHG Inventory Report (NIR, 2022) for 2022 estimates that international aviation emitted 2.31 $MtCO_2e$ per annum; however, these emissions are monitored but not included in the inventory as they fall under the jurisdiction of ICAO. Emissions from domestic aviation account for 1.3% of total transport emissions, roughly 0.68 $MtCO_2e$, and are subject to carbon tax. The carbon tax threshold is set at 100,000 litres per annum for airline and aircraft operators (Carbon Tax Act, 2019). The SET report aims to implement emission reduction measures to cumulatively reduce the transportation sector's emissions by 18 $MtCO_2e$ by 2050.

The Integrated Resource Plan (IRP) (2019) focuses on renewable energy growth to mitigate pollution and strain on the grid. The IRP aims to map out the future energy mix for the country with the intention of subjecting it to public comment for further improvement. It is continuously updated with the long-term electricity demand projection and how this demand can be met. Recognizing the adverse impacts of the transport sector on land, water, air quality, and biodiversity, the Department of Transport (DoT) is committed to mitigating greenhouse gas (GHG) emissions. This commitment is demonstrated through the implementation of the Green Transport Strategy (GTS), which aims to reduce emissions while promoting sustainable development (Green Transport Strategy, 2018). Specifically, the DoT has published a white paper titled "National Civil Aviation Policy" which specifies the intention to develop an implementation strategy into alternative fuels for use in aviation and reduce aviation emissions. Furthermore, South Africa's overarching low-emission development strategy considers various economic, energy, industrial, and waste factors to achieve significant emissions reductions while also acknowledging the need for economic development.

3.3 Observed Trends and Projected Climate Change

3.3.1 National Overview

The National Climate Change Adaptation Strategy (NCCAS) provides a common vision for resilience, focusing on vulnerable groups, systemic changes, and technological advancements (NCCAS, 2019). It integrates adaptation into policies, coordinates efforts across sectors, and aligns with international obligations under Article 7 of the Paris Agreement. The NCCAS is the key domestic policy instrument to guide the implementation of key adaptation strategies. Adaptation efforts aim to reduce vulnerability through increased resilience in human, economic, and environmental domains, supported by services like early warning systems and stakeholder engagement.

The LTAS study conducted by the Department of Environmental Affairs in 2012, highlights the significant challenges South Africa faces from climate change, with rising temperatures, rainfall variability, and extreme weather events impacting various sectors. To alleviate these effects, mitigation strategies as laid out in LTAS must be implemented.

The following points outline the various sectors within South Africa that are anticipated to undergo significant effects because of climate change:

Water Sector

- The water sector is significantly affected, especially in regions like the Western Cape, due to the anticipated decreased rainfall and increased evaporation rates.
- The viability of stored water resources could be threatened due to the change in rainfall patterns.

Agricultural and Forestry sectors

- Increased irrigation demands could occur, threatening agricultural viability such maize production in the Western Cape.
- Climate-induced changes in diseases for plants pose risks to food security and crop yield.

Human Health

- Temperature and weather cycle changes increase the risk of heat strokes and vector-borne diseases.
- Potential displacement from extreme weather events impacts communities and their well-being.

Forestry, Fisheries and Biodiversity

- The forestry and fishery sectors face challenges due to changing ecosystems, while biodiversity, such as the Fynbos biome in the Western Cape, is under threat.

3.3.2 Provincial Overview

The Western Cape faces challenges and vulnerabilities due to climate change as outlined in the Western Cape Climate Change Response Strategy 2023 (WCCCRS, 2023). The region is prone to natural hazards such as drought, heatwaves and flooding, which are expected to increase in frequency and intensity. The Western Cape government envisions a Net-Zero emissions and climate-resilient province with an equitable and inclusive society and economy. The WCCCRS sets out four objectives to achieve this, i.e., transitioning to net zero emissions by 2050, reducing climate risks, increasing climate resilience, and enabling a just transition.

The Western Cape already experiences the effect of climate changes with temperatures rising at an approximate rate of 0.1˚C per decade. The coastal regions are at risk of rising sea levels which would negatively impact infrastructure along coastal lines. The changing climate patterns will impact society's day-to-day activities, and economic activities such as agriculture and tourism and increase water security issues and wildfire events. The increased cost of carbon-intensive activities such as air travel may decrease tourism in the area, impacting the region's economy.

The Western Cape's climate future is uncertain, with two proposed narratives offering contrasting scenarios (South Africa’s Third National Communication, 2018). The first narrative paints a picture of a drier, hotter, and windier future, characterised by cycles of drier and wetter years over the next few decades. An increased frequency of hot spells in summer and a decrease in cold spells in winter. Stronger summer winds, fuelled by sub-tropical high-pressure systems and intense inland heating, will exacerbate evaporation and evapotranspiration, resulting in drier soils and increased demand for irrigation. Rainfall patterns are expected to shift towards more frequent and consecutive dry years, rendering agricultural activities unviable and causing heightened stress during summer months.

Furthermore, intensified winter storms may lead to increased flooding-related damages, posing significant challenges to both rural and urban areas.

In contrast, the second narrative presents a warmer, wetter future. changes in rainfall patterns are anticipated, with increased rainfall over mountains due to more energetic winter storms and enhanced moist southerly flow off the ocean during summer months. This could lead to higher river flows and increased runoff into dams, partially alleviating water supply concerns. Nonetheless, agriculture and urban water demands will continue to strain water resources, necessitating measures to reduce demand and improve water management practices.

Both narratives highlight the need for proactive adaptation measures to address the challenges posed by climate change in the Western Cape. Strategies to enhance water efficiency, manage water resources effectively, and build resilience in agricultural and urban systems will be crucial in navigating the uncertainties of the region's climate future. Additionally, efforts to mitigate greenhouse gas emissions and reduce the drivers of climate change are essential for minimising the severity of future impacts.

The Western Cape boasts a diverse climate influenced by its coastal proximity and expansive mountain ranges. These geographical features generate pronounced rainfall gradients and localized weather dynamics across the region. Such climate diversity fosters a rich array of natural resources and varied productive potentials. However, the province also grapples with recurrent weather extremes and disasters, including floods, droughts, hailstorms, wildfires, heatwaves, and coastal storm surges. These events pose significant challenges to both the environment and communities, necessitating proactive measures for resilience and adaptation. Despite the inherent climatic variability, the Western Cape's unique climate landscape underscores its potential for sustainable resource management and underscores the importance of comprehensive disaster preparedness strategies

Adaptation efforts in the Western Cape focus on water and food security, coastal impacts, biodiversity, ecosystem services, and community resilience, particularly for vulnerable groups. Resilience-building requires an understanding of both near and long-term adaptation measures to avoid maladaptation and address inevitable climate-related disasters. To effectively respond to climate change, the Western Cape must reimagine its approach to economic development and initiate shifts in key sectors such as agriculture, tourism, and manufacturing to match expected conditions and enhance infrastructure resilience. Early warning systems, improved weather assessments, and climate-conscious spatial planning are crucial steps toward achieving the province's goal of becoming net-zero by 2050 and mitigating the increasing frequency of climate-related extreme weather events, which currently account for 90% of disasters in the Western Cape region.

3.3.3 Metropolitan Municipal Overview

The proposed Cape Winelands Airport is located within the City of Cape Town Metropolitan Municipality (CoCT), a region known for its rich biodiversity. The CoCT is situated in the Cape Floristic Region, boasts 307 km of coastline and includes several seasonal wetlands, freshwater bodies, and watercourses. In recognition of the region's environmental significance, the CoCT implemented a climate change policy in 2017, followed by a revised climate strategy in 2019. The Climate Change Action Plan outlines ten focus areas aimed at creating a sustainable future, with the goal of transforming Cape Town into a climate-resilient, resource-efficient, and carbon-neutral city (City of Cape Town Climate Strategy, 2021).

Cape Town's climate, classified as "warm-summer Mediterranean," features cool, wet winters and warm, dry summers. The average monthly climatology for the Western Cape is shown in Figure 5. However, climate change is disrupting this balance. The city has experienced rising temperatures and more frequent heatwaves.

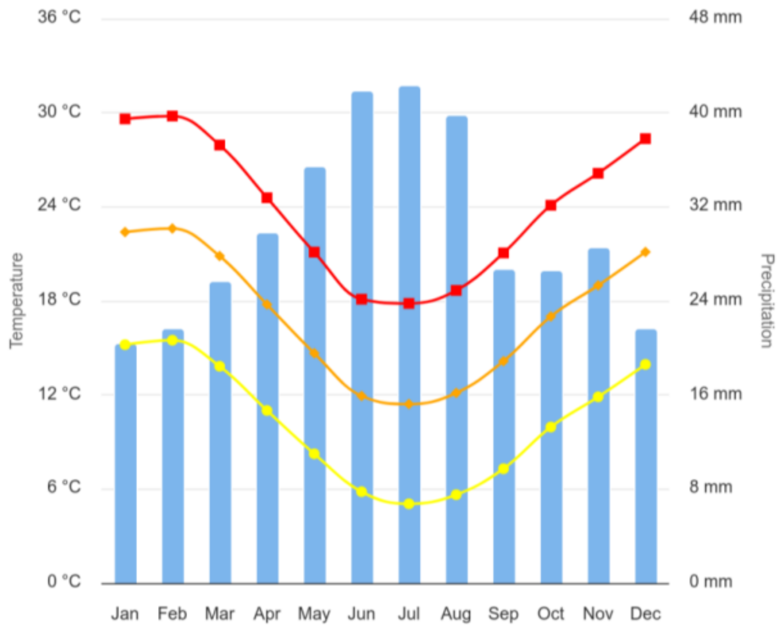

Figure 5 – Monthly climatology of average minimum, mean and maximum temperatures and precipitations for the western cape (The World Bank Group, 2021)

The average precipitation for the Western Cape region is shown in Figure 6 below. The annual precipitation over the Western Cape has been recorded to increase at a rate of 14.7 mm per decade since 1950. However, when considering only the recent past (i.e., the last 30 years), a decrease in annual precipitation at a rate of 23.3 mm per decade is evident. While droughts are common, their severity has increased. The severe drought from 2015 to 2018 highlighted the city's water security vulnerabilities, prompting the CoCT to develop a dedicated Water Strategy. Extreme wet weather events during winter pose flood risks in low-lying areas and regions with high water tables. Additionally, severe storms can cause significant damage to infrastructure and property. The Water Strategy addresses strategic areas two and three of the Climate Change Action Plan, aiming to achieve "water sensitivity" by 2040. It focuses on water security and drought preparedness, as well as flood readiness and storm management. These changes in temperature and rainfall impact the agricultural and tourism industries, in a region highly dependent on them.

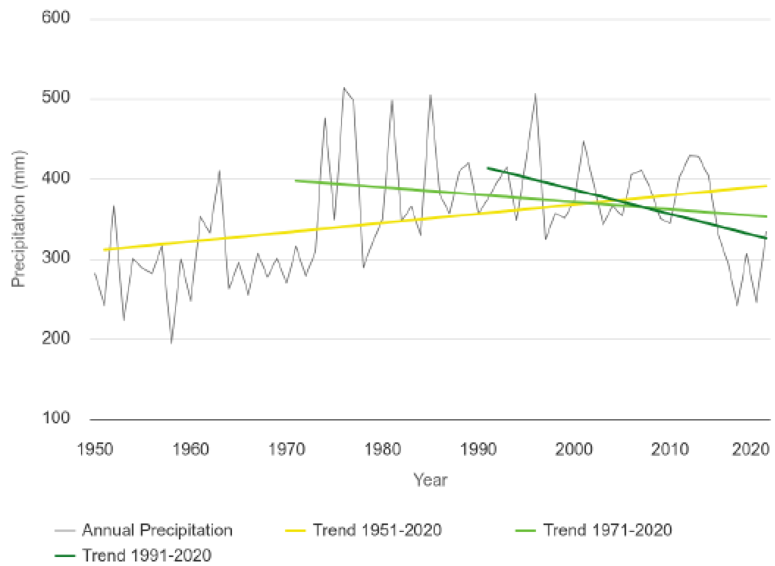

Figure 6 – Precipitation annual trends with significance of trend per decade, 1951 - 2020; South Africa (The World Bank Group, 2021)

The coastline is an important asset to the CoCT supporting tourism and recreational activities. Changes to wind speed and direction and in ocean currents are contributing to coastal erosion. Rising sea levels due to climate change further threaten coastal areas, worsening existing coastal erosion. Cape Town's native vegetation, Fynbos, is adapted to fire and requires periodic burning for regeneration. However, climate change has introduced new challenges, including increased fire frequency and intensity. These altered fire regimes can damage ecosystems. The CoCT exposure to climate-related impacts due to key Climate Challenges faced are summarised in Table 1.

Table 1 – Summary of climate-related impacts in the Western Cape region

Projected claim in Climate	Magnitude	Impact or risk
Significant decrease in mean annual rainfall	60 – 120 mm decrease in annual rainfall	Decreased agricultural productivity Decreased food security Loss of jobs and livelihoods in key sectors i.e. agriculture and tourism
Altered seasonality of rainfall patterns	0 – 3 days decrease in rainfall	Decreased agricultural productivity Decreased food security Loss of jobs and livelihoods in key sectors i.e. agriculture and tourism
Increase in average, maximum and minimum temperatures	1 – 3˚C increase	Increased risk of fire Loss of biodiversity Decreased agricultural productivity Decreased food security Loss of jobs and livelihoods in key sectors i.e. agriculture and tourism
More frequent and intense heatwaves	0 – 10 days increase of heatwave days (i.e. >32˚C for 3 consecutive days) Very hot days >35˚C	Negative health impacts Loss of biodiversity Decreased agricultural productivity Decreased food security Loss of jobs and livelihoods in key sectors i.e. agriculture and tourism
Wind speed	0 – 0.3 m/s increase	Damage to infrastructure
High fire-danger days	0 – 20 days increase	Health impacts Loss of biodiversity Damage to infrastructure
Rising sea levels	~ 1 m by 2100	Increased coastal erosion and damage to infrastructure

3.3.4 Rainfall

The Western Cape faces significant risks from climate change, with reduced average rainfall being a major concern. The current annual rainfall experienced in the Fisantekraal region is shown in Figure 7 below. The rainfall projections for the region show considerable variability, estimating minimal reduction to as much as 20%. The reduction is expected to be mainly from lower rainfall intensity per event than from a decrease in the frequency of rainy days. The rising temperatures are anticipated to escalate evapotranspiration rates, leading to more frequent and prolonged dry spells. In summer, dry periods could extend up to 20 days. The frequency of droughts is also expected to increase, current 1-in-10-year drought events could potentially occur as frequently as once every two years by the end of the century.

The current Cape Winelands airport site relies heavily on groundwater, due to minimal municipal water connections being available. The proposed airport site falls within the Spes Bona Reservoir supply zone but is not currently supported by municipal potable water pipelines of adequate size to meet the projected demand of the proposed airport. Connecting the airport to the municipal system would require significant infrastructure changes. In the short to medium term, the airport will continue to depend on groundwater. While groundwater sources can be replenished, its sustainability is contingent on careful management to avoid overuse. Climate change has exacerbated reliance on groundwater, as surface water sources face increased stress due to higher temperatures, reduced rainfall, and increased evaporation rates. Reduced annual rainfall and increased evaporation would not allow groundwater sources to be replenished effectively. Effective groundwater management will be essential to maintain a sustainable water supply amid the challenges posed by climate change.

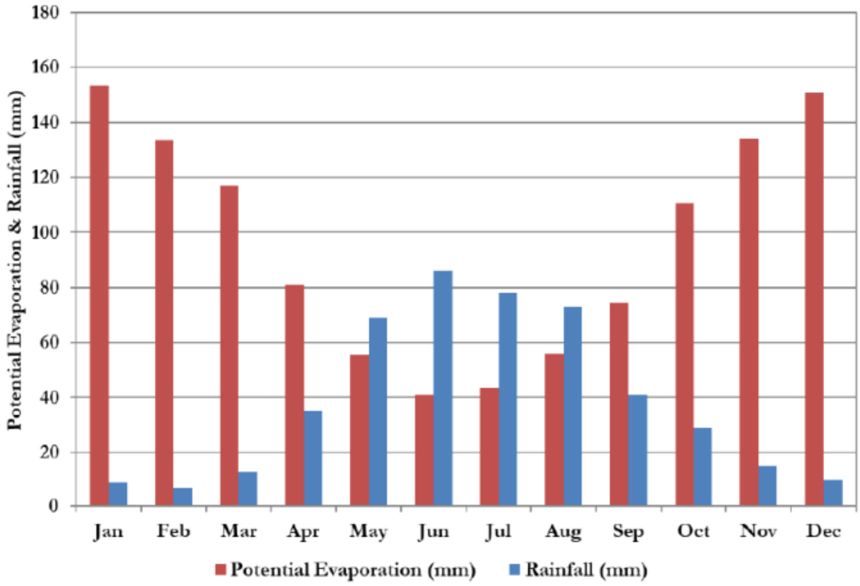

Figure 7 – Current monthly average rainfall and evaporation for the Fisantekraal area
(Groundwater Impact Assessment Scoping Report, 2024)

3.3.5 Temperature

The Western Cape has been experiencing a 0.1˚C increase per decade, resulting in a rise in the number of extreme temperature events and a decrease in cold nights. As the projected temperatures continue to rise, evapotranspiration rates increases and along with decreased rainfall, the likelihood of droughts occurring increases twofold. Temperature indices forecast a rise in mean temperatures across the province between 1 and 1.8˚C with the mean annual daily temperature to reach up to 2 – 2.7˚C in inland areas. Increased temperatures will increase the number of hot days (days exceeding 30˚C) by five-fold, reaching 30 hot days per annum.

The average air temperature in the Fisantekraal Region is shown Figure 8. The rise in average and extreme temperatures can exceed design standards, leading to heat-related deterioration of airport infrastructure such as runways, taxiways, and aprons. High temperatures cause materials to expand and contract, resulting in cracks and structural damage over time. When runway surfaces are compromised, asphalt can soften or melt, creating holes or buckling, which poses significant risks during aircraft take-off and landing. Aircraft performance is affected at higher temperatures as hot air reduces the lift generated by an aircraft's wings during take-off. Consequently, longer take-off distances may be required, necessitating runway extensions. Higher temperatures reduce engine efficiency, leading to higher fuel consumption.

Electricity consumption at airports increases due to the heightened demand for cooling systems, necessary to maintain passenger comfort and protect ground staff from heat exposure. This includes the need for more shaded areas, frequent breaks, hydration stations, and ensuring proper equipment functioning. Elevated temperatures impact fuel handling and storage areas, increasing the volatility of aviation fuel. This leads to higher vapour pressures within storage tanks and fuelling systems, which can result in fuel losses and pose significant safety hazards. Volatile organic compounds (VOCs) released under these conditions are potential fire hazards, raising the risk of explosive incidents.

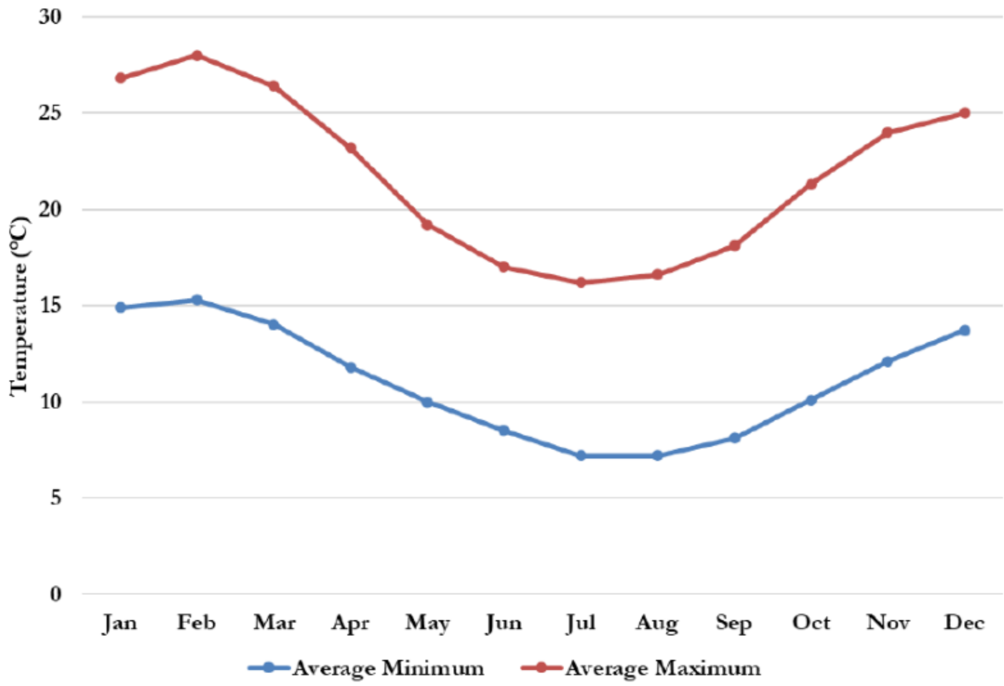

Figure 8 – Current average air temperature for the Fisantekraal area
(Groundwater Impact Assessment Scoping Report, 2024)

4 METHODOLOGY

In conducting the CCIA, two aspects should be considered: the impact of GHGs produced by the Project on climate change and the impact of climate change on the Project. In Section 4.1, the approach in determining the project's impact on climate change by defining the carbon footprint methodology and assessing the cumulative impact of the project's emissions on the South African National GHG Inventory. In Section 4.2, the methodology for assessing the physical impacts of climate change on the project is described. The latter includes evaluating potential risks and necessary adaptive measures.

4.1 CARBON FOOTPRINT METHODOLOGY

The total amount of GHGs that are emitted directly and indirectly by an entity's activities and value chain, is termed its 'carbon footprint' which is used to quantify and assess its contribution to climate change.

The GHG Protocol's Corporate Accounting and Reporting Standard (GHG Protocol, 2024) is an internationally recognised standard for calculating and reporting GHG emissions for corporate and public entities on a voluntary basis, i.e., non-compliance reporting. It provides guidance on defining operational and organisational boundaries (such as determining which activities and GHG emission sources to include), methods for calculating emissions to create a GHG emissions footprint, and procedures for reporting emissions. The GHG Protocol's standards cover seven GHGs - Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluorides (SF_6) and Nitrogen trifluorides (NF_3). The GHG Protocol categorises the different GHG emissions produced by a company during its operations and from its wider value chain into three "Scopes", as illustrated in Figure 9 below.

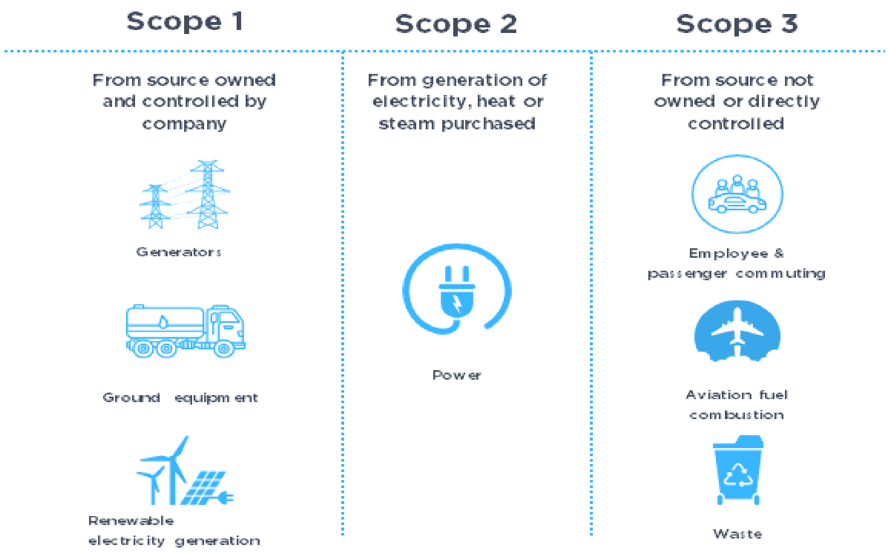

Figure 9 – Scope 1, 2 and 3 emissions as per the GHG protocol

Scope 1 - direct emissions, are emitted through activities owned and/or controlled by a company, such as the company-owned ground equipment vehicles, wastewater treatment processes and onsite electricity generation. Since the activities are owned/controlled by the company, all possible mitigation activities can be implemented by the company itself to reduce Scope 1 emissions.

Scope 2 - indirect emissions emanate from **purchased electricity and/or heat (energy) consumed by a company** and come from where the energy is produced. The company consuming the energy can reduce these indirect emissions by reducing consumption or switching to renewable sources. However, the company is not directly in control of the generation of the energy and depends on the energy supplier to reduce the emissions related to its generation.

Scope 3 emissions, also known as value chain emissions, encompasses emissions that are not produced by a company itself and are not the result of activities from assets owned or controlled by them, but by parties that it is indirectly responsible for up and down its value chain. Scope 3 emissions are often excluded in line with global practices for CCIA's, mostly because the project and/or project owner has no control over such emissions. However, in this case, Scope 3 emissions will also be included on a voluntary basis to create an overall holistic perspective. Examples include GHG emissions from production of purchased goods and services, business travel and employee and aviation. Aviation includes flights from domestic and international airlines and aircraft operators.

The GHG Protocol guidelines follow the general procedure of setting the boundary of the project, identifying GHG emission sources, collecting activity data and then using emission factors to calculate the various GHG emissions. This process was followed to calculate the emissions of the Project and is described below.

4.1.1 Boundary Identification

In setting the organisational boundary, the GHG protocol defines three consolidation approaches - equity share, financial control, and operational control. In equity share, an organisation accounts for the GHG emissions resulting from its assets and operational activity in proportion to its equity in the operation. Under financial control, the organisation reports emissions linked to activities it has full control over. If the organization has the full authority to introduce and implement operating policies and is generally the operator of the facility it may report emissions under operational control. For the CWA Expansion Project, the operational boundary was used to determine the activities that would result in GHG emissions. In addition to defining the boundary of the Project, the Project was divided into three functional phases as listed:

- **Baseline phase** – the current state of the CWA site i.e., a small airbase. There is minimal activity occurring. It predominantly serves flight schools and private aircraft movements.
- **Construction phase** – includes all the activities that occur onsite during the construction of the Project. Construction activities include site clearance, earthworks for runways and roads, stormwater infrastructure, building foundations and other airside support infrastructure.
- **Operations phase** – accounts for all airport activities occurring according to the various PALs as described under the anchor scenario. The airport is expected to reach maximum capacity by 2050.

4.1.2 Identification of GHG Emission Sources

After identifying the boundary and functional phases of the Project, the relevant GHG emission sources within this boundary were identified.

The Airport Council International's (ACI) Airport Carbon and Emissions Reporting Tool (ACERT) and desktop research were used as guidance to compile a list of emission sources for the airport's operation. ACERT was designed using principles of the GHG Protocol to assist airport operators in calculating GHG emissions associated with airport infrastructure, operations, and value chain activities.

After identifying emission sources, data collection was carried out using information from the draft EIA, client engagement sessions, and a data collection questionnaire. The client engagement sessions were conducted to better understand the functional phases (i.e. baseline, construction and operation) of CWA. These sessions were guided by questions from the supporting documentation from the draft EIA, the engineering plans, and the proposed capital expenditure. Additional emission sources and activity data were extracted from these documents. A data collection questionnaire was also provided to CWA to collect information on the baseline operations of CWA.

The following emission sources under scopes 1, 2 and 3 apply to CWA across its functional phases.

Scope 1 Emissions

Baseline phase – fuel combustion emissions from the on-site vehicles and stationary generators.

Construction phase – In the absence of detailed construction plans at the time of this assessment, informed assumptions to estimate fuel use during construction were developed, and these assumptions have been reflected in the indirect emissions calculations.

Operational phase – fuel combustion emissions from onsite vehicles, ground support equipment, stationary diesel generators and from biogas for electricity production as well as process emissions from the wastewater treatment plant. Fugitive emissions may arise from fuel storage and air-conditioning systems on site.

Scope 2 Emissions

Baseline Phase – currently, CWA purchases electricity from the South African National Power Grid, primarily produced by Eskom. The supply of electricity from Eskom is carbon-intensive due to electricity mainly being generated from coal-fired power stations and the operation of open-cycle gas turbines that use diesel. The electricity consumption data was provided by CWA in the form of monthly utility bills.

Construction Phase – In the absence of detailed construction plans at the time of this assessment, informed assumptions to estimate energy use during construction were developed, and these assumptions have been reflected in the value chain (Scope 3) emissions calculations.

Operation Phase – the Project intends to utilise renewable electricity produced from Solar PV and from biogas combustion to meet its electricity needs. The CCIA estimation of indirect emissions related to electricity consumption will therefore rely on the sourcing of renewable electricity in full of the potential to deliver any excess of renewable electricity to the local grid.

Scope 3 Emissions

There are fifteen Scope 3 categories defined under the GHG Protocol. Each category has its own set of activity data requirements, specific emission factors and calculation methodology. The following relevant Scope 3 categories have been identified.

Category 1 – Purchased Goods and Services

Relevant for baseline, construction and operation phases.

This category includes emissions tied to the production of goods and services purchased, acquired, and consumed by CWA. Under this category, upstream emissions linked to the production of consumed goods during the respective phases are reported. For the construction phase this includes material like cement, steel, asphalt and plastic used in ground earthwork.

Category 2 – Capital Goods

Relevant for construction and operation phases.

This category includes upstream emissions linked to the production of capital goods purchased by CWA during the respective phases. The emissions related to the acquisition of capital goods are based on CWA's infrastructure and capital investments over time. For the construction phases, emissions linked to the construction of buildings and utility infrastructure such as the solar PV farm, the biodigester plant and substations are considered. During the operations phase, the purchase of ground support equipment necessary for the smooth operation of the airport was considered.

Category 3 – Fuel and Energy-Related Activities

Relevant to baseline and operation phases.

This category considers emissions linked to the production of CWA's energy sources consumed, encompassing extraction, production, and transportation emissions. The activity data for this emissions category is informed by available Scope 1 and Scope 2 activity data and uses different emission factors for calculations related to the extraction, production and transportation of fuels and electricity consumed on site.

Category 5 – Waste Generated in Operations

Relevant to the baseline, construction and operation phase.

Considers emissions from third-party waste disposal and treatment of waste generated by CWA's operations.

Category 6 – Business travel

Relevant to baseline and operation phases

Accounts for emissions from business travel undertaken by CWA employees. Emissions from business travel activities shed light on the carbon footprint linked to employee mobility and business activities.

Category 7 - Employee Commuting

Relevant to baseline, construction and operations phases

This category encompasses emissions from CWA's employees commuting to and from site, using private vehicles. Activity data for private transportation emissions includes how many employees use their own or other transportation as well as the distance they travel.

Category 11 – Use of Sold Product

Relevant to baseline and operation phases

This category accounts for the use of goods and services sold or provided by CWA. This includes the scope 1 and 2 emissions of end users. The operational phases include emissions from the sale of aviation fuel and the commute of passengers to and from the airport and cargo operations.

Scope 3 emissions categories not relevant to airport operations as confirmed by ACERT include: Category 4 – Upstream transportation and distribution, Category 8 – Upstream leased assets, Category 9 – Downstream transportation and distribution, Category 10 – Processing of sold products, Category 12 – End of life treatment of sold products, Category 13 – Downstream leased assets, Category 14 – Franchises and Category 15 – Investments.

4.1.3 Emission Factor Collection

Emission factors are coefficients that convert activity data into GHG emissions. Based on the activity data collected, the respective emission factors for Scope 1, 2, and 3 were sources. Scope 1 fuel emission factors were adjusted to account for their NCVs (energy content of the fuel) and adjusted to account for emissions due to CH_4 and N_2O by using their global warming potentials. Scope 1 emissions were calculated at a Tier 2 level based on the South Africa-specific emission factor and NCVs. Scope 2 emission factors were obtained from Eskom's Integrated Annual 2023. Scope 3 emission factors were sourced from the United Kingdom's Department for Environment Food and Rural Affairs (DEFRA) and where no emission factors were available, alternative sources (such as supplier specific factors) were researched, or reasonable assumptions were made. Construction emission factors were sourced from the Ministry of Environment Finland's emissions database for construction. All emission factors convert activity data in tonnes of carbon dioxide equivalent (tCO_{2e}) and consider the global warming potential of carbon dioxide (CO_2), methane (CH_4) and Nitrous Oxide (N_2O) as further described below. All respective emission factors used as well as their references are outlined in Annexure.

4.1.4 Quantification of GHG emissions

To enable the quantification of these various GHGs, the resulting emissions are reported in 'metric tonnes of carbon dioxide equivalents' (tCO_2e). This is the standardised unit of measure (UoM) used to quantify and aggregate GHG emissions based on their global warming potentials (GWPs).

The GWP quantifies the amount of infrared thermal radiation absorbed by a greenhouse gas after its introduction to the atmosphere over a specified timeframe, i.e., it is used to convert respective GHG emissions into tCO_2e. The GWPs considered in this project are outlined in Table 2 and are aligned with the DFFE's Methodological Guidelines for the Quantification of Greenhouse Gas emissions. Expressing all GHG emissions in a single equivalent amount of tCO_2e, allows for a comprehensive assessment of the overall climate impact.

Table 2 – Global Warming Potentials (IPCC 2001, Chapter6, page 388)

Greenhouse Gas	Global Warming Potential
Carbon Dioxide	1
Methane	23
Nitrous Oxide	296

In line with the GHG Protocol, the quantity of tCO2e for Scope 1, 2 and 3 emissions were calculated using

Equation 1 below:

Equation 1

$$tCO_2e = \text{Activity Data} * \text{Emission Factor}$$

Where:

- tCO_2e denotes a tonne of carbon dioxide equivalent per type of activity
- Activity Data – refers to the specific information about the activities or processes of a company that results in direct or indirect GHG emissions within its boundaries. It includes the quantity of these activities per type of activity over the time frame of the Project.
- Emission Factor (EF) - convert the activity data of the various emission sources into specific GHG emissions (i.e. CO_2, CH_4, N_2O, SF_4, PFCs and HFCs) per type of activity.

4.1.5 Emission Factors

The choice of the emission factors should be relevant to the local context where possible. Where the emission factors are not available locally, the factors should be sourced from a reputable international source. Local emission factors have been sourced from the Department of Forestry, Fisheries and Environmental Affairs – Methodological Guidelines for Quantification of Greenhouse Gas Emissions.

Reputable international emission factors have also been sourced from the UK's Department of Environment, Food and Rural Affairs (DEFRA, 2022) dataset when local values do not exist. Construction emission factors for different construction activities (i.e., site clearance and excavation) and building types (i.e. commercial, industrial, hotel or hangars) were used and applied to determine fuel and energy consumption emissions, transportation emissions and waste emissions. These construction emission factors were collected from the CO2 Database, a construction emission factor database operated by the Ministry of the Environment Finland. All emission factors convert activity data into tonnes of carbon dioxide equivalent (tCO_2e) and consider the global warming potential of carbon dioxide (CO_2), methane (CH_4) and Nitrous Oxide (N_2O).

4.1.6 Climate Change Impact Assessment and Assessing the Environmental Impact of GHG Emissions

To ensure that the best possible information is available to evaluate the environmental sustainability of the project, the analysis of this CCIA report is conducted following the principles outlined in the National Environmental Management Act (NEMA), 1998 (Act No 107 of 1988). The following criteria will be applied to assess the environmental impact of the project in terms of climate change.

Nature of Impact – This is the description of what causes the effect, what will be affected and how will it be affected. In the case of CCIA's, the nature of the impact is the contribution of the project to global anthropogenic climate change.

Extent (E) – This is an indication of the spatial influence i.e. will the impact be local, regional, national, international or global. A score of 1 to 5 is assigned as indicated:

1	2	3	4	5
Local	Regional	National	International	Global

The extent of climate change is always global and a 5 will be assigned in the impact assessment.

Duration (D) – This is an indication of the length of time a certain impact is meant to last (short, medium, long-term or permanent). A score of 1 to 5 is assigned as indicated:

1	2	3	4	5
Very Short (0 – 1 years)	Short (2 – 5 years)	Medium (5 – 15 years)	Long (>15 years)	Permanent

The duration of the impact of climate change is a long-term impact and a 4 will be assigned in the impact assessment.

Magnitude (M) – assesses the severity or extent of the impact. A score of 1 to 5 is assigned as indicated:

1	2	3	4	5
Very Low	low	Medium	High	Very High

The magnitude of the impact of GHG emissions by the Project on climate change will be determined by calculating the contribution of GHG emissions to the national carbon budget. The methodology to determine the magnitude is discussed in Section 4.1.7.

Probability (P) – how likely is an impact expected to occur. A score of 1 to 5 is assigned as indicated:

1	2	3	4	5
Very Improbable	Improbable	Probable	Highly Probable	Definite

It has been scientifically determined that anthropogenic GHG emissions are the leading cause of climate change. A value of 5 is assigned to projects which contribute to climate change

Significance (S) – degree of signification on the activity of the operation and its environment. It is calculated in Equation 3.

Equation 2

$$S = (E + D + M) \times P$$

The weighting of S can be determined as low (S < 30), medium (30 < S < 60) or high (S > 60).

4.1.7 Calculation of the contribution of GHG emissions by the operation of CWA to the South African National Budget

To contextualise the Project's share of GHG emissions in the South African NDC, a national GHG emissions or carbon budget must be determined. The carbon budget as per the national NDC (see Section 3.2), along with Global NDC's are said to be insufficient to limit the global temperature increase to 2 degrees Celsius, let alone the 1.5-degree Celsius Paris target. The IPCC sixth amendment states that a total global emission budget of 500 Gigatonnes CO_2e is required to achieve or limit global warming to a 1.5-degree Celsius increase by 2050.

South Africa's contribution to this global emission budget was determined by using Equation 3 and the South African budget of emissions up to 2050 is estimated to be 3 780 tCO_2e as shown Table 3.

Equation 3

$$National\ Budget = \frac{National\ Population}{Global\ Population} * Global\ Emission\ Budget$$

Table 3 – South African share of Global Carbon budget (per capita basis) (The World Bank Group, 2022)

Global Population	Global Budget ($MtCO_2e$)	Local Population	Local Budget ($MtCO_2e$)
8 200 000 000	500 000	62 000 000	3 780

The following GHG impact categories have been defined in Table 4 according to an exponentially increasing scale as a percentage of the national budget calculated using Equation 3.

Table 4 – GHG impact rating categories defined as a % of the South African carbon budget

GHG impact rating as a % of South Africa's carbon budget	Amount of GHG emissions		% of South African carbon budget over the lifetime of the project	
	Lower limit (tCO_2e)	Upper limit (tCO_2e)	Lower limit	Upper limit
Very Low	1	10 000	0%	0.0003%
Low	10 000	1 000 000	0.0003%	0.0265%
Medium	1 000 001	10 000 000	0.0265%	0.2645%
High	10 000 001	+	0.2645%	+

The upper limit of the category "Low" roughly aligns with the 10 MW-thermal threshold, DFFE applies to data providers for reporting under the National GHG Emissions Reporting Regulations. The total emission calculated from the carbon footprint process for the project is then compared to these impact categories to determine whether the impact is very low, low, medium, high. The Magnitude defined in Section 4.1.6 will be assessed using the defined in Table 1

4.1.8 Assumptions and Limitations in Quantifying GHG Emissions

The accuracy of the carbon footprint calculation in this study is inherently dependent on the quality and scope of the data collected. As with any analysis, certain assumptions had to be made to fill gaps where data might be incomplete, unavailable, or estimated. These assumptions aim to standardise the methodology and ensure consistency throughout the study, but they also introduce limitations that should be acknowledged. This section outlines the key assumptions made during the data collection and analysis processes, highlighting their potential impacts on the overall accuracy and reliability of the results.

Baseline Assumptions

The current airport site is undeveloped with minimal activity occurring relating to flight training, recreational training, private charter and unscheduled general aviation. The related emissions are therefore marginal compared to the construction and operations phase. Within this context, the following assumptions were made due to limited data availability:

- The litres of diesel burnt on site were assumed from the approximate number of times the truck's tank is filled up per month (Brundtland Questionnaire, 2024).
- As related activities during the year are relatively stable, the electricity consumption for the baseline phase was assumed to be constant each month over a one-year period and was calculated from the provided electricity statement for one month (CWA Electrical Bill, 2024).
- Due to very low activity levels, the waste generated onsite is minimal and therefore it was assumed that the related emissions would be negligible and not material (Brundtland Questionnaire).

- The emissions from business travel were estimated based on the cost of flights undertaken by CWA staff (Brundtland Questionnaire, 2024).
- The emissions for employee commuting (20 employees in total) were based on a round-trip average travel distance of 57.4km to the neighbouring towns in the area and that employees work onsite daily (Brundtland Questionnaire, 2024 and Google Maps, 2024).

Construction Phase Assumptions

- The calculation of emissions related to the bulk earthworks was limited Scope 3 – category 1. The total areas requiring bulk earthworks was stated in the capital expenditure (Capex) sheets provided. These earthworks account for the site preparation up to the ground level and include clearance for runway laying, road layout and stormwater infrastructure and cabling. The choice of emission factor used accounts for the energy inputs required for the earth-moving equipment (Emission Factor Database for Construction, 2024).
- The Scope 3 – Category 1 emission for steel purchases only accounts for steel fencing mentioned in the Capex report. The length of the fence was obtained in the Capex sheet. A sample fence from First Fence was used to determine the weight of steel per meter of 21.44 kg, which was then used to calculate emissions using the CO2 Database emission factor which accounts for embedded emissions.
- The Scope 3 – Category 1emissions for plastic purchases was limited to water management pipes and major telecommunications cables. The type and specification of these were obtained from the Capex report where only the outer diameter and length was provided. The inner diameter was found through standard pipe dimensions retrieved online (Plastic Pipe Shop, 2024). The weight required was determined using a Pipe Weight Calculator (Omni Calculator, 2024).
- The Scope 3 – category 1 emissions related to purchasing asphalt was determined using the depth and area of asphalt used stated in the Capex sheet and the corresponding weight was assumed using the PAVEPRO Asphalt calculator.
- The calculation for Scope 3 – category 1 emissions from concrete use is limited to the concrete used in earthworks, runways and stormwater infrastructure. The weight of this concrete was determined using the concrete calculator from Calculator.net. For the concrete pipes, only the outer diameter was given in the Capex sheet, so typical concrete pipe sizes found online were assumed as standard. The specification of manhole covers provided online by Cementile Group were assumed as standard.
- Building function was allocated according to the SDP linear coordinates document. The area was provided in the document, and 70% of this area is assumed to be used by buildings (Capex Projects – SDP Linear coordinates, 2024). The average emission factor for buildings was 569 $kgCO_2/m^2$.

- For these buildings, the emissions are divided into construction energy-related emissions ($7kgCO_2e/m^2$ for any earth-moving equipment and $27kgCO_2e/m^2$) and embedded construction material emissions (Emission Factor Database for Construction, 2024).
- Only construction materials that have material associated production emissions were considered, namely concrete, cement, steel and glass. These materials make up 70% of construction material. Other materials may include wood and sand with minimal related emissions, thus considered non-material. Additionally, the emission factors from the CO2 Database based on building type (i.e. commercial buildings, hotels and industrial) were used to account for any additional emissions not considered.
- Quantities for the above-state materials were estimated from a study under UC Berkly on the Life-cycle Environmental and Economic Management of Airport Infrastructure and Operation (Greer, 2023).
- For areas that have been denoted for hangar use, the primary material used was assumed to be steel (Airport Hangar Design, 2018).

- The cost of capital goods in the construction phase was stated in the Capex sheet, these include electrical utility infrastructure. Because the weight of these items cannot be determined from the Capex sheet and supplier-specific emission factors are not available, spend-based emission factors for manufactured goods were used. This was done using the Worldwide Embodied Impacts Journal (Mishina et al, 2021).
- An average of three sources stated that 20% of construction materials purchased become waste products. The required materials to be purchased for construction were assumed to be the main waste items and as such 20% top-up was used considering wastage.

Operations Phase Assumptions

- The fuel consumption for ground servicing equipment and airport activity for the operational phase has not been determined by CWA. For emissions calculations, this data was estimated by benchmarking the average fuel consumption per passenger using information from various airports available in (Heathrow, Sydney, Istanbul, Hong Kong and Malta International Airport Integrated reports, Airports Association South Africa Integrated Report 2023).
- The Master Plan Report compiled by NACO contains the expected volumes of wastewater to be treated per PAL.
- For each PAL, a minimum electricity load of 5 MVA will be supplied to CWA by the national electricity utility, i.e. Eskom. It is assumed that CWA operates at full capacity 24/7.
- It is assumed that the biodigester operates at full capacity for the entire duration of the Project. The Biogas Budget Proposal prepared by Global Energy Biogas (Pty) Ltd details the design of a 1 MW continuous biogas plant. The biogas (predominantly methane) is produced in a biodigester using energy crop and effluent water. The estimated production of biogas and

calorific value was provided by the budget proposal It was also assumed that a negligible amount of electricity will be required from the grid for operation of the biodigester.

- The types of ground equipment were based on desktop research regarding what is typically used in existing airports. The number of each type of equipment was estimated based on the average amount needed to service the peak number of flights the airport can handle during each phase of the expansion (Tronair, 2024).
- The emissions from the upstream delivery of energy crops were based on the average distance of 43 km between the airport location and the surrounding farms. This average distance was calculated by measuring the distances between CWA and 10 local farms. The mean of these distances was then assumed to represent the daily travel distance required to meet the biodigester's daily input needs. The upstream emission of the energy crop production was based on the required quantity of Napier grass (i.e. 15 tonnes per day) for the biodigester (Global Energy - Biogas Budget Proposal, 2023).
- The predicted waste generated was based on a waste per passenger basis but was not further divided into types of solid waste, thus it was assumed to be commercial and industrial waste (NACO – The Master Plan Report, 2023).
- The emissions from business travel of the operation phase were calculated on the assumption that the money spent is predominantly on flight costs, thus the full amount was allocated to flights. The emissions estimate for business travel was calculated by using the business travel spend from Airports Association South Africa (ACSA, 2023) as a benchmark. The ratio of business travel expenditure to number of employees was used to get the future expected expenditure.
- The emissions from employee travel assumed that employees would come from the stated catchment area of the Master Plan (NACO - The Master Plan Report, 2023), the two-way average distance of 57.4km between these areas and the airport was used in the emission calculation.
- The emissions for the transportation of passengers to and from the airport is determined in the same way as employee commuting, thus the same assumptions apply as above (NACO - The Master Plan Report, 2023).
- The emissions estimates concerning the transportation of cargo to and from the airport were based on the assumption that cargo will originate/be delivered to the catchment areas stated above and that they will be delivered using standard Heavy Goods Vehicles and standard Vans (NACO - The Master Plan Report, 2023).
- The emissions estimate related to the combustion of downstream aviation fuel emissions is based on the fuel required by the airport for sales to airlines according to its Fuel Master Plan and assumes that all the forecasted fuel usage will be combusted (KANTEY & TEMPLER – Fuel Master Plan, 2022).

4.2 Physical Climate Risk Assessment

This section focuses on the physical climate risks associated with the proposed expansion of the CWA. The impacts of climate change are likely to increase climate-related vulnerabilities for the CWA. Using public and scientific resources, climate-related hazards have been identified, and their potential effects on the project area will be assessed.

4.2.1 Approach to PCRA

There are two categories of climate-related risks. The first are transitional risks, which are related to the transition to a lower carbon economy and the second are physical risks, which are related to the physical impacts of climate change. This section will focus on physical risks. Physical risks that are event-based such as extreme weather, floods or fires are classified as acute risks. Alternatively, physical risks associated with longer-term shifts in climate patterns like rising mean temperatures are classified as chronic risks (TCFD, 2017). Physical risks have many implications, often causing damage to assets and supply chain disruptions which affect businesses financially and/or impact the wellbeing and safety of employees.

In conducting the Physical Climate Risk Assessment (PCRA), a comprehensive analysis of climate change impacts specifically relevant to the project region was undertaken. This involved a thorough examination of historical climate data, as well as projections for future climate conditions, considering factors such as temperature changes, precipitation patterns and extreme weather events. Furthermore, the assessment investigated the potential impacts of these climate changes on the proposed projects processes and infrastructure. Material climate hazards were identified, and the associated risks assessed, considering both the likelihood and potential impacts of these hazards on the project site. A list of tools used in this PCRA is shown in Table 5.

Table 5 – Climate change related tools used throughout this PCRA

Tools Utilized	Description
The World Resources Institute (WRI) Aqueduct Tool	This tool provides an understanding of water-related risks and assesses exposure to various water related risks across multiple locations (WRI, 2019), including that of the project site.
The Council for Scientific and Industrial Research (CSIR) GreenBook Municipal Risk Tool	This tool provides information on vulnerabilities, population projections and exposure to climate hazards for various municipalities within South Africa (CSIR, 2023).

Tools Utilized	Description
The Global Facility for Disaster Reduction and Recovery (GFDRR) Think Hazard Tool	This tool provides a general overview of hazards for various locations, including that of the project site, that should be considered in project design and implementation to climate resilience (GFDRR, 2019). The likelihood of climate related hazards affecting the project site is assessed. Levels of likelihood include very low, low, medium and high.
The World Bank Groups Climate Change Knowledge Portal	This tool provides historical and projected climate data for various regions including that of the project site (i.e., the Western Cape).

The materiality of the physical climate risks was determined based on a qualitative assessment of the likelihood and potential impact over time. This was demonstrated in a matrix which defines the level of risk as low, medium, high or extremely high. Recommendations to enhance the resilience of the CWA to climate hazards, through the application of climate adaptation and mitigation measures will be made.

4.2.2 Assumptions and Limitations in the PCRA

The proposed project's risk to various climate-related hazards is assessed in this report through the analysis of available data sets. This physical climate risk analysis is subject to the following assumptions and limitations:

- Impacts solely related to the direct value chain of the proposed project were assessed.
- No modelling was conducted on the impacts of hazards identified, or the future timelines thereof.
- Only impacts anticipated to occur during the lifetime of the proposed project were assessed.
- Historical climate data and future climate projections at a regional level were utilised and assumed to be representative of the site.
- It is assumed that all information provided by the EAP is accurate and factual.
- It is assumed that the information gathered from online resources is accurate and factual.
- The outputs of the climate change models used are limited spatially and temporal.

5 IMPACT OF THE PROJECT ON CLIMATE CHANGE

In this Section, the GHG emissions of the Baseline, Construction and Operational phases are quantified. The carbon footprint of the Project was defined by considering the relevant emissions under the South African Regulatory context. The impact of the CWA expansion project on climate change, was assessed in terms of its overall impact on the environment and the significance was determined.

5.1 QUANTIFICATION OF THE PROJECT'S GHG EMISSIONS

The GHG emissions for the CWA have been determined using the GHG protocol procedure for developing a carbon footprint across the three defined functional phases i.e., the baseline phase, the construction phase and the operational phase. The calculation of the carbon footprint of CWA is dependent on certain assumptions as stipulated in Section 4.1.6 to overcome the data limitations. The development of the carbon footprint took into consideration the relevant emissions from core operations and the value chain associated with the Project.

5.1.1 Baseline Phase

The current airport site is undeveloped with minimal activity occurring. The current site has an estimated carbon footprint of 647 tCO_2e each year. The baseline emissions, divided into relevant GHG scopes are shown in Table 6 below.

Table 6 – GHG emissions breakdown for the baseline phase

Emission Source	**Category**	**Emissions (tCO_2e)**
Scope 1 – Direct emissions	Mobile diesel	72
	Stationary diesel	3
Total Scope 1 emissions		*75*
Total Scope 2 – Indirect emissions	Grid electricity	6
Total Scope 2 emissions		**6**
Scope 3 - Category 3	Mobile diesel	15
	Stationary diesel	1
	Grid electricity	1
Scope 3 – Category 6	Business travel	5
Scope 3 – Category 7	Employee commuting	14
Scope 3 – Category 11	Use of aviation fuel	531
Total Scope 3 emissions		*567*
Total Baseline Emissions		**647**

5.1.2 Construction Phase

For the construction phase, the best possible emission factors that account for energy use and transportation were used. However, as these emissions were calculated using a single construction emissions factor, we were unable to distinguish between direct and indirect emissions. Currently, there are no detailed design plans indicating the quantities of construction materials or the specific energy requirements from fuel and electricity for the construction phase. Nevertheless, based on the assumptions outlined in Section 4.1.6, construction emissions were estimated at a high level, capturing the most significant material emission sources. It is estimated that the construction phase will produce approximately 326 662 tCO2e. When the design of buildings is done, the Project developer should ensure that green building standards are incorporated to improve the energy efficiency of the buildings. A breakdown of these emissions is provided in Table 5 below. All construction emissions have been categorised under various relevant categories in Scope 3.

Table 7 – GHG emissions breakdown for the construction phase

Emission Source	Category	Emissions (tCO_2e)
Scope 3 - Category 1	Bulk earthworks	106 430
	Steel	912
	Plastic	1 790
	Asphalt	8 246
	Concrete	2 880
Scope 3 – Category 2	Buildings	191 883
	Substation	1 311
	Solar PV Farm	114
	Biodigester	428
Scope 3 – Category 5	Construction waste	2 649
Scope 3 – Category 7	Employee Commuting	10 019
Total construction emissions		**326 662**

Scope 3 Category 1 - Purchased Goods contains the most significant GHG emissions, including the usage of cement, steel, asphalt, and plastic for the development of roads, runways, and stormwater infrastructure. Material consumption estimates were derived from the details provided in the Capex Sheet. These emissions arise from the fuel and energy use of on-site machinery, such as cranes, bulldozers, rollers, excavators, tractors, and dumpers. Emissions from building construction were estimated based on the embedded material emissions from common construction materials like cement, steel, and glass. This estimate also included fuel and energy-related emissions per square meter, accounting for material transport and earthworks, sourced from the CO2 Database. Emissions

related to electrical infrastructure were estimated using spend-based information from the Capex sheet. Employee commuting emissions for construction workers have been determined based on the estimated number of direct jobs the construction is expected to create.

5.1.3 Operational Phase

The design of the Project is based on the Anchor Scenario as defined in the NACO Master Plan (NACO – The Mater Plan, 2023), which specifies the maximum passenger capacity the airport will cater to at the highest expected growth rate. The Master Plan further outlines planning activity levels (PALs) according to the Project's growth. The activity data was sourced from the various planning documents provided by the EAP, which includes the Master Plan, detailing airport facility volumes and usage, and the Traffic Master Plan, detailing the expected aircraft and passenger movements. To complete data gaps, some activity data for the operational phase were determined using the assumptions in Section 4.1.6. The total emissions across different scopes and categories up to the year 2050 are approximately 5.3 million tCO2e.

A breakdown of emissions for the operational phase is shown in Table 8. GHG emissions for the operational phase have been determined per PAL to project emissions up to 2050. This approach aligns with the NDC and the Net-Zero by 2050 scenario, as well as with other planning documents which also project operations until 2050. The assumption is that by 2050, CWA will have fully implemented renewable technologies and mitigated any hard-to-abate emissions through offsetting.

CWA aims to be self-sustainable and off-grid in meeting its electricity needs. Consequently, the bulk electrical services report proposes investing in a Solar PV farm with a 20-100 MW capacity, incorporating a 1 MW biogas generation plant, and planning a lithium-ion backup battery system. The proposed backup diesel generators have a capacity of 8 MW. Implementing these developments will reduce reliance on grid electricity. However, CWA will still be reliant on grid electricity of up to 5 MVA of the total electrical requirements, the project will not be optimally running off the grid. While emissions from the biodigester have been calculated and included in the operational emissions, it's important to note that the biodigester uses renewable biomass (e.g., energy crops), making its emissions climate-neutral. For direct emissions, it is assumed that ground servicing equipment and on-site vehicles use combustion engines. However, CWA's commitment to sustainability suggests a potential investment in electric vehicles, which could further reduce Scope 1 emissions by 8% (5350 tCO2e).

Additional Scope 1 emissions arise from the operation of the wastewater treatment plant. These emissions were determined using a DEFRA default value, as the plant's design is not yet finalised. Over 60% of emissions from wastewater treatment plants are direct process emissions, with the remainder related to energy use. Methane (CH_4) and nitrous oxide (N_2O) are the primary GHG's emitted during treatment depending on the process type. Mitigation strategies include energy production from methane in anaerobic systems to reduce fugitive methane emissions and energy consumption and optimising nutrient recovery and control strategies in bioreactors to minimise N_2O emissions.

The majority of emissions during the operational phase result from downstream (Scope 3) emissions shown in Figure 10. Scope 3 Category 11 – Use of Sold Products is the largest contributor, estimated at 3.8 million tCO2e. This category includes emissions related to passenger movement, cargo movement, and aircraft operations. The primary source of Scope 3 emissions is aeroplane movements, projected to reach 3.15 million tCO2e by 2050, representing 79% of total Scope 3 emissions. However, only domestic aviation emissions of 1.5 million tCO2e will be accounted for in the GHG impact assessment on the South African national inventory, in accordance with the determination of sectoral emissions in South Africa. Category 7 – Employee Commuting accounts for 4% of Scope 3 emissions, followed by Category 5 – Waste Generated in Operations.

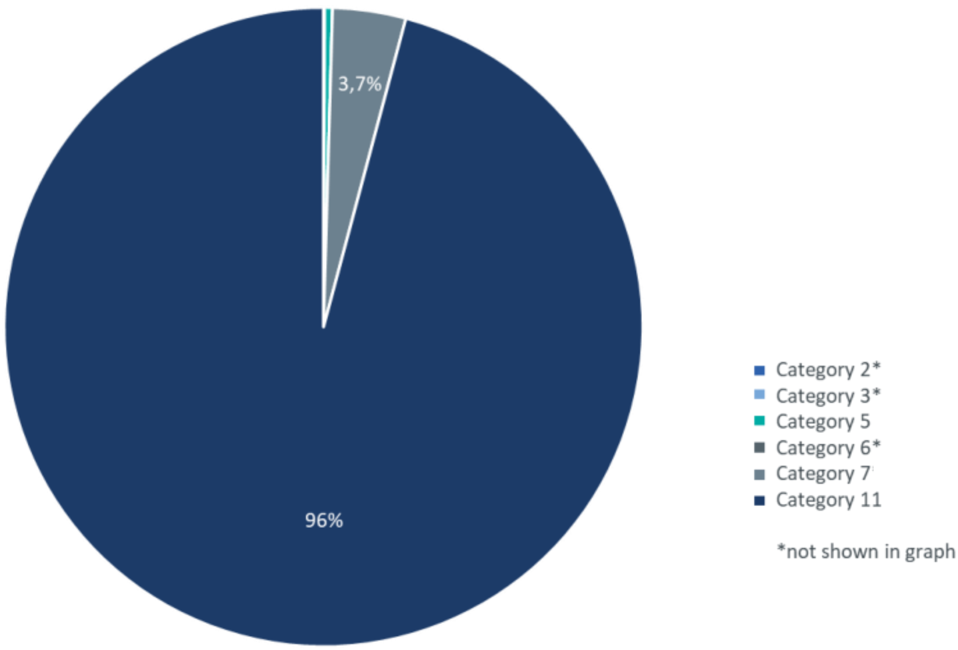

Figure 10 – Emissions breakdown for the operational phase

Mitigating Scope 3 emissions is challenging, as a significant portion of these emissions are produced by operations outside the control of the airport. However, the project should consider the options to reduce emissions from Category 5, 6, 7 and 11. When developing the waste reduction and management plan, the project developer should consider implementing comprehensive recycling programs for items such as paper, plastic, glass, and metal. Additionally, on-site composting facilities for organic waste disposal should be established, creating job opportunities and promoting sustainability. In employee and passenger, the project should promote the use of electric vehicles (electric busses or shuttle services) and collaborate with the government and the transport sector to improve public transportation links to and from the airport. For business travel, the project should prioritise sustainable travel options and implement carbon offset programs for unavoidable business travel to neutralise the carbon footprint. The airport operation should also support and promote the development and of sustainable aviation fuel and strive for operational efficiencies such as reduced aircraft idling times on runways and taxiways.

Table 8 – Emissions breakdown per PAL for the operational phase

Emission Source	Category	Emissions per PAL (tCO_2e)					Total Emissions (tCO_2e)
		PAL 1A	PAL 1B	PAL 2	PAL 3	PAL 4	
Scope 1 – Direct emissions	Mobile diesel	437	964	1 350	1 697	344	4 792
	Stationary diesel	17	36	51	64	13	181
	Wastewater treatment	35	77	105	133	27	377
Total Scope 1 emissions		***488***	***1 077***	***1 506***	***1 894***	***385***	***5 350***
Total Scope 2 emissions	***Grid Electricity Usage***	***176 952***	***265 428***	***265 428***	***265 428***	***44 238***	***1 017 474***
Scope 3 – Category 2	Passenger busses	5.7	0.9	0.6	1.4	0.6	9.2
	Mobile stairs	1.7	0.3	0.1	0.4	0.3	2.9
	Tractors	1.7	0.3	0.1	0.6	0.6	3.3
	Aviation Fuel Handling	0.7	0	0	0	0	0.7
	Conveyors	0.7	0.7	0.8	1.1	1.2	4.5
Scope 3 – Category 3	Diesel	99	214	299	376	76	1 063
	Energy Crops Transport	468	703	703	703	117	2694
Scope 3 – Category 5	Commercial and industrial waste	1 429	3 152	4 413	5 548	1 126	15 669
Scope 3 – Category 6	Business travel	7	16	23	30	6	82
Scope 3 – Category 7	Bus	942	2 055	2 953	3 724	728	10 401
	Minibus Taxi	3 425	7 473	10 742	13 544	2 647	37 831
	Private car	8 449	18 434	26 499	33 411	6 529	93 321
	Motor/scooter	524	1 143	1 643	2 072	405	5 787
Scope 3 – Category 11	Passenger movement	63 665	140 438	190 051	234 582	46 635	675 371
	Cargo movement	70	104	104	104	17	400
	Domestic aviation combustion	130 053	273 133	423 876	551 054	106 592	1 484 709
	International aviation combustion	137 333	369 746	450 358	585 450	113 245	1 656 133
Total Scope 3 emissions		***346 473***	***816 613***	***1 111 668***	***1 430 602***	***278 125***	***3 983 104***
TOTAL EMISSIONS OPERATIONAL PHASE		**523 913**	**1 083 118**	**1 378 601**	**1 697 924**	**322 748**	**5 005 928**

5.1.4 The Overall Carbon Footprint of the CWA Expansion Project

The carbon footprint of the CWA expansion project is determined by calculating the direct and indirect emissions associated with the construction and future operation. The carbon footprint is presented in Table 9. It is expected that the Project Scope 1 emissions produced up to 2050 is 5350 tCO_2e. Due to the design plans indicating self-sufficiency using a solar plant, biogas to electricity facility and a battery system, no Scope 2 emissions have been included. The total footprint of the project (construction and operation) is approximately 4.3 million tCO_2e. Scope 1 emissions for the operations phase contribute 0.12% and the value chain emissions from construction contribute approximately 8%, and from the operational phase 92%.

Table 9 – Carbon Footprint of CWA Expansion Project up to 2050

Project Phase	Direct Scope 1 & 2 Emissions (tCO_2e)	Indirect Scope 3 Emissions (tCO_2e)	Total Emission (tCO_2e)
Construction Phase	0	326 662	326 662
Operation Phase	1 022 824	3 983 104	**5 005 929**
Total	**1 022 824**	**4 309 766**	**5 332 590**

The emissions trajectory for the operations of the airport is shown in Figure 11. In terms of the impact on South Africa the carbon footprint would be 3.35 million tCO_2e as emissions from international aviation are excluded from the National Inventory. 1.7 million tCO_2e emissions is associated with international aviation flights. The average annual impact from the operation of the CWA expansion project is estimated to be 217 649 tCO_2e per annum.

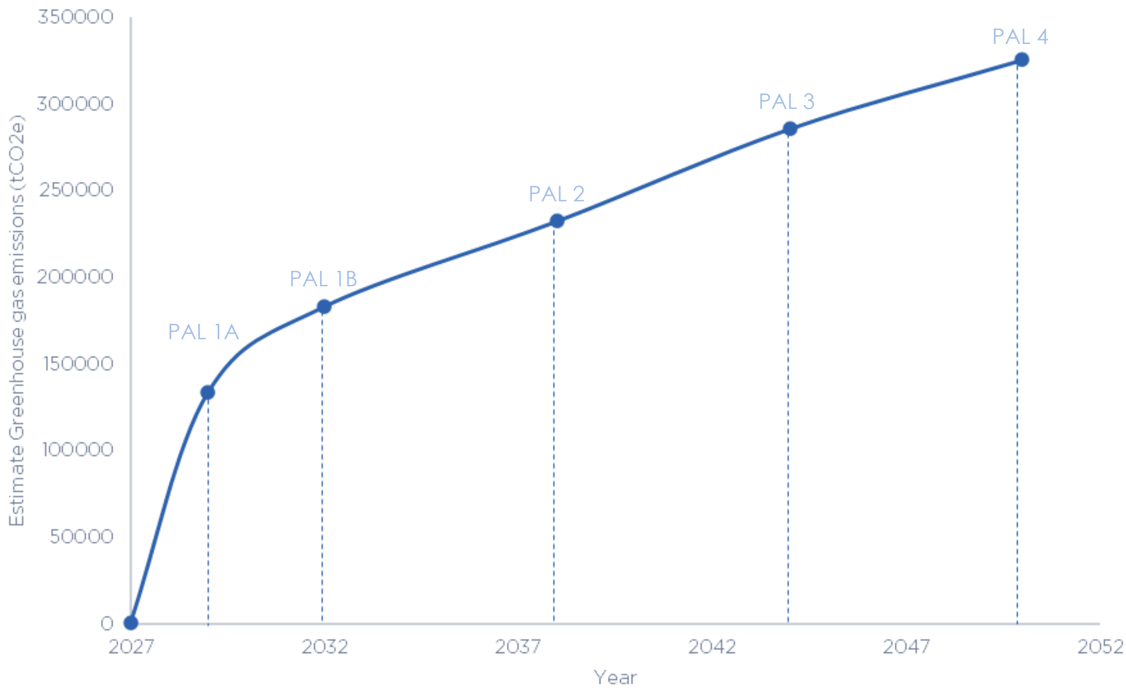

Figure 11 – GHG emissions trajectory for the CWA expansion project

5.2 Impact of the Project on both South African and Global Inventories

To provide context for the impact of the approximated GHG emissions calculated in Section 5.1.4, these emissions should be compared to the national GHG emissions budget calculated in Section 4.1.7. It is crucial to differentiate where emissions occur. It can be reasonably assumed that the manufacture of all construction materials and the direct emissions during the operations phase would occur within the boundaries of South Africa. International aviation emissions, categorised under indirect emissions, would not be included, as these are monitored by ICAO and not included in the national inventory. For this reason, the total calculated emissions for the expansion project only including domestic aviation amount to 3.68 million tCO2e. The CWA calculated emissions inventory as a portion of the global budget is presented in Table 10.

Table 10 - Impact of Project emissions on national carbon budget

	Contribution to National Carbon Budget (%)	Impact on National Carbon Budget
Total Scope 1+2 emissions (up to 2050)	0.027	Low-Medium
Cape Winelands Expansion Project Total emissions (up to 2050)	0.097	Medium

The direct operation of the CWA would have a **low-medium impact** due to the planned sustainability measures of the Project. The total project emissions including value chain emissions would have a **medium impact** on the National Carbon budget due to the significant contribution of Scope 3 emissions to the Project's overall footprint. The major contributor to Scope 3 emissions, are emissions from domestic aviation, representing 40% of total emissions. The impact of emissions from domestic aviation should be considered in light of the regulatory and legislative instruments in place or under development to deal with emissions from domestic aviation, namely the Carbon Tax and the mandatory carbon budgets allocation under the Climate Change Act. As the regulatory environment and framework is designed to deal with these Scope 3 emissions from domestic aviation, a reduction in emissions can be expected as the year 2050 approaches.

It should also be considered that a substantial portion (over 88%) of these Scope 3 emissions is likely to occur even without the expansion. The aviation industry and tourism market are projected to grow regardless of the CWA project. This inherent growth will cause increased passenger traffic at Cape Town International Airport (CTIA). This organic growth will necessitate additional employees to service the increased flights and passengers and increase energy demand and waste produced. Further, the expected growth in aviation and tourism would likely strain the existing infrastructure, leading to increased traffic congestion and associated emissions.

The potential of the CWA project to mitigate some of the future growth-induced emissions such as improved Infrastructure, which would result in more efficient operations, potentially reducing overall energy consumption per passenger and sustainability practises if effectively implemented, could help limit the growth of Scope 3 emissions associated with the airport's operations. It's important to consider that the Scope 3 emissions are largely due to domestic and international aviation. In the context of aviation, a distinction is made between airport operator and airline operator, the deciding factor hinges on the classification of the activity according to the IPCC Guidelines and the National Greenhouse Gas Emission Reporting (NGER) regulations of the Department of Environment, Forestry and Fisheries (DEFF). Domestic aviation, categorized under IPCC code 1A3a, is subject to carbon tax and future carbon budget regulations. The nationality of the airline and the registration of the aircraft are irrelevant for tax purposes; however, domestic law mandates that entities conducting domestic aviation must have a significant legal presence in the Republic, and aircraft used for domestic flights must be registered within the Republic. This ensures that all domestic aviation activities comply with national regulations controlling emissions.

As imposed by ICOA, all flights must carry additional reserve fuel in the event of diversion to an alternate airport in the case of emergencies or unexpected events. Carrying excess fuel places a weight burden on airline/aircraft operators, leading to increased emissions and operational costs for airlines. Currently, flights may divert to OR Tambo International airport (1 270 km away) or Port Elizabeth International Airport (747 km away). CWA on the other hand is 25 km away from CTIA and as a closer alternative would significantly reduce excess fuels required in the event of diversion. By using CWA as an alternative airline could reduce the GHG emissions resulting from diversion by 3-5% (CWA Diversion Airport Analysis Summary Report, 2022). This would directly contribute to combating climate change and aligning with sustainable aviation goals. Additionally, airlines can optimise their operations by carrying less fuel on flights resulting in lower operating costs and passing the savings from freed up weight to lowering airfare and increasing cargo capacity.

5.3 Overall Impact of Project on Climate Change

The impact of the CWA expansion project has been assessed as per the Environmental Impact Criterion described in Section 4.1.6. The CWA expansion project will impact climate change from a construction and operational perspective.

Nature – the GHG emissions resulting from the construction and operation of the CWA will contribute to global anthropogenic climate change. However, the expected changes in global climate cannot be specifically linked to the GHG emissions of a specific emission source or individual emitter. Direct emissions resulting from fuel combustion and wastewater treatment are expected. There are specific indirect emissions associated with the operation/value chain of the airport such as waste generation, employee commute, passenger commute and aviation. The emissions taken into consideration are those which occur within the boundaries of South Africa (i.e., international aviation is excluded). The estimated emission from the airport is estimated to be 3.68 million tCO_2e, approximately 0.097% of the South African budget of 3 380 $MtCO_2e$. The value of 3.68 million is high to the national budget. The criteria for evaluating the impacts posed by climate change and the ratings are presented in Table 11.

Table 11 – Evaluation of environmental impact criteria

	1	2	3	4	5
Extent (E)	Local	Regional	National	International	Global
Duration (D)	Very Short (0 – 1 years)	Short (2 – 5 years)	Medium (5 – 15 years)	Long (>15 years)	Permanent
Magnitude (M)	Very low	low	Medium	High	Very High
Probability (P)	Very Improbable	Improbable	Probable	Highly Probable	Definite

The extent of climate change impacts is classified as global, and the duration is defined to be long as climate change impacts could potentially be reversed. The magnitude of the impact was assessed using the methodology defined in Section 4.1.7. The total impact of the Project's emissions was assessed as medium as described in Section 5.2 hence the magnitude is rated as medium. Using Equation 2 as defined in Section 4.1.6, the significance of the environmental impact criteria was determined to be **medium**.

Mitigation – the project developer proposes many measures to mitigate its carbon footprint, such as using renewable energy and will consider any of the mitigation measures proposed. Particularly, mitigation measures such as adopting a 100% renewable electricity policy, wastewater treatment plant technologies with limited GHG emissions and measures around waste disposal have been proposed. The largest impact is the indirect emissions from domestic aviation. Mitigation measures in this regard fall under the airline operator. However, mitigation options will not be able to alter the impact that the GHG emissions will have on climate change in terms of their extent, duration or probability. It is only the magnitude of the GHG emissions impact that can be reduced by reducing the quantity of GHG emissions.

6 IMPACT OF CLIMATE CHANGE ON THE PROJECT

Climate change poses significant risks to ecosystems, economies, and human health, making it crucial to understand and address these vulnerabilities. In the following sections, the various physical risks associated with climate change were investigated by conducting vulnerability assessments. The vulnerability assessments are essential for identifying at-risk regions, operations or people and guide mitigation strategies. This enhances the adaptive capacity to minimise the adverse impacts of climate change.

6.1 CLIMATE CHANGE RISK AND VULNERABILITY ASSESSMENT

By defining risk, a framework to understand how the interconnected impacts of climate change are becoming more severe can be developed. When considering climate change, risks typically originate from interactions between climate-related hazards and the exposure or vulnerability of the affected systems, whether human or ecological. Vulnerability is defined by the IPCC (2022) as the degree to which a system is susceptible to, and unable to cope with or adapt to, the adverse effects of climate change.

According to the Global Facility for Disaster Reduction and Recovery (GFDRR, 2019), the Cape Winelands District Municipality (CWDM) where the CWA site is located, is vulnerable to hazards including wildfires, landslides, water scarcity, extreme heat, river floods and urban floods. The baseline air quality report prepared for the CWA expansion (DDA Environmental Engineers, 2022), concludes that air quality in the vicinity of CWA is considered good with low concentrations of relevant air pollutants derived from airport operations. Therefore, we do not expect air quality itself to be significant climate hazard. However, potential implications of hazards such as wildfires and heatwaves on air quality at the site are discussed. The identified hazards can be considered acute physical climate risks, since they are events based in nature. How the above-mentioned hazards might impact the proposed project, and on what time scale are detailed in the tables that follow.

The climate projections for the Western Cape obtained from The World Bank Group (2021), which are informed by Coupled Model Intercomparison Project Phase 6 (CMIP6) database are shown in Figure 12 and Figure 13. CMIP6 data formed the basis of the IPCC’s sixth assessment report. Five shared socioeconomic pathways (SSPs) are considered. SSPs are various climate change scenarios of anticipated global socioeconomic changes up to the year 2100, defined by the IPCC Sixth Assessment Report on climate change in 2021. They are used to derive different greenhouse gas emission scenarios under various climate policies (IPCC, 2021). SSP1-1.9 represents a stringent mitigation scenario, while SSP5-8.5 represents a very high warming scenario. It should be noted that current climate tools available in South Africa only provide for information at provincial level. As such, the Western Cape context described and considered relevant to the proposed site.

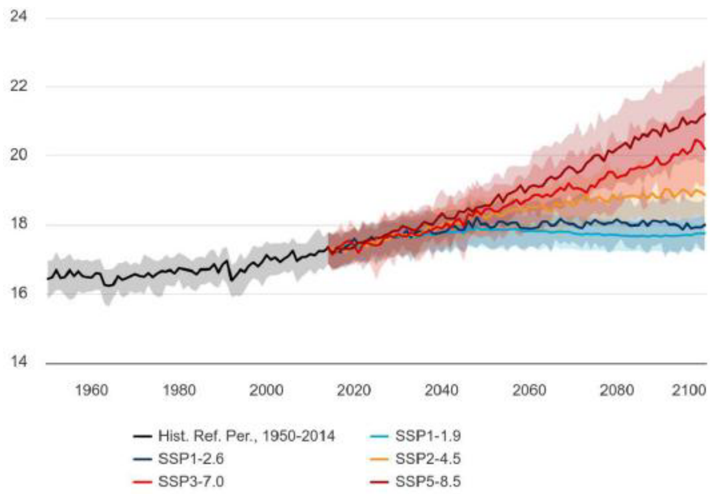

Figure 12 – Projected mean temperature for the Western Cape (reference period 1995 - 2014) (The World Bank Group, 2021)

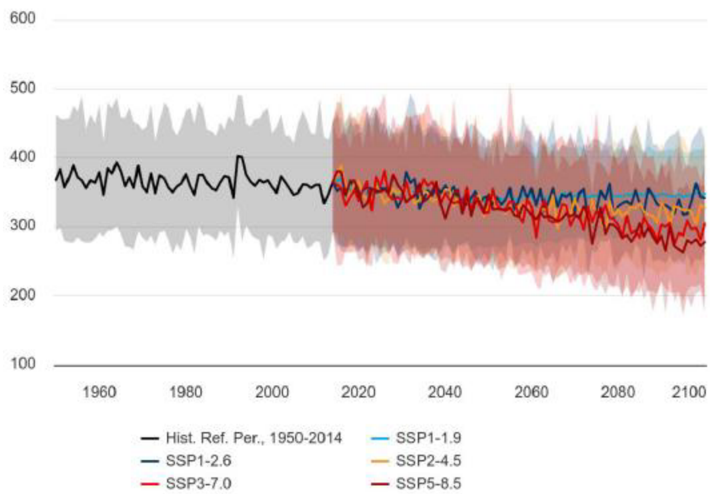

Figure 13 – Projected precipitation for the Western Cape (reference period 1995 - 2014) (The World bank Group, 2021)

According to Figure 12, mean annual temperatures in the Western Cape are projected to increase under all SSPs. Increased temperatures are expected in all seasons (The World Bank Group, 2021). Based on Figure 13, a slight decreasing trend for future precipitation in the Western Cape is apparent, however substantial multiyear fluctuations are predicted for future scenarios.

The Western Cape Climate Change Response Strategy (WCCCRS, 2022) reports on projections of future climate for the province. The findings are formulated from an assimilation of climate change projections from multiple global climate models compiled by CSAG (2022) for the Department of Agriculture's SmartAgri plan update. The finding presented are based on projections forced by the SSP2-4.5 shared socio-economic pathway. SSP2-4.5 represents a "middle of the road" global response to climate changes where some level of mitigation is achieved (CSAG, 2022). Projections for the

Western Cape indicate that temperatures will continue to rise. Expected increases in mean temperature averaged over the entirety of the Western Cape are 1°C to 1.8°C by 2060, in comparison to the recent past (1981-2010). Increases in temperature are also expected to result in a greater number of hot days (days exceeding 30°C). Projected increases in the number of hot days for the Western Cape ranges from 5 more hot day per year to 30 more hot days per year for inland regions (CSAG, 2022).

Higher uncertainty is associated with projected changes in annual precipitation over the Western Cape, with some models predicting minor decreases and others suggesting that a decrease of 20% can be expected (CSAG, 2022). Potential evapotranspiration (PET), an indicator of evaporation, is expected to increase and is largely driven by the expected temperature increase, while the frequency of droughts in the Western Cape is also expected to increase (CSAG, 2022). Thus, a decrease in rainfall is expected for most regions of the Western Cape, and even when reductions in rainfall are not predicted, increasing temperatures will result in water availability challenges for the province. Rising surface temperatures and changing precipitation patterns can be considered chronic climate related physical risks that the CWA expansion will be subjected to, due to its positioning within the Western Cape.

6.1.1 Risk of Wildfires

Wildfires can cause significant social, economic and environmental impacts (CSIR, 2023). In the CWDM, increased temperatures and greater rainfall variability are expected, consistent with a projected increase in the frequency of wildfire occurrences for the region (GFDRR, 2019). The Project site is situated in a region where climate and fire prone vegetation (fynbos and renosterveld) increase the risk of fires (CSIR, 2023). The description of the hazards related to wildfires is given in Table 12. There is a greater than 50% chance of the CWDM region experiencing weather conditions conducive to significant wildfires in any given year (GFDRR, 2023). The potential for wildfires can be expected in the short-term. As a result, risk of wildfires is considered high (GFDRR, 2023)

Table 12 – Risk of Wildfires

Impact	Description of hazard
Health and safety	• Fires may lead to injuries/hospitalisations/loss of life. • Increased smoke and ember storms may lead to injuries and hospitalisations. • Compromised food (i.e., due to crop loss) and water supplies may affect the nutrition and wellbeing of personnel. • Wildfires can impact air quality by increasing emissions of particulate matter and ozone precursors, posing a risk to human health (Fann et al., 2016).

Impact	Description of hazard
Operational and value chain	• Damage and/or loss of property and infrastructure due to fire, strong winds and/or lifted debris. • Smoke from wildfires can travel long distances, and reduced visibility may impact the efficiency of air traffic operations, that could lead to economic losses. • Electricity generation may be disrupted, which could halt operations. The site is currently supplied by Eskom. Sustainable energy sources including a bio-digestor plant and photo-voltaic power supplies (solar PV) are being considered to meet electricity requirements above 5 MVA. The accessibility of the airport may be reduced impacting goods and service delivery, arrival of staff/personnel and passengers. This could halt/delay operations leading to economic losses.

6.1.2 Risk of Landslides

Due to rainfall patterns, terrain slope, geology, soil and land cover, the site locality is considered susceptible to landslides, however this hazard does not occur often. Landslides are more common in areas with steep slopes. The current project site is characterised by flat terrain with little undulation, while the northern extent of the proposed expansion is characterised by undulous terrain with rolling hills. Therefore, although the direct vicinity of the project site may not be influenced, impacts may be felt by staff/personnel that reside in adjacent communities built on steeper slopes. Changes in precipitation and temperature under changing climate conditions may alter slope and bedrock stability, however it in important to note that this is highly dependent on local geological conditions. Future locations and timing of landslides is difficult to determine, given that these depend on local geology and other non-climatic condition. The description of the hazards due to landslides is provided in Table 13 therefore, the CWDM is considered to be at medium risk of landslides (GFDRR, 2019).

Table 13 – Risks of Landslides

Impact	Description of hazard
Health and safety	• Landslides may lead to injuries/hospitalisations/loss of life in affected areas. • Compromised food (i.e., due to crop loss) and water supplies in affected areas may impact the nutrition and wellbeing of staff/personnel.
Operational and Value Chain:	• Landslides may lead to damage and/or loss of property and infrastructure in affected areas. • The accessibility of the airport may be reduced impacting goods and service delivery, arrival of staff/personnel and passengers. This could halt/delay operations leading to economic losses.

6.1.3 Risk of Water Scarcity

The risk of water scarcity to the region is considered medium by the GFDRR (2019). This is due to the potential increase in "drought tendency", and "physical area of drought" projected for the region, which will impact water scarcity. According to the GFDRR (2019), there is up to a 20% chance that droughts will occur in the next 10 years. Thus, droughts can be expected in the short to medium term. The risk of water stress in the region, defined as "the ratio of total water demand to available renewable surface water and ground water supplies" by WRI (2019), is considered extremely high. The CWA plans to make use of groundwater at site. According to WRI (2019), groundwater decline in the region is expected to be 0 – 1 cm/year and is rated as a low-medium risk. the description of the hazard is provided in Table 14. Based on all risk tools reviewed, the risk rating applicable to the site has been adjusted to high.

Table 14 - Risk of water scarcity

Impact	Description of hazard
Health and safety	• Water scarcity may lead to reduced water quantity and quality on site and in adjacent areas which could create human health risks. • Drought conditions can impact food security, leading to the malnutrition of staff/personnel.
Operational and Value Chain	• Airports rely on water during construction, in daily operations, on the airfield and in terminals. Reduced water supply may impact the functioning of airport facilities, and halt/delay operations that could lead to economic losses. • Increases in operational costs may be experienced, if the cost of water increases which may result in reduced profits.

6.1.4 Risk of Extreme Heat

The Western Cape is projected to experience increased temperatures and greater numbers of hot days where temperatures exceed 30°C (CSAG, 2022). The risk of extreme heat to the CWDM is considered medium, meaning that there is a 25% chance that at least a period of prolonged exposure to extreme heat, causing heat stress, will take place in the following five years (GFDRR, 2019). The description of the hazard is provided in Table 15. Thus, extreme heat events can be expected in the short – term.

Table 15 - Risk of extreme heat

Impact	Description of hazard
Health and safety	• Heat stress may cause staff/personnel to experience heat related illnesses, dehydration and fatigue, which consequently could impact operations on site. • Compromised food (i.e., due to crop failure) and water supplies due to heat waves may impact the nutrition and wellbeing of staff/personnel.

Impact	Description of hazard
	• Heat waves can lead to poor air quality, as increased temperatures can lead to increased ozone concentrations (a key component of smog). Poor air quality poses a risk to human health (Fann et al., 2016).
Operational and Value Chain	• Heat stress may impact the health of the workforce leading to operational delays, that could result in economic losses. • Extreme heat events may lead to equipment failures/malfunctions that could halt/delay operations. • Heat wave can also negatively influence road and rail infrastructure causing transportation delays, that may impact goods and service delivery, arrival of staff/personnel and passengers.

6.1.5 Risk of Flooding Events

There are no rivers located within the project area, however, the Mosselbank River is located about 1 km west of the site and the Klapmuts River is located about 1.1 km northeast of the site (FEN Consulting, 2023). According to the flood risk assessment conducted for the CWA expansion (Zutari, 2024), the airport itself is at zero risk of flooding from surrounding rivers due to its elevated position. However, run-off from the site will change with the airport development, and slopes and drainage patterns will change. Thus, flood risks for catchments downstream of the CWA will change. The CWA plans to construct detention ponds as a mitigation measure. According to both the GFDRR (2019) and WRI (2019), the site region is at low risk of both urban and riverine floods. This is consistent with modelled predictions for the Western Cape, which show that an increase in temperature and decrease in rainfall can be expected in the future (CSAG, 2022). There is a greater than 1% chance of floods occurring in the coming 10 years (GFDRR, 2019). The description of the hazard is provided in Table 16. Thus, floods may be expected in the medium to long term. It should be noted, however, that with inconsistencies in modelled projections of rainfall in the Western Cape, this hazard level may increase in the future due to climate change.

Table 16 - Risk of flooding events

Impact	Description of hazard
Health and safety	• Workplace injuries and potentially loss of life • Compromised food (i.e., due to crop failure) and water supplies due to flooding may impact the nutrition and wellbeing of staff/personnel.
Operational and Value Chain	• Flooding may result in infrastructure and property damage. • Flooding may result is road closures, causing transportation delays, that may impact goods and service delivery, arrival of staff/personnel and passengers.

7 CLIMATE CHANGE MITIGATION AND ADAPTATION OPTIONS

In the following section, mitigation and adaptation measures to reduce the vulnerability of the CWA to identified climate-related risks are discussed. Recommendations for consideration in project design, planning, construction and operation are outlined in Table 17.

Table 17 - Recommended mitigation and adaptation measures

Risk	Adaption and Mitigation measures
Wildfires	• Identify infrastructure and areas on site that are vulnerable to wildfire risks. • Consider wildfire risks in site design and layout planning and fuel management procedures. • Construct firebreaks in areas vulnerable to wildfires. • To ensure the health and safety of employees, site evacuation and emergency response plans for wildfire events should be implemented. • Ensure backup power systems are available, should the energy supply be disrupted.
Landslides	• Avoid building near steep slopes, close to cliffs or near stream channels and drainage ways. • Plant ground cover on slopes. • If the area is prone to landslides, seek professional evaluation of the site as construction plans may need to consider structures for debris flow diversion or retention. • Ensure multiple transportation routes of entry to and exit from the site in case roadways are damaged.
Water Scarcity	• A water scarcity management plan should be developed to mitigate water scarcity risks. • The CWA should increase water storage, reduce water use and improve water consumption efficiencies. • Ensure that multiple potable water sources are available for the site to alternate between should it be required. • Investigate monitoring and forecasting systems to help predict future periods of drought and enhance preparedness. • Monitor water consumption during drought periods to prevent compromising water availability.
Extreme Heat	• Keep facilities/buildings cool with efficient use of air-conditioning. • Consider building designs appropriate for local climate that are conducive to cooling in summer i.e., consider building orientation, natural shading, and ventilation. • Ensure that equipment and vehicles purchased for use on site can operate under increased ambient temperatures to avoid downtime. • Investigate early warning/monitoring systems to inform the site of expected heat wave occurrences. • Ensure health and safety of employees by regularly monitoring hydration levels, avoiding work hours during the hottest part of the day and providing medical attention/resources to those who are vulnerable.

Risk	Adaption and Mitigation measures
Urban and Riverine Floods	• Ensure that drainage infrastructure is well maintained. • Ensure infrastructure built on site is resilient to projected flood levels, and that site design and layout planning considers the potential for flooding event on site • To ensure health and safety of employees, site evacuation and emergency response plans for flooding events should be implemented. • Ensure backup power systems are available, should energy supply be disrupted.

The CWA expansion plans to implement a variety of climate change adaptation mitigation measures which are aligned with the City of Cape Town Climate Change Strategy (2021). These measures are described in more detail below:

Urban cooling and heat responsiveness – The CWA aims to develop buildings appropriate for the local climate that reduce the need for cooling/heating in summer/winter.

Water scarcity and drought readiness – The CWA expansion aims to utilise treated groundwater abstracted from boreholes on site as a short to medium term solution to potable water supply. In the medium to long term, potable water supplied by the City of Cape Town will be added. To treat the ground water to a potable standard, a water treatment facility will be established on site. Non-potable water needs will be met using treated sewage water. Water saving technologies such as rainwater harvesting, water reuse and recycling, efficient irrigation and drought resisted landscaping will be implemented.

Water sensitivity, flood-readiness and storm management – The CWA expansion plans to develop a full stormwater design to accommodate the increase in hardened surfaces and additional stormwater runoff anticipated from buildings. The stormwater design will focus on the prevention of flooding.

Managing fire risk and responsiveness – The CWA expansion plans to implement the placement of fire water tanks on site and include fire protection measures in its building designs. A fire response plan will also be developed. Fire response vehicles and trained fire fighters will be present on site, to ensure fast emergency response times. Fire breaks will also be constructed along the site perimeter and alien vegetation removal will be prioritized to decrease the likelihood of veld fires crossing the site.

Zero emissions buildings - Two sustainable energy options are being considered, including a bio-digester plant and photo-voltaic power supplies (solar PV) with optional storage batteries. Ideally, diesel generators will serve as a back-up option in case of unfavourable weather conditions, plant failure or maintenance operations. As mentioned above, the CWA expansion plans to construct buildings that minimise the need to heating and cooling, which will subsequently reduce electricity needs and associated emissions.

Waste generation, management and disposal – waste is expected to be generated from the biodigester, the wastewater treatment plant and from the daily operation of the airport. The design of the wastewater treatment plant should consider best practises for mitigation depending on the technology chosen. i.e., a standard wastewater treatment plant using anaerobic digestion should consider capturing methane generated and use it to provide some of the energy requirements. When drafting the waste management plan, should include aspects such as recycling and composting.

8 SPECIALIST OPINION

The Climate Change Impact Assessment (CCIA) for the proposed expansion of the Cape Winelands Airport (CWA) presents a detailed evaluation of the Project's climate-related impacts and vulnerabilities. The assessment emphasises the project's low Scope 1 and 2 emissions, substantial Scope 3 emissions and highlights significant socio-economic benefits. Furthermore, it identified various climate change physical risks, some of which of high risk posing significant but manageable threats.

The CCIA includes an analysis of GHG emissions from both the construction and operational phases of the CWA expansion. The total emissions from the construction and operation of the project are estimated to be 5.3 million tCO_2e up to 2050. Construction emissions are projected to be 326,662 tCO_2e, contributing 6.13% to the total project emissions. For the operational phase, Scope 1 and Scope 2 emissions, are estimated to be 5 350 tCO_2e and 1 017 474 tCO_2e respectively, reflecting the project's direct environmental footprint. Scope 3 emissions are projected to be 4.3 million tCO_2e, contributing 81 % to the overall carbon footprint. Notably, only domestic aviation Scope 3 emissions are accounted for in the National GHG Inventory (NIR, 2022), reducing the Project's reported impact on the national budget to 3.7 million tCO_2e. Domestic aviation, contributing 40% to total project emissions, are considered to be addressed by the regulatory environment setting limits to airline operators through the current carbon tax and future carbon budgets system. The cumulative impact of the CWA's carbon footprint up to 2050 is of medium significance and estimated to consume less than 0.1% of South Africa's carbon budget if aligned with a 1.5˚C goal.

The project design includes several mitigation strategies. The CWA aims to be partially self-sustainable in meeting its energy needs by implementing renewable energy solutions such as Solar PV and a biodigester system. These measures are important for reducing the Project's carbon footprint and enhancing sustainability. Further mitigation actions identified in the CCIA for consideration are:

- Further investment in renewable energy to make the project completely self-sustainable, with minimal reliance on grid electricity.
- Collaboration with airline partners to facilitate the development and use of sustainable aviation fuels.
- Collaboration with local authorities to optimise public transport to and from the airport.
- Feeding of excess renewable electricity to the grid.
- Designing green buildings with materials of low embedded GHGs, incorporating designs that reduce the need for external heating and cooling
- A waste management system focusing on recycling and/or composting
- Incorporating mitigation measures, appropriate to the chosen design of the wastewater treatment plant.

The physical risks that climate change poses to the CWA expansion project were examined. Based on modelled climate projections and various risk identification tools, several vulnerabilities at the project site were identified. The site is at high risk of wildfires and water scarcity, posing significant but manageable threats to the labour force, infrastructure, and operational continuity. Medium risks include landslides and extreme heat, which could disrupt operations and impact worker safety. To address these vulnerabilities, the CCIA recommends several proactive adaptation measures. Developing early warning systems for extreme weather events is essential for proactive risk management. Additionally, upgrading site plans and enhancing existing infrastructure to withstand climate-related impacts will help mitigate potential damages and disruptions. Ongoing research and monitoring are also recommended to continuously assess climate impacts and adjust strategies accordingly.

While the CWA expansion project will produce GHG emissions, it offers a socio-economic boost to the region through job creation through the construction and operation of the airport and stimulating the local economy. As a reliever airport, the CWA could improve operational efficiencies for airlines by decongesting aviation space in the region, reducing reserve fuel requirements and shorter rerouting distances in case of safety concerns. The organic growth of tourism and aviation in the Western Cape region should also be considered. As such, the establishment of the CWA as an alternative international aviation centre in the region could avoid congestion related to this growth.

In conclusion, it is our opinion that the Project can align with national and global climate goals while ensuring resilience against evolving climate challenges by implementing the planned mitigation and adaptation strategies. In this respect, we also considered that the emissions controlled by the airport are low compared to the emissions related to fuels burnt by incoming and outgoing flights, which will be managed through future carbon budgets imposed on airlines under the Climate Change Act. Furthermore, the additional benefits in terms of decongestion and enhanced operational efficiencies that come with the role of the Project in the region may facilitate sustainable growth.

We do not propose any special conditions with respect to the authorisation of this Project.

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Table A1 – Scope 1 emission factors

Fuel Type	Emission Source	Units	Value	Reference	Comments
Mobile Diesel	Carbon Dioxide	kg CO_2/TJ	74 638.00	DFFE Methodological Guidelines	Country Specific
	Methane	kg CH_4/TJ	4.15		
	Nitrous Oxide	kg N_2O/TJ	28.60		
	Carbon dioxide equivalent	kg CO_2e/litre	2.93	Calculated	
	Calorific Value	TJ/litre	0.0000355	DFFE Methodological Guidelines	
	Density	kg/l	0.83		
Stationary Diesel	Carbon Dioxide	kg CO_2/TJ	74 638.00	DFFE Methodological Guidelines	Country Specific
	Methane	kg CH_4/TJ	3.00		
	Nitrous Oxide	kg N_2O/TJ	0.60		
	Carbon dioxide equivalent	kg CO_2e/litre	2.66	Calculated	
	Calorific Value	TJ/litre	0.0000355	DFFE Methodological Guidelines	
	Density	kg/l	0.83		
Wastewater Treatment	Carbon Dioxide	kgCO_2e/m3	0.201	DEFRA Emission Factors 2023	Wastewater treatment
Biogas	Carbon Dioxide	kg CO_2/TJ	54 600.00	DFFE Methodological Guidelines	Country Specific
	Methane	kg CH_4/TJ	1.00		
	Nitrous Oxide	kg N_2O/TJ	0.10		
	Carbon dioxide equivalent	kg CO_2e/m3	1.3058	Calculated	
	Calorific Value	TJ/m^3	0.00	DFFE Methodological Guidelines	
	Density	kg/l	0.72		

Table A2 – Scope 2 emission factors

Emission Source	Unit	Value	Reference	Comments
Grid Emission Factor in 2023	tCO_2e/MWh	0.10100	Eskom Integrated Report 2023	Page 170

Table A3 – Scope 3 Category 1 emission factors

Emission Source		Unit	Value	Reference	Comments
Construction emission factors	Building Demolition	$kgCO_2e/m2$	14.00	Finnish Study	Demolition research pdf Energy pdf
	Site Clearance	$kgCO_2e/m2$	7.00	Finnish Study	Construction process pdf Transportation pdf Infrastructure pdf
	Metal	$kgCO_2e/tonne$	4005.14	DEFRA Emission Factors 2023	Materials used – construction – metals
	Plastic PVC Pipe	$kgCO_2e/kg$	3399.18	DEFRA Emission Factors 2023	Materials – Plastics – Plastic PVC
	Plastic HDPE cables	$kgCO_2e/kg$	3255.93	DEFRA Emission Factors 2023	Materials – Plastics – HDPE
	Asphalt	$kgCO_2e/tonne$	39.21	DEFRA Emission Factors 2023	Materials – Construction – Asphalt
	Concrete	$kgCO_2e/tonne$	131.75	DEFRA Emission Factors 2023	Materials – Construction - concrete
	Paving	$kgCO_2e/m_2$	364.67	Calculated	
	Steel Rebar	$kgCO_2e/tonne$	980.00	e-scholar	Life-Cycle Environmental and Economic Management of Airport Infrastructure and Operations
	Structural Steel	$kgCO_2e/tonne$	2390.00	e-scholar	
	Glass	$kgCO_2e/tonne$	1402.77	DEFRA Emission Factors 2023	Material – Other - Glass

Table A4 - Scope 3 Category 2 emission factors

Emission Source	Unit	Value	Reference	Comments
Electric Vehicle Supply	$kgCO_2e$/product	142.965	Energy Star	Commercial Application Emission Factor
Fabric Conveyor Belts	tCO_2e/tonne	1.05	Rubber element - 0.64 tCO_2e/tonne: The overall emissions from the production of concentrated latex, STR 20, and RSS amount to 0.54-, 0.70-, and 0.64-ton CO-$_2$e/ton product, respectively. https://www.reContainer Shiprchgate.net/publication/223310370_Greenhouse_Gas_Emissions_from_Rubber_Industry_in_Thailand Steel element - 2.29 tCO_2e/tonne: Report - World Steel Organisation states global average emission factor is 1.89 tCO_2e/t steel: Steel Emissions Plus, additional forging emissions: Article - Morrell, S., 2022. Helping to reduce mining industry carbon emissions: A step-by-step guide to sizing and selection of energy efficient high pressure grinding rolls circuits. Minerals Engineering, 179, p.107431. "forging/casting to obtain the finished product adds, on average, a further 0.4kgs of CO_2... per kg of steel balls consumed"	Assumed standard conveyor
Sub Station	tCO_2e/million Rand	13.00	Embodied Impacts Tool	
Biodigester	tCO_2e/million Rand	10.73	Embodied Impacts Tool	
Solar Pannel	tCO_2e/kWh	0.00007	solarbelobal.	

Table A5 – Scope 3 Category 3 emission factors

Fuel Type	Emission Source	Units	Value	Reference	Comments
Mobile Diesel	Locomotives	$kgCO_2e$/litres	0.62409	DEFRA Emission Factors 2023	WTT Fuels – Liquid Fuels – Diesel (100% mineral diesel)
Stationary Diesel	Generators	$kgCO_2e$/litres	0.62409	DEFRA Emission Factors 2023	WTT Fuels – Liquid Fuels – Diesel (100% mineral diesel)
Electricity Generation	Delivery of energy crop	$kgCO_2e$/tonne.kilometer	0.0970	DEFRA Emission Factors 2023	Freighting Goods HGV – diesel 100% laden
	Energy Crop Production	kgCO2e/tonne Napier grass	17.2	Somjai & Suwan (2020)	Irrigated Farm land

Table A6 – Scope 3 Category 5 emission factors

Emission Source	Unit	Value	Reference	Comments
Commercial and Industrial Waste	$kgCO_2e$/tonne	467.01	ACERT Tool	Waste Disposal - Refuse – Landfill
Construction Waste	tCO_2e/kg	0.057	CO2 Database	Estimated construction waste emission factor

Table A7 – Scope 3 Category 6 emission factors

Emission Source	Unit	Value	Reference	Comments
Send Based emission factor for flights	$kgCO_2e$/ZAR	0.09	Estimate Emission Factor Air Tavel	1.7 kilograms of CO2 generated per dollar spent - converted to ZAR with 1:18,62 exchange rate of May 2024

Table A8 – Scope 3 Category 7 emission factors

Emission Source	Unit	Value	Reference	Comments
Average Local Bus	$kgCO_2e$/passenger.km	0.1	DEFRA Emission Factors 2023	Business travel – land – average local bus
Minibus	$kgCO_2e$/passenger.km	0.15	DEFRA Emission Factors 2023	Business travel – land – regular taxi
Average Car	$kgCO_2e$/km	0.17	DEFRA Emission Factors 2023	Business travel – land – Average Car – Unknown fuel
Average Motorbike	$kgCO_2e$/km	0.11	DEFRA Emission Factors 2023	Business travel – land – Average Motorbike

Table A9 – Scope 3 Category 11 emission factors

Emission Source	Unit	Value	Reference	Comments
Average Local Bus	$kgCO_2e$/passenger.km	0.1	DEFRA Emission Factors 2023	Business travel – land – average local bus
Minibus	$kgCO_2e$/passenger.km	0.15	DEFRA Emission Factors 2023	Business travel – land – regular taxi
Average Car	$kgCO_2e$/km	0.17	DEFRA Emission Factors 2023	Business travel – land – Average Car – Unknown fuel
HGV (all)	$kgCO_2e$/tonne.km	0.097	DEFRA Emission Factors 2023	Freighting Goods – HGV (all diesel)
Vans – average	$kgCO_2e$/tonne.km	0.575	DEFRA Emission Factors 2023	Freighting Goods – Vans
Aviation Turbine Fuel	$kgCO_2e$/litre	3.163	ACERT Tool	Input Sheet General factor
Jet A1 Fuel	$kgCO_2e$/kg	3.398	ACERT Tool	Input Sheet General factor