Tillegra Dam

Planning and Environmental Assessment

Sustainable Resource Use

WORKING PAPER

f

aurecon

Hunter Water

Document Control

aurecon

Rev No	Date	Revision Details	Typist	Author	Verifier	Approver
0	Mar 2008	Draft	JS	JS/KL	CM	CC
	Aug 2009	Final	JS/AD	JS/LAD	CM	CM

A person using Aurecon documents or data accepts the risk of:

a) Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.

b) Using the documents or data for any purpose not agreed to in writing by Aurecon.

Aurecon came into existence in March 2009 through the merger of Connell Wagner Pty Ltd and two South African companies, Africon (Pty) Ltd and Ninham Shand (Pty) Ltd. This post-dated Hunter Water Corporation's engagement of Connell Wagner in July 2007 for professional services for the Tillegra Dam Planning and Environmental Assessment. All references to Connell Wagner in this report should be taken to now refer to Aurecon.

Contents

1. Context of Sustainable Resource Use

1.1 Background

A widely recognised definition of sustainability (World Commission for Environment and Development 1987) is

> *meeting the needs of the present without compromising the ability of future generations to meet their own needs.*

The concept of sustainability recognises that social well-being and economic equity are invariably linked to ecosystem health.

The concept of sustainability is also referenced at a statutory level. Section 3A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) refers to ESD in the context of the need to integrate social, economic and environmental considerations into decision-making processes. At the State level, Section 5(a)(iiv) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) states that ESD is a primary objective of the NSW planning process; this is further reflected in Schedule 2 to the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). The objectives of other NSW legislation such as the *Protection of the Environment Operations Act 1997* (POEO Act) includes the fulfilment of sustainability principles.

The integration of the principles of sustainability into the Australian utility industry is by no means a new concept. By 2006 the *National Water Initiative* (NWI) had been released and signed by the Coalition of Australian Governments (CoAG) and a commission setup to regulate its implementation. Among other objectives, the NWI aims to incorporate the principles of ESD into the Australian water utility industry. Section 2 of the NWI (Council of Australian Governments 2004) states that there is a need to

> *ensure that water is allocated and used to achieve socially and economically beneficial outcomes in a manner that is environmentally sustainable.*

Subsequent to the release of the NWI, the NSW implementation plan for the NWI was released which nominated deliverables for NSW utility companies (including Hunter Water Corporation (HWC)) and led to the incorporation of the principles of sustainability into their operations. For example, HWC's *Corporate Environmental Management Plan* (Hunter Water Corporation 2007a) includes statements about ESD such as:

> *integration of ecological, economic and social objectives into the management of operations and resources.*

1.2 Overview of sustainable resource use goals

In recognition of the importance of sustainability principles, HWC has identified the following sustainability goals for the Project:

- to provide an equitable, reliable and efficient water body for present and future generations while ensuring environmental protection and neutralising contributions to climate change
- to leave a positive economic, social and environmental legacy to the community.

The impact on resources is an important consideration of the overall sustainability of the Tillegra Dam Project. This report assesses the direct and indirect impacts of the Project on resources both during construction and operation. It discusses the implications for sustainable resource use and considers the Project's contribution to greenhouse gas emissions. Opportunities to maximise the reclamation and reuse of resources in the inundation area are also considered, as well as opportunities to minimise waste generation.

The implementation of measures to avoid, minimise, mitigate and, in some circumstances, offset impacts described within this report would assist HWC to achieve the sustainability goals of the Project.

1.3 Sustainable resource use and the Project

Natural resources are finite. In recognition of this fact, HWC intends to construct and operate Tillegra Dam in the most efficient manner practicable to avoid, or where this is not practicable, to reduce excessive resource use and waste generation. An important aspect of sustainable resource use is cleaner production which emphasises resource and waste minimisation, rather than the more traditional approach to the use of materials and waste treatment (Australian Academy of Science 1998).

Sustainable resource use can be considered as the basis of all sustainable construction, which is defined as

> *the creation and responsible management of a healthy built environment based on resource efficient and ecological principles.* (CSIRO 2004)

This definition indicates a connection between sustainable resource use and the fulfilment of sustainability goals.

To achieve the desired goals of the Project, components that are dependent on the use of natural resources have been analysed to identify the most efficient allocation and use of resources over the life of the Project. Additional analysis during detailed design would include explicit consideration of the viability of suitable alternatives to conventional construction materials. On the premise that all relevant materials considered for use in dam or road construction could be demonstrated as being durable and safe, material selection would be undertaken on a sustainability basis and include a review of issues such as:

- recycled content
- embodied energy
- life cycle/reliability of the product
- cost.

In relation to waste, HWC recognises that while avoidance is the most desirable outcome, it is not always possible. The principles to follow when avoidance is not possible are to reduce, reuse and recycle. The NSW Department of Environment and Climate Change (DECC 2008) defines the process as follows:

- reduce: to create less waste
- reuse: to use a product again for a different use without going through processing
- recycle: to process an old product into a new one.

Minimisation or avoidance of resource use is most effective at the design stage of a project through innovation and early consideration of key sustainability issues. However, it can also be meaningfully implemented at the construction and operation stages.

1.4 Director-General's Environmental Assessment Requirements

The Director-General's environmental assessment requirements (DGRs) for the Tillegra Dam Project state that a greenhouse gas assessment shall be undertaken as part of the environmental assessment (EA) for the Project. In addition, it is required that offset strategies for greenhouse gas emissions be identified where appropriate. The results of the greenhouse gas assessment for the Project are outlined in this report and a carbon neutral strategy has been developed which is underpinned by a number of offset strategies. The strategy is described in Chapter 4.

The DGRs for the Project include the requirement to provide details of options for the reclamation and reuse of resources from the proposed inundation area to reduce resource use and waste generation. The DGRs also require the consideration of the principles of reduce, reuse and recycle in the EA. These requirements are considered throughout this report and addressed specifically in Chapters 4 and 5.

2. Legislation and Policy Context

2.1 Introduction

The following sections discuss the statutory context of sustainable resource use for the Tillegra Dam Project. The legislation and policy discussed throughout this report identifies three main resource categories – energy, water and materials – that the Project would likely impact on. For convenience of discussion, the relevant legislation and policy relating to these categories and the Project is separated into an energy category, and a materials and water category.

2.2 Energy and greenhouse gas emissions

This section outlines the international and domestic policy and legislation pertaining to greenhouse gas emissions assessment and discusses its relevance to the Project.

2.2.1 International

Greenhouse Gas Protocol

The *Greenhouse Gas Protocol* (GGP) was developed by the World Business Council for Sustainable Development and the World Resources Institute, and is the most widely recognised tool to quantify and manage greenhouse gas emissions. The GGP is continually revised to reflect changes in international understanding of climate change and greenhouse gas emissions inventories and management. The GGP has largely been translated in Australia through AS/NZS ISO 14064 *Greenhouse Gases – Parts 1, 2 and 3*.

2.2.2 National

National Greenhouse Gas Inventory

An obligation for signatories under the *United Nations Framework Convention on Climate Change* (UNFCCC) is to provide National Greenhouse Gas Inventories. Australia's National Greenhouse Gas Inventory (NGGI) produced by the Department of Climate Change reports on the trends in Australia's greenhouse gas emissions for a given time period. The most recent inventory was published in 2005. This reported that Australia's emissions were 102.2 per cent of 1990 levels, largely consistent with Australia's 108 per cent emissions target as prescribed under the UNFCCC in 1992.

National Greenhouse and Energy Reporting System

Introduced in 2008 the *National Greenhouse and Energy Reporting Act 2007* (NGER Act) it underpins the National Greenhouse and Energy Reporting System. The System requires organisations to report on their greenhouse gas emissions, and details compliance measures and reporting requirements. The NGER Act captures emission-intensive industries from the outset and will progressively include organisations with smaller emission profiles. The NGER Act is also supported by the *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2008 V1.1 and National Greenhouse and Energy Reporting Guidelines 2008*.

The NGER (Measurement) Determination report outlines four methods that can be used to estimate emissions including through the use of the *National Greenhouse Accounts* (NGA) Factors Workbook (the NGA Factors workbook), published in January 2008, and by direct monitoring of emissions.

Both greenhouse gas emissions thresholds and reporting under the NGER Act would relate to Scope 1 (direct) and Scope 2 (indirect from the consumption of purchased electricity, heat or steam) emissions. Scope 2 emissions have been included, consistent with international reporting standards and previous commitments relating to the NGER Act. Under the NGER Act, reporting of Scope 3 (other indirect emissions) is not required (Department of Climate Change 2008).

National Carbon Accounting System (NCAS)

The development of the National Carbon Accounting System (NCAS) was initiated by the Commonwealth Government as a direct response to the greenhouse accounting demands for land systems created by the UNFCCC's NGGI reporting and the Kyoto Protocol compliance monitoring. The NCAS:

- supports Australia's position in the international development of policy and guidelines on sinks activity and greenhouse gas emissions mitigation from land-based systems
- reduces the scientific uncertainties that surround estimates of land-based greenhouse gas emissions and sequestration in the Australian context
- provides monitoring capabilities for existing land-based emissions and sinks, and scenario development and modelling capabilities that support greenhouse gas mitigation and the sinks development agenda through to 2012 and beyond.

2.2.3 New South Wales

NSW Greenhouse Gas Plan 2005

The *NSW Greenhouse Gas Plan 2005* discusses the various frameworks in place within NSW that address climate change, including the Greenhouse Gas Abatement Scheme (GGAS). The Plan highlights the need for cost-effective reduction strategies and adaptation plans to provide solutions in a carbon constrained future. The Plan sets an 'aspirational' 60 per cent emissions reduction target for 2050 and aims to return to 2000 levels by 2025. Importantly, due to the ratification of the *Kyoto Protocol* and in response to the upcoming United Nations COP15 Climate Change Conference scheduled for December 2009 in Copenhagen, the *NSW Greenhouse Gas Plan* targets are likely to be revised to reflect a coordinated national approach.

NSW Government – carbon neutral by 2020

On May 8 2008, the NSW Premier announced that the NSW Government would become carbon neutral by 2020. This relates to State Government operations and specifically includes government-owned or tenanted buildings. Some of the initiatives identified at this stage include:

- requiring all government buildings to obtain a 4.5 stars environmental performance rating for energy efficiency and water by 1 July 2011

- the purchase of products and appliances with minimum four-star water and energy ratings for government facilities
- requiring all NSW State Fleet vehicles to use ethanol blended fuels where available.

2.2.4 Local

Hunter Water Corporation Environmental Management Plan 2008-2013

HWC has released its *Environmental Management Plan for 2008-2013*. Goal 6 of the Plan contains an objective to minimise the environmental impact of HWC's energy use and greenhouse gas emissions. An action identified for this objective is the development of a *Greenhouse Gas Emission Strategy* by the end of 2008. As this strategy at the time of compiling this report was still under development, the preliminary carbon neutral strategy for the Project may take an alternate approach to this strategy. However, the feasibility of approaches to greenhouse gas reductions identified by HWC in the development of the *Greenhouse Gas Emissions Strategy* have been considered in the carbon neutral strategy for the Project.

2.3 Materials and water

This section outlines the national, State and local policy and legislation relevant to both material and water resource use for the Project.

2.3.1 National

WasteWise Construction Program Handbook Techniques for Reducing Construction Waste

The Australian Government has published the *WasteWise Construction Program Handbook Techniques for Reducing Construction Waste* (Environment Australia 1998) that outlines the ways an organisation can reduce the amount of waste generation during construction. The handbook is written as a practical guide for businesses, especially those in the construction and demolition industry, for best practice in waste reduction.

The guidelines are based on the principles of sustainability and how these apply to waste management. The handbook encourages companies to practice sustainable waste management and uses the waste management hierarchy (refer Section 2.2 *Code of Best Practice for Waste Processing in the Construction and Demolition Industry*).

2.3.2 State

Environmental Planning and Assessment Act 1979

At a State level, the EP&A Act, through Schedule 2 to the *Environmental Planning and Assessment Regulation 2000*, requires a proponent to justify the undertaking of a development or activity or with regard to the following sustainability principles:

- the precautionary principle
- intergenerational equity
- conservation of biological diversity and ecological integrity
- improved valuation, pricing and incentive mechanisms.

There are also references to ESD within the EP&A Act, for example Section 5 (objects of the Act).

Protection of the Environment Administration Act 1991

The *Protection of the Environment Administration Act 1991* (POEA Act) also promotes sustainable resource use through the promotion of the reduction in the use of materials and the reuse, recovery or recycling of materials, the making of progressive environmental improvements, including the reduction of pollution at source, and pollution prevention and cleaner production.

Waste Avoidance and Resource Recovery Act 2001

The objectives of the *Waste Avoidance and Recovery Act 2001* (WARR Act) have been considered in the waste management approach for the Project (Section 4.8). These objectives are:

a) to encourage the most efficient use of resources and to reduce environmental harm in accordance with the principles of ecologically sustainable development

b) to ensure that resource management options are considered against a hierarchy of the following order:

  – avoidance of unnecessary resource consumption.

  – resource recovery (including re-use, reprocessing, recycling and energy recovery)

  – disposal.

c) to provide for the continual reduction in waste generation

d) to minimise the consumption of natural resources and the final disposal of waste by encouraging the avoidance of waste and the reuse and recycling of waste

e) to ensure that industry shares with the community the responsibility for reducing and dealing with waste

f) to ensure the efficient funding of waste and resource management planning, programs and service delivery

g) to achieve integrated waste and resource management planning, programs and service delivery on a State-wide basis

h) to assist in the achievement of the objectives of the *Protection of the Environment Operations Act 1997*.

NSW Government Waste Reduction and Purchasing Policy

The NSW Government *Waste Reduction and Purchasing Policy* (WRAPP) requires all State government agencies to develop and implement a WRAPP plan. A WRAPP plan details strategies and targets for reduction in waste generation, resource recovery and increased purchasing of products with recycled content in the following areas:

- paper products
- office consumables (eg toner cartridges)
- vegetation and landscape material
- construction and demolition material.

The WRAPP requires all government agencies to collect data on the quantities of specified types of materials being disposed of. The data collected is then reported to the DECC every two years in order for the NSW Government to determine compliance with the WRAPP or the individual agency's strategy. WRAPP plans require strategies and targets for reduction in waste generation, resource recovery and increased purchasing of products with recycled content.

2.3.3 Local

HWC is required to hold an operation licence issued by the Government to lawfully provide services within its Area of Operations. The operating licence requires HWC to implement a monitoring and reporting protocol (the Protocol) and an environmental management plan (the most recent being the *Hunter Water Environmental Management Plan 2008-2013)*. The licence is supervised and reviewed by the Independent Pricing and Regulatory Tribunal (IPART).

HWC must record, compile, monitor, measure and report against the environmental performance indicators contained in the Protocol. Indicators contained within the Protocol that directly relate to sustainable resource use include:

- electrical energy efficiency of water assets
- electrical efficiency of wastewater assets
- electricity consumption from renewable sources or renewable sources generated by HWC expressed as a percentage of total electricity consumption
- solid waste generation
- waste recycled or reused expressed as a percentage of solid waste generated.

Hunter Water Environmental Management Plan 2008-2013

HWC has developed environmental improvement objectives and actions to address the Protocol indicators. These objectives and actions are outlined in the *Hunter Water Environmental Management Plan 2008-2013* (EMP) and in aims and commitments detailed in the *Hunter Water Community and Environment Policy 2007*. Through this policy HWC commits to promoting the efficient use of resources and minimisation of waste.

The *Hunter Water Environmental Management Plan 2008-2013* also outlines the areas of opportunity where HWC can efficiently use resources and implement measures to reduce demand for water. Within the EMP, HWC identifies a number of objectives and subsequent actions relevant to sustainable resource use. These objectives include those relevant to energy efficiency and the consequent reduction in greenhouse gas emissions. A waste recycling and reduction policy is also articulated.

Direct actions in the Plan include:

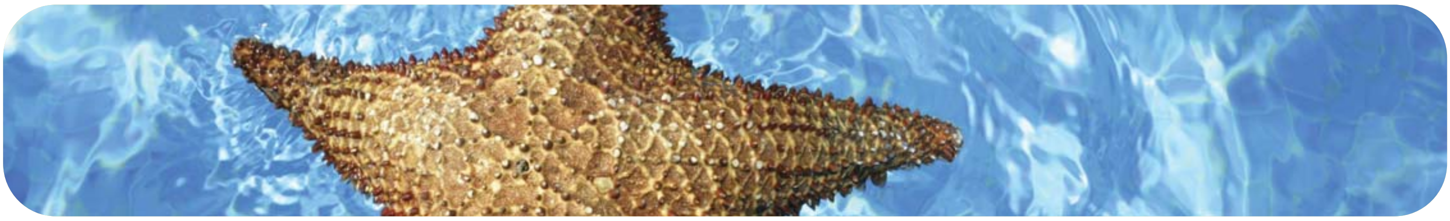
- the development and implementation of energy savings plans for major facilities
- the development of an incentive program for HWC to take up fuel efficient fleet cars
- the consideration of LPG and bio-diesel fuel alternatives
- the development of a recycled materials strategy, including initiatives that would reduce the use of virgin extracted natural materials
- a commitment to increase the amount of recycled materials used for new infrastructure projects where it is feasible and appropriate for this to occur.

These actions are currently being pursued by HWC and would be reported within its annual catchment report to IPART, as well as within its annual report.

Hunter Water Corporation's Waste Reduction and Purchasing Policy

HWC has committed to conserving natural resources through responsible purchasing and waste management practices through the development of its own WRAPP 2001. This means that HWC would strive to:

- reduce waste created from its day to day activities as far as practical
- design its management systems, services and products to avoid generating wastes that must be disposed to landfill
- purchase services and products that are recycled or low waste and that are also competitive in price and performance
- involve staff, clients and customers where they can contribute to HWC successfully reducing waste.



3. Overview of the Project

HWC is proposing to construct a dam at Tillegra near the town of Dungog in the Hunter Valley. It is envisaged that Tillegra Dam would more than double the total existing water storage capacity of the Hunter and the Central Coast regions and is deemed an important component of the NSW Government's State Plan to secure the water future of the region for at least the next 50 years.

The Project would inundate an area of approximately 2,100 hectares and have the capacity to store 450,000 megalitres of water. This additional storage volume would increase the reliable system yield by an additional 52,000 megalitres per year, providing increased security of supply for drought periods, and capacity to service population growth and projected demand beyond 2050.

Subject to HWC securing all necessary environmental assessment and approvals, construction would commence with the relocation of Salisbury Road. Construction of the dam would begin approximately 18 months later. The upper Williams River catchment receives large, regular flood flows which are expected to allow the dam to begin delivering water approximately three years after the start of construction.

The Project would comprise the following components (refer Figure 1):

- dam wall and spillway construction
- a multi-level offtake tower
- provision for a mini hydroelectric power (HEP) plant capable of generating up to 3,000 MWh of electricity annually
- relocation and reconstruction of Salisbury Road (including construction of three waterway crossings) and provision of alternative access currently provided from Quart Pot Creek Road
- a pipeline and pump station connecting Tillegra Dam to the Chichester Trunk Gravity Main (CTGM)
- electrical and telecommunication installations (approx 20 kilometres route)
- relocation/upgrading of other public infrastructure (such as the RFS station)
- heritage conservation works (including relocation of a cemetery and preservation of an historic house)
- carbon offsetting initiatives (refer Section 5)
- ancillary works as required (potential recreational access areas, lookouts and related facilities).

The construction and operation of these components would result in impacts on resources. A sustainable approach to these resource impacts is discussed in the following sections.

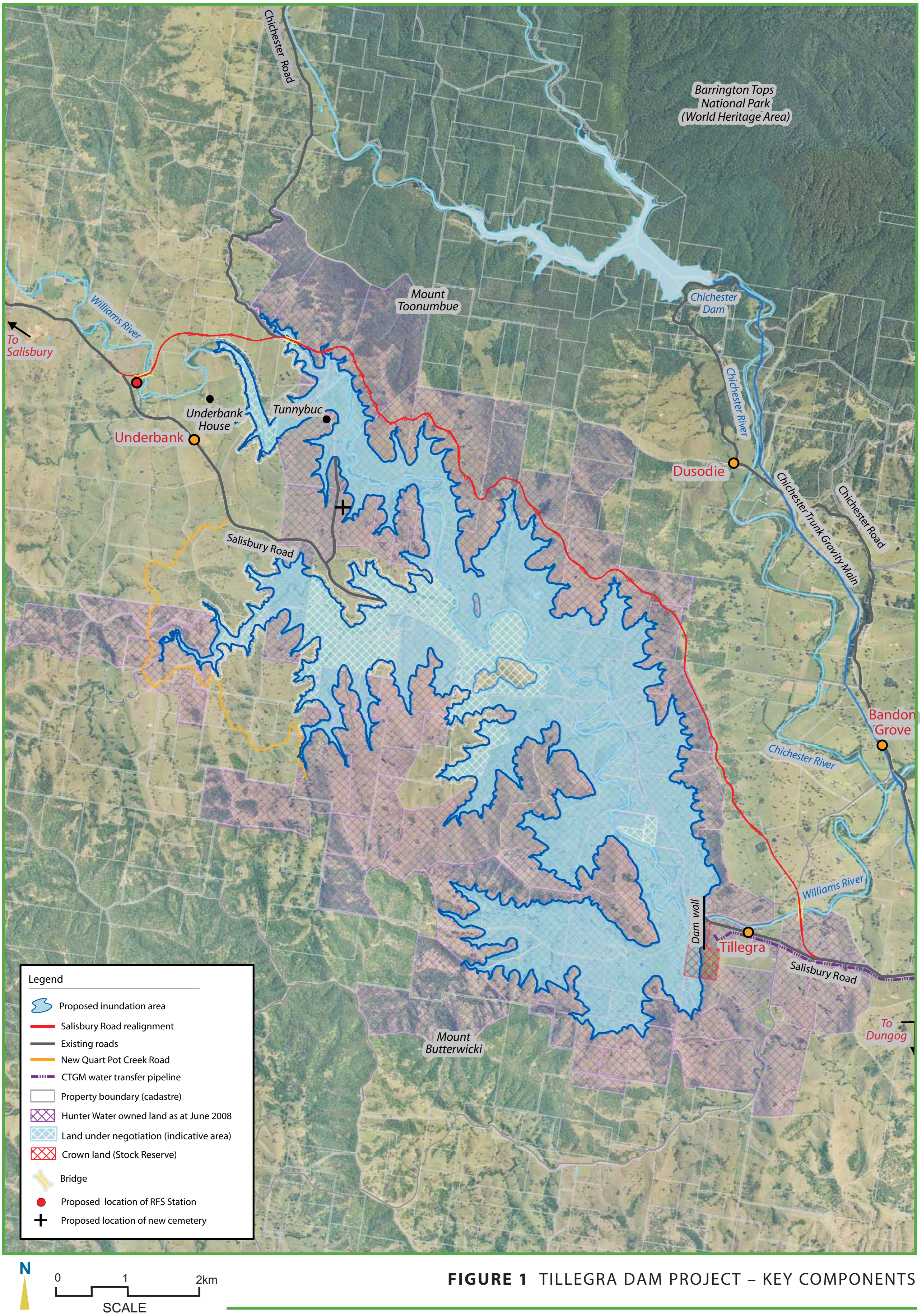


FIGURE 1 TILLEGRA DAM PROJECT – KEY COMPONENTS

4. Impact on Resource Use

It is expected that the Tillegra Dam Project would impact on a number of resources. To achieve the sustainability goals of the Project (as outlined in Chapter 1), measures to reduce, reuse and recycle are considered for the construction and operation stages of the Project. For the purposes of this assessment, the key areas of resource use considered are:

- energy
- water
- materials (including metals, rocks, plastics and vegetation).

The plant and material types discussed in this section of the report have been gathered from preliminary investigations undertaken by HWC. The materials and quantities listed are assumed not to include any materials containing recycled content nor items that could be reused from the existing site (such as items of infrastructure from within the inundation area). During detailed design, more precise estimates of plant and material types as well as their respective recycled content would be developed.

4.1 Energy and greenhouse gas emissions

4.1.1 Overview

The Project would impact on resources through the consumption of energy. A known consequence of energy consumption is the production of greenhouse gas emissions. Other Project activities would contribute to greenhouse gas emissions such as waste generation and the decomposition of vegetation in the inundation area (refer Section 5). As one of the goals of the Project is neutralising contributions to climate change, there is a need to consider how the Project can achieve carbon neutrality. To achieve this there is a need to develop a carbon neutral approach.

It is important to note that for the purposes of this report, the term 'carbon' is interchangeable with 'greenhouse gases' as emissions from other gases such as methane have been translated into a carbon emission equivalent (CO_2-e) using conversion factors produced by the former Australian Greenhouse Office (now the Department of Climate Change) (Australian Greenhouse Office 2007).

4.1.2 Definition of carbon neutrality

Becoming carbon neutral is an increasingly popular response to the climate change issue. The Australian Competition and Consumer Commission (2008) has defined carbon neutrality as follows:

> *Carbon neutrality is, broadly speaking, achieved by reducing and offsetting a business or individual's carbon dioxide equivalent (CO_2-e) producing activities and requires comprehensive accounting of the carbon footprint.*

At present, there are no mandated standards regarding carbon offsets and carbon neutrality in Australia. However, there are various recognised standards and an emerging consensus of 'best practice' in the area, that may help consumers and business assess claims.

The carbon neutral approach for the Tillegra Dam Project would cover all Scope 1 and Scope 2 emissions for both construction and operation for the Project. Refer to Section 4.1.4 for an outline of the emission types applicable to the Project and HWC's obligations for reporting and off-setting these emissions.

An important consideration in the implementation of a carbon neutral approach is the application of a carbon reduction hierarchy. A carbon reduction hierarchy can be defined as the staged approach to reducing greenhouse gas emissions. Such a hierarchy would consider the following elements:

- avoid energy usage
- improve energy efficiency
- utilise waste energy
- substitute for renewable energy
- sequestration of carbon
- purchase carbon offsets.

For the purpose of this report, the focus is upon recommending mechanisms for achieving carbon neutrality at the Project site, during construction and subsequent operation.

4.1.3 A staged and portfolio approach

HWC recognises that the development of a carbon neutral strategy for the Project requires a staged approach. Stage 1 comprises the estimation of the greenhouse gas emissions profile for the Project during construction and operation using a greenhouse gas inventory. The first stage also includes the preliminary establishment of reduction targets and a temporal target for reaching carbon neutrality. Stage 2 comprises avoiding and reducing greenhouse gas emissions as far as practicable. Stage 3 involves an offsetting approach, which may involve energy conservation measures and sequestration activities in order to achieve carbon neutrality. Details relating to each of these stages are described in Sections 4.2 to 4.4.

The benefit of a portfolio approach is that there is a buffer to reduce risk should one or more activities not meet the reduction targets and objectives set for the Project. Part of HWC's portfolio approach is provision for the installation of a mini HEP plant as part of the dam infrastructure (and which would be operated by a third party).

4.2 Stage 1: Greenhouse gas emissions estimate and targets

A greenhouse gas (GHG) inventory has been prepared for both the construction and operation phases of the Project. This provides an indication of the contribution of the Project to climate change.

Greenhouse gas emissions attributable to the Project have been calculated in terms of relevant direct emissions and indirect emissions, and have been divided into energy consumption, waste emissions and decomposition emissions.

The GHG inventory was developed using the approach outlined in the *Technical Guidelines for the Estimation of Greenhouse Emissions and Energy at Facility Level – Energy, Industrial Process and Waste Sectors in Australia, 2007*. The scope that emissions are reported at is determined by whether the activity is within the organisation's operational boundary (direct–Scope 1) or outside it (indirect – Scope 2 and Scope 3).

4.2.1 Direct emissions (Scope 1)

Direct emissions are produced from sources within the boundary of an organisation and as a result of that organisation's activities. These emissions typically arise from the following activities:

- generation of energy, heat, steam and electricity, including carbon dioxide and products of incomplete combustion (methane and nitrous oxide)
- manufacturing processes which produce emissions (eg cement, aluminium and ammonia production)
- transportation of materials, products, waste and people (eg use of vehicles owned and operated by the reporting organisation)
- fugitive emissions: intentional or unintentional GHG releases (eg methane emissions from coal mines, natural gas leaks from joints and seals)
- onsite waste management, such as emissions from landfill sites.

Emission factors for calculating direct emissions are generally expressed in the form of a quantity of a given greenhouse gas emitted per unit of energy (kg CO_2-e/GJ), fuel (t CH_4/t coal) or a similar measure. Emission factors are used to calculate greenhouse gas emissions by multiplying the factor (eg kg CO_2/GJ energy in petrol) with activity data (such as kilolitres x energy density of petrol used).

4.2.2 Indirect emissions (Scope 2 and Scope 3)

Indirect emissions are generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation. The most important category of indirect emissions is from the consumption of electricity. Other examples of indirect emissions from an organisation's activities include upstream emissions generated in the extraction and production of fossil fuels, downstream emissions from transport of an organisation's product to customers, and emissions from contracted /outsourced activities. The appropriate emissions factor for these activities depends on the parts of upstream production and downstream use considered in calculating emissions associated with the activity.

4.2.3 Energy consumption

Energy consumption refers to the primary and secondary energy sources by the end user, with energy sources being fossil fuels and renewable energy sources. This section applies to Project activities that would directly or indirectly require the use of energy and result in the production of greenhouse gas emissions. Relevant activities and the energy source required to complete the activity are listed in Table 1 for the construction phase of the Project and Table 2 for the operational phase of the Project.

The primary energy demand during construction would be associated with use of petrol/diesel powered mobile construction equipment and use of automobiles to transport workers to and from the construction site(s). Fuel consumption is based on number of heavy vehicles used on site, assumptions regarding the average distance travelled, and fuel efficiency (from NPI Workbooks and the National Transport Commission).

Electricity would also be used for construction lighting, field services (trailers), and electrically driven construction devices such as air compressors, pumps and other equipment. Electricity consumption estimated from the intensity of site work, and previous audits of electricity use on major construction sites.

TABLE 1 PROJECT COMPONENTS THAT WOULD CONSUME ENERGY AND APPROXIMATE CONSTRUCTION-RELATED GHG EMISSIONS

ENERGY TYPE	ACTIVITY	ESTIMATED QUANTITY	GHG EMISSIONS (t CO_2-e/yr)
DAM EMBANKMENT AND ASSOCIATED INFRASTRUCTURE			
Electricity	amenities security lighting staff / personnel dewatering relocation of services construction site offices water treatment mechanical generators drilling	300 MWh[1]	360[2]
Diesel/petrol	concrete production dust suppression machinery excavation of materials movement of excavation materials movement of other materials movement of spoil/fill operation of machinery construction site offices waste removal maintenance vehicle dewatering relocation of services water treatment mechanical generators drilling	8,000 kL[3,5]	21,600[4]
ROAD			
Electricity	bitumen production staff / personnel security lighting	50 MWh[1]	48[2]
Diesel/petrol	dust suppression machinery excavation of fill/aggregates excavation/fill of road area movement of machinery operation of machinery bitumen production	3,500 kL[3,6]	9,450[4]

ENERGY TYPE	ACTIVITY	ESTIMATED QUANTITY	GHG EMISSIONS (t CO_2-e/yr)
PIPELINE AND ASSOCIATED INFRASTRUCTURE			
Electricity	drilling/excavation pump station construction operation of machinery staff/personnel security lighting caretakers cottages	50 MWh[1]	48[2]
Diesel/petrol	concrete production drilling movement of machinery movement of materials pumping station construction operation of machinery	1,750 kL[3,7]	5,075[4]
Total over construction period			**36,581**
Total per year[8]			**9,145**

Notes:
1 Electricity consumption estimated from the intensity of site work, and previous audits of electricity use on major construction sites
2 Emissions estimate based on the predicted NSW pool coefficient
3 Fuel consumption based on number of heavy vehicles used on site, assumptions regarding the average distance travelled, and fuel efficiency (from NPI Workbooks and the National Transport Commission)
4 Emission factor of 2.7 t CO_2-e/kL from the NGA Factors, January 2008
5 Intensity of construction work for dam wall as per Section 4.7
6 Intensity of construction work for road realignment as per Section 4.7
7 Embodied energy is not included
8 Based on an estimated construction time of four years.

TABLE 2 PROJECT COMPONENTS THAT WOULD CONSUME ENERGY AND APPROXIMATE OPERATION-RELATED GHG EMISSIONS

ENERGY TYPE	ACTIVITY	ESTIMATED QUANTITY	ANNUAL GHG EMISSIONS (t CO_2-e/yr)
DAM EMBANKMENT AND ASSOCIATED INFRASTRUCTURE			
Electricity	amenities security lighting staff / personnel pump station[3] electric motors for valves etc monitoring and control	35 MWh[1]	42[2]
Total			**42**

Notes:
1 Electricity consumption estimated from the intensity of site work, and previous audits of electricity use on major construction sites
2 Emissions estimate based on the predicted NSW pool coefficient
3 Emissions estimate based on motors of similar capacity

4.2.4 Waste emissions

Greenhouse gas emissions from construction waste are largely Scope 3 emissions resulting from decomposition processes in landfill. The key material and waste streams generated during these activities include:

- concrete
- reclaimed asphalt
- scrap metal
- general construction waste
- green mulch and vegetation from clearing
- fuels, oils, liquids and chemicals
- wastewater
- sewage from site compounds
- contaminated/unsuitable spoil material
- excavated soil where cut/fill balance may not be achieved
- paper and cardboard.

The total volume of waste created may be reduced through the implementation of the reuse and recycle measures as discussed in Section 5.1. These measures include the reuse of cleared vegetation (mulched/chipped) for landscaping or habitat restoration, where appropriate.

As the GHG emissions from waste are not expected to be significant, waste-generating activities during construction, including clearing, restoration works, equipment maintenance and site office activities, have not been included in the estimation of total GHG emissions for the Project.

This approach of excluding the Scope 3 emissions relating to waste is consistent with the NGER Act which excludes Scope 3 emissions from being reported.

4.2.5 Decomposition of vegetation in the inundation area

The time elapsed since flooding has a significant influence on GHG fluxes from flooded lands and also on the partition of the gases. Recent statistical analyses on reservoirs worldwide indicate that there is a rapid surge of emissions immediately after flooding, after which emissions return to a relative stable level (Tremblay *et al* 2005; Therrien *et al* 2005; Soumis *et al* 2005; Huttunen *et al* 2002, 2003). The rate of the post-flooding decrease in emissions may depend on the region in which the reservoir is located, but seems to vary in about a 10 year period (Delmas *et al* 2005; Abril *et al* 2005; Tremblay *et al* 2005).

There is evidence to suggest that for approximately the first 10 years after flooding, GHG emissions are the results of decay of some of the organic matter on the land prior to flooding. The easily degradable carbon and nutrients are made available to producer organisms upon flooding and metabolized. After this time period, GHG emissions are sustained by the input of organic material transferred into the flooded area from the watershed (Houel 2003; Hélie 2004; Cole and Caraco 2001).

Subsequent to flooding and any land clearing, GHG emissions from land converted to flooded land can occur via the following pathways:

- diffuse emissions, due to molecular diffusion across the air-water interface; this is the major pathway for greenhouse gas emissions

- bubble emissions, or gas emissions from the sediment through the water column via bubbles; this is a very minor pathway for greenhouse gas emissions
- degassing emissions (including methane release from dam spills) or emissions resulting from a sudden change in hydrostatic pressure, as well as the increased air/water exchange surface after reservoir waters flow through a turbine and/or a spillway (Duchemin 2000; Hélie 2004; Soumis *et al* 2004; Delmas *et al* 2005).

Methane emissions are an important component of the total GHG emissions from decomposition. With respect to methane emissions, the greatest levels of emissions are generally produced from dams located in tropical regions and methane emissions from dams in more temperate climates have yet to be sufficiently quantified. As such it is anticipated that the conditions at Tillegra are less favourable for methane production. In calculating total GHG emissions, methane emissions are generally converted into a CO_2 equivalent (CO_2-e) and are subsequently included in the total emissions figure.

The terrestrial ecology assessment carried out for the Project (Working Paper E) identified the following five natural vegetation communities within the study area:

- Subtropical Rainforest
- Moist Gully Blue Gum Wet Sclerophyll Forest
- Spotted Gum – Ironbark Forest
- Forest Red Gum Moist Slopes Forest
- Riparian Forest.

These occupy approximately 10 per cent of the study area. The assessment also identified one highly modified community. This was predominantly cleared open pasture or derived grassland with sporadic remnant paddock trees including small farm dams.

Land conversion and tree planting are addressed in Section 5 of the NGA Factors workbook in the *Land-use Change and Forestry* (vegetation sinks) section. The national greenhouse gas account for land-based activities is estimated by the *National Carbon Accounting System* (NCAS). The NCAS is a model-based accounting system supported by resource inventories, field studies and remote sensing methods. The *National Carbon Accounting Toolbox* (the Toolbox) allows access to NCAS modelling and data, providing a set of tools for tracking carbon stock changes in forests including carbon sequestration and losses, for example through harvesting. Use of the Toolbox ensures that project-level carbon accounts for forest sinks are determined on a similar basis to Australia's national reporting.

The NCAS draws on a number of parallel programs to inform the suite of integrated models which make up the FullCAM model as used to generate land use change emissions estimates.

The Toolbox is described in detail in *National Carbon Accounting System Greenhouse Gas Emissions from Land Use Change in Australia: An Integrated Application of the National Carbon Accounting System* (Australian Greenhouse Office 2002). With expert advice from the NSW Department of Primary Industries (Forest Science Centre) the carbon content of the existing pasture and forest areas (including forest biomass in trees, forest litter and soil) were estimated using the Toolbox. The GHG emissions from decomposition in the existing pasture and forest area as a result of inundation are shown in Table 3.

TABLE 3 ESTIMATED GHG EMISSIONS FOR INUNDATION AREA DECOMPOSITION

LAND TYPE	AREA (HECTARES)	TOTAL CARBON (TONNES)	t CO_2-e
Forest	208.3[1]	30,082[2]	110,399[3]
Pasture	1,891.7	17,010[2]	62,426[3]
Total	**2,100[4]**	**47,092**	**172,825**

Notes:
1 Assumed 10% of the total inundation area is "Natural Communities" of vegetation (being mainly forest) based on the Terrestrial Ecology Report
2 Carbon stocks in the area to be inundated were based on the AGO's National Carbon Accounting Toolbox and Data Viewer (refer to Planning forest sink projects – a guide to forest sink planning, management and carbon accounting).
3 Emissions were determined as a direct mass-balance conversion to carbon dioxide (C:CO_2 ratio of 1:3.67 based on molecular weight). Emissions include carbon content of soil
4 Total inundation area

4.2.6 Total greenhouse gas emissions

Table 4 summarises the estimated GHG emissions for the Project based on the preceding analyses for a 25 year period.

TABLE 4 SUMMARY OF SCOPE AND EMISSIONS FOR EACH STAGE OF THE PROJECT TO BE OFFSET AS PART OF THE CARBON NEUTRAL STRATEGY OVER A 25 YEAR PERIOD

STAGE	SCOPE 1 (t CO_2-e)	SCOPE 2 (t CO_2-e)	Scope 3 (t CO_2-e)
Construction	diesel/petrol: 36,125[1]	electricity: 456[1]	36,581
Operation	decomposition: 172,825[1]	electricity: 1,050[1,2]	173,875
Total	208,950	1,506	**210,456**

Notes:
1 Scope 1 and Scope 2 emissions are covered by the mandatory reporting provisions of the *National Greenhouse and Energy Reporting Act 2008*.
2 This figure is the total emissions for electricity usage over a 25 year operational period.

As indicated in Table 4, the scope and emissions for each stage of the Project are as follows:

- Scope 1 emissions in relation to the Project during the construction stage include the use of diesel and petrol in contractors vehicles that equates to 36,125 tonnes of CO_2-e
- Scope 1 emissions in relation to the Project during operation include the fugitive emissions from the decomposition within the inundation area that equate to 172,825 tonnes of CO_2-e
- Scope 2 emissions in relation to the Project during the construction stage include consumption of electricity by construction contractors that equates to 456 tonnes of CO_2-e
- Scope 2 emissions in relation to the Project during the operation stage include the consumption of electricity that equates to 42 tonnes of CO_2-e pa or 1,050 tonnes of CO_2-e over a 25 year period.

Overall, a total 210,456 tonnes of CO_2-e needs to be offset. These total offsetting figures include both Scope 1 and 2 emissions so that they are consistent with the reporting provisions of the NGER Act.

It should be noted that it is difficult to provide an exact carbon mass balance for the dam and account for the cycling of all sources of carbon, particularly carbon sources originating from outside of the dam area. On this basis it should be noted that some of the carbon entering the reservoir post construction, over the longer term, that would have also entered the river prior to construction of the dam, will be entrained into supporting biological processes and primary production, while at other times, a portion may settle and be captured by the benthic zone where it may be subject to anaerobic decomposition, producing methane. The extent of this process is unlikely to be as significant and/or worthy of consideration as the matter of the decomposing terrestrial vegetation as the dam is located in a temperate, rather than tropical, environment where carbon inputs are not as significant.

4.2.7 National Greenhouse and Energy Reporting System requirements

Given the GHG emissions profile of the Project and the requirements of the NGER Act, it is likely that HWC would report on emissions derived from the Project. Section 1.3 of the *National Greenhouse and Reporting Guidelines 2008* sets out the following four criteria that can be used to determine whether an activity or series of activities forms a facility under the Act:

- activities must produce greenhouse gas emissions or produce or consume energy
- activities are part of a single production process
- activities occur at a single 'site'
- activities are attributable to a single industry sector.

Without considering thresholds for reporting emissions, Tillegra Dam satisfies the criteria of being considered a reporting site, however, network facilities for electricity, gas, water, sewerage and telecommunications can be reported as a single facility, even though they cross significant distances. In this regard it is likely that HWC will be obliged to report emissions related to Tillegra, as part of its greater responsibilities to report on the activities of its entire water supply and distribution system.

Where construction activities are being undertaken on behalf of HWC by a separate corporation, the emissions generated would be classifiable into an industry sector under the construction division of ANZSIC. A construction activity would need to be classified as a facility in a similar way to any other activities. Reporting thresholds would apply to the facility on an annual basis as with any other facility. From the initiation of a construction project, the energy and emissions data from that project would be collected and reported each year as part of the inventory if the threshold of 25 kt is met (Department of Climate Change 2008). This is to be reported by the corporation with operational control, in this case HWC. Based on the emission estimates provided in Table 4, it appears that HWC would need to report its construction emissions at a facility level due to the Scope 1 fuel emissions.

Emissions from the inundation area during operation would not be required to be reported under the NGER Act as they are currently classified as land use change emissions. These have not been included for reporting purposes and are to be considered as zero for the purposes of thresholds and reporting under the NGER Act (Department of Climate Change 2008). Notwithstanding this, given these emissions dominate they have been included in the assessment.

Overall HWC will need to report its operational emissions for this Project as a 'corporation' under the NGER Act as HWC's entire corporate emissions from network facilities across all areas of its operations would meet the thresholds under the NGER Act.

4.3 Stage 2: Abatement of greenhouse gas emissions

Abatement is most achievable in the design phase of the Project. Considering this, HWC aims to utilise climate responsive design by ensuring that consultants engaged to design the accompanying facilities for the Project reduce energy use for heating, cooling and lighting including designing offices and amenities to maximum advantage with respect to natural lighting and heating during the design phase.

GHG emissions from vegetative decomposition processes (also known as native vegetation carbon stock) contribute significantly to the GHG emissions profile of the Project. Avoidance of these emissions is therefore integral to the carbon neutral approach for the Project. Native vegetation carbon stock could be retained (and therefore not act as a GHG emission source) through beneficial reuse of timber as furniture or wood chips (considered as a substitute for other sources, such as plantation timber), or as fuel in biomass or co-fired power stations (eg Liddell power station in the upper Hunter Valley recently trialled co-firing with biomass or wood waste, generating 4,760 MWh of electricity). The reuse of vegetation is therefore an important avoidance strategy provided that the fuel used to harvest the trees does not exceed the offset.

Through its carbon abatement cost curve, McKinsey & Company (2008) has highlighted the effectiveness of introducing abatement measures. As such there are a number of abatement measures that are feasible for the Project. For the construction stage these may include:

- utilisation of optimum light intensity for security and safety purposes during construction
- place site offices in areas where the full advantage of solar aspects can be gained
- where solar aspects are not sufficient, 'green' energy should be utilised. This could include solar power cells, energy purchased from sources including hydro-electricity, natural gas, gas flaring
- utilisation of bio-fuels derived from waste by-products in vehicles and equipment in place of traditional fossil fuels
- ensure efficient work practices and schedules are implemented to avoid unnecessary movement of staff, vehicles and machinery
- implementation of dust suppression (using untreated water) measures only where necessary
- protect materials from weather to avoid the need for production/transportation of new materials
- specify the use of energy efficient equipment to be used during the construction process
- utilisation of local materials to reduce transportation distances
- for items that must be manufactured and transported from non-local sources, order items in bulk and preferably from the one place to remove doubling of transportation energy when the items are from the same area
- regular maintenance of equipment to ensure optimum operations and fuel efficiency
- design temporary access roads to reduce transportation distances
- switching off all office equipment when not in use, especially after hours
- additional materials that are not required during the construction process should be stockpiled and protected from the weather for use in maintenance procedures during the operation phase
- possible use of the RTA Green Spec. This specification allows for the use of up to 15 per cent reclaimed asphalt pavement within asphalt, for the use of recycled materials within base and sub-base of pavements, and for recycled content within selected formation material.
- use of products that have been certified by a recognised accreditation provider to ensure all products have undergone a rigorous certification process based on the principles of life cycle assessment, the 'cradle-to-grave' greenhouse gas emissions associated with the production, use and disposal of certified products or services
- balance cut and fill where possible to reduce the requirement for sourcing external materials
- recycle as much of the materials and resources to avoid unnecessary energy consumption to produce new materials
- recycle any materials that are unable to be re-used – materials can be recycled on or off-site.

Potential abatement strategies for operation may include:

- use of renewable energy sources for all structures associated with the daily maintenance of the dam and associated infrastructure
- when required, replacement of existing components with the latest technology that provides greater energy efficiency
- use of energy efficient maintenance equipment and switching off equipment when not in use
- regularly servicing equipment to maintain energy efficiency
- where possible source materials required for maintenance from a local source to reduce energy consumption during transportation
- recycle products that are required to be removed during maintenance for other applications
- install energy efficient lighting
- install timer controls or movement sensors which switch off lights automatically.

These abatement measures have not been factored into the carbon neutral approach for the Project as they will be further defined at the detailed design stages of project delivery. However, the inclusion of hydro-electricity measures has been considered as an abatement measure and is included in the carbon neutral approach.

4.3.1 Hydro-electricity generation

Hydro-electricity is a renewable energy source. This uses the natural water cycle to create energy from falling water to produce electricity. The hydro-electricity generated can be returned to the power grid for sale or could be utilised as a power source for dam operations.

The Project provides for a mini HEP plant that would have capacity to generate up to 3,000 MWh of electricity annually. The amount of GHG emissions that would be saved is calculated as a function of the amount of electricity in MW hours that the mini HEP plant would contribute to the National Electricity Market.

The NSW Pool Coefficient is an indicator of the average emissions intensity of electricity sourced from the electricity grid in NSW. It represents the emissions of greenhouse gases (in tonnes of carbon dioxide equivalent) per MW of electricity supplied from the 'pool' of major power stations serving the NSW electricity grid. All projections indicate a steady increase in the Pool Coefficient up to 2009 before any levelling out. In 2012, the range is from about 0.983 to 0.946 t CO_2-e/MWh, with the most likely values clustered around 0.96 to 0.97 t CO_2-e/MWh. This would result in a reduction of emissions of 2,910 t CO_2-e per year.

Advantages of HEP generation as an offset for the carbon emissions associated with the Project include limited staff required to operate the mini HEP plant. The mini HEP plant is also able to begin generating electricity in a short period of time. Other advantages include reduced emissions as the mini HEP plant would not be using fossil fuels and it could be an additional source of income from the Project.

An issue with HEP generation is that there is relatively small capacity of the proposed generator to produce electricity. In addition, the mini HEP plant is reliant on flow releases from the dam so the activity is dependent on the water supply and environmental flow regimes.

Another issue surrounding the construction of HEP plants is the carbon emissions released when an area is inundated. However, this is not applicable to the Project as the mini HEP plant would be an addition to the proposed infrastructure and carbon emissions produced from the inundation area have already been considered.

When agreements are finalised for the construction and operation of the mini HEP plant, HWC would stipulate that all carbon offsets generated by the plant would be owned by HWC and would be used to offset the Project's emissions.

4.4 Stage 3: Offsetting residual emissions

Once abatement measures have been identified and actioned as far as is practicable, the implementation of a carbon neutral approach requires the use of carbon offsets or the purchasing of viable carbon credits should offsetting strategies be inadequate in fulfilling offsetting requirements. Carbon offsetting which is seen to be the last resort in the carbon abatement hierarchy is a method of reducing the amount of greenhouse gases being emitted or a process of removing greenhouse gases from the atmosphere by way of sequestration.

4.4.1 Carbon sequestration

Carbon sequestration refers to the capture and long-term storage of carbon in forests, soils or in the oceans (IPCC 2000). Carbon sequestration through forestry occurs through the uptake of carbon from the atmosphere for use in photosynthesis where it is effectively captured in the structure of the tree. For the purposes of this report the term carbon sequestration will be used to refer to carbon sequestration through forestry.

HWC's carbon sequestration initiative

A key component of HWC's carbon neutral approach for the Project is implementation of a carbon sequestration initiative. The proposed carbon sequestration is based on a natural regeneration process, utilising the proposed habitat corridor. Essentially, the carbon sequestration initiative consists of a biodiversity scenario as oppose to a plantation scenario. The aim of the carbon sequestration initiative is to offset the total residual GHG emissions from the Project (following abatement provided by the mini HEP plant that offsets 2,900 tonnes of tCO_2 ha per year as outlined in Section 4.4.1) over time to reach a point of approximate carbon neutrality. Table 5 provides a summary of the offset approach as well as an outline of the approximate number hectares and trees required where total emissions are offset over a 25 year period.

After achieving a carbon neutral position, the forest plantings will continue to uptake carbon. There is potential for HWC to use this excess capacity to offset other organisational GHG-emitting activites. The manner in which this excess capacity embedded within the sequestration strategy could be used to manage other coroporate-wide emissions from oeprational activities would be considered by HWC at a later date.

Potential benefits and disadvantages

It is important to note the potential benefits and disadvantages associated with carbon sequestration and that there is some public debate on the viability of this approach (TEC 2007). The 2007 Total Environment Centre (TEC) report cites a study undertaken by the Planck Institute which found that while trees do sequester carbon they may also contribute to climate change simply because vegetation metabolism also generates methane which is a more significant GHG for climate change than carbon. New plantings, even eucalyptus trees, also require large amounts of water to become established which can cause a strain on water resources (Elbakidze and McCarl 2007; TEC 2007).

Another related issue is the permanence of plantings. The TEC report notes the reality of the occurrence

TABLE 5 SUMMARY OF OFFSET APPROACH

25 YEAR SCENARIO	
Total emissions to be offset	210,456 tonnes of CO_2-e
Mini hydro electric plant abatement	72,750 t CO_2-e total (2,910 t CO_2-e per year)
Residual emissions	137,706 tonnes of CO_2-e
Sequestration rate	249 tCO_2 per hectare[1,2]
Hectares required	553 hectares
Area available for planting in corridor	672 hectares
Residual land available	119 hectares
Trees planted per hectare	600[1] trees per hectare
Trees required	331,800 trees

Notes:
1 Figure based on expert advice from the Department of Primary Industries (Barton 2009)
2 Nett sequestration rate is 497t per ha, however only 50% is sequestered with a 25 year period. Forest maturity is achieved at 100+ years.

of fire in the Australian landscape. It also flags the potential that the manifestation of climate change will bring lower levels of rainfall in some areas which could also have bearing on the reliability of forestry plantings as offsets. Pests and diseases can also be an issue in carbon sequestration projects. It should be noted, however, that the use of native species and a biodiversity scenario strategy may result in a system that is more resilient to potential threats such as fire, disease and storm events.

As discussed above, water requirements can be an issue. The area designated at Tillegra for the carbon sequestration work, however, has annual rainfall often in excess of 1,200 millimetres (BoM 2008). The provision of water to allow the establishment of the plantings is therefore unlikely to be an overriding factor for consideration.

Benefits of carbon sequestration are often termed 'co-benefits' or indirect benefits. Co-benefits of carbon sequestration include the prevention of GHG emitting land use activities on a carbon sequestration strategy site. For the Tillegra Dam Project, this co-benefit is apparent when considering that current land use is predominately agricultural which can produce considerable GHG emissions. There have been a number of international studies that discuss co-benefits generated by carbon sequestration strategies (Elbakidze and McCarl 2007; McCarl and Schneider 2000; Plantinga and Wu 2003). Although these benefits may be substantial, there are limited studies at a local scale that quantify co-benefits such as a reduction in soil erosion and salinisation.

There are also anthropogenic and ecological benefits associated with carbon sequestration strategies. For example, these projects may improve local human health by removing toxins from the atmosphere and by improving water purification processes (McHale *et al* 2007). The site of the carbon sequestration may also be suitable for recreational activities that are compatible with the Project such as eco-tourism activities. Carbon sequestration can also improve ecosystem health and increase ecosystem habitats.

4.5 Meeting targets: monitoring and reporting

The NGER Act should guide assessments about HWC's reporting obligations.

AS/NZS ISO 14064 is the accepted protocol under the NGER Act which outlines the requirements for the quantification, verification, monitoring and reporting of GHG emissions. As per the Standard, HWC's GHG report would need to describe its GHG inventory and include the following information:

- description of the reporting organisation (ie HWC),

- person responsible and reporting period covered
- documentation of organisational boundaries
- direct GHG emissions, quantified separately for each GHG, in tonnes of CO_2e
- a description of how CO_2 emissions from combustion of biomass are treated in the GHG inventory
- if quantified, GHG removal, quantified in tonnes of CO_2e
- explanation for the exclusion of any GHG sources or sinks from the quantification
- energy indirect GHG emissions associated with the generation of imported electricity, heat or steam, quantified separately in tonnes of CO_2e
- the historical base year selected and the base-year GHG inventory
- explanation of any change to the base year or other historical GHG data, and any recalculation of the base year or other historical GHG inventory
- reference to, or description of, quantification methodologies including reasons for their selection
- explanation of any change to quantification methodologies previously used
- reference to, or documentation of, GHG emission or removal factors used
- description of the impact of uncertainties on the accuracy of the GHG emissions and removals data
- a statement that the GHG report has been prepared in accordance with ISO 14064
- a statement describing whether the GHG inventory, report or assertion has been verified, including the type of verification and level of assurance achieved.

In addition to the NGER Act reporting requirements, HWC would also report on its GHG progress through its annual catchment report as well as part of the final construction EIS verification report.

4.6 Materials and water

The Project would impact on a number of resources through the consumption of water resources and various non-renewable materials. The resources consumed during maintenance have not been assessed due to difficulties in estimation; however, options for reducing, reusing and recycling during maintenance have been included in this section.

It is important to note that offsetting, although an important component of the carbon neutral approach for the Project, would not be feasible for the material and water resource use components of the Project. Currently no viable offsetting systems exist for offsetting material and water resource use. As a result, only avoidance, reduction, recycling and reuse measures have been considered for this part of the assessment.

4.6.1 Materials

Components

This section identifies the materials required for the Project, including related infrastructure. In any project, materials are unavoidably consumed. Table 6 identifies materials and likely quantities to be used.

Measures to reduce, reuse and recycle materials

This section outlines issues for consideration for the sustainable use of materials for the Project in the construction and operation stages. The implementation of these and other strategies would be subject to the ongoing development of the Project, contractor requirements and innovation as well as technology advances.

TABLE 6 MATERIALS CONSUMED IN CONSTRUCTION

COMPONENT	MATERIAL TYPE	QUANTITY
Dam wall and associated infrastructure	Fill (rock)	2,144,000 m^3
	Fill (earth)	130,000 m^3
	Cement	10,800 tonnes
	Fly ash	3,630 tonnes
	Steel	3,585 tonnes
	Copper (water stops)	6,120 metres
	Reinforcing fabric	21 tonnes
Roads	Pavement materials	6,500 tonnes
	Cement and sand for in situ RC	850 tonnes
	Reinforcement for in situ RC	480 tonnes
	Pre-cast planks	2,000 tonnes
	Guardrails, guide posts, etc	450 tonnes
	Culvert pipes	1,200 tonnes
	V-channel	4,000 tonnes

Construction stage:

- review ordering strategies to limit potential overordering
- utilise recycled materials wherever possible
- protect materials from climatic exposure to avoid the need for additional resources being consumed through production, transportation and use
- utilise materials with a high recycled content wherever possible, include requirements for purchasing of materials with recycled content within the tender process for all construction related activities
- seek expressions of interest for the sale and collection of surplus material and resources currently found within the inundation area
- encourage free waste collection – possibility of a publicly accessible inventory of materials currently located within the inundation area that would not be required for the construction of the Project
- reuse mulch from removed vegetation for landscaping purposes
- reuse excess materials such as off cuts in other areas if possible
- utilise materials that are currently in the inundation area to minimise the total quantities of materials sterilised
- provide adequate resources to ensure that waste streams are not mixed. This would provide for simpler resource recycling and reduced probability of waste streams becoming contaminated
- where practical, introduce offsite recycling for all materials that cannot be re-used or recycled within the Project area
- order materials that have high durability and extended life spans.

Operation:

- where possible use recycled materials when performing maintenance
- if renewable sources of power have not been established during construction, consider purchasing green power for electrical needs
- utilise recycled material, where possible, when replacing existing infrastructure
- utilise local materials to reduce resource use through extended freight travel distances
- implement recycling practices throughout the site

- include requirements for purchasing of materials with recycled content within the tender process for all operation and maintenance related activities
- offsite recycling for all materials that cannot be re-used or recycled within the Project area
- order materials that have high durability and extended life spans.

As part of this management approach, HWC would aim to procure materials with a high recycled content. HWC would also aim to purchase materials that have high durability and an extended lifespan. The procurement of such materials would be in line with HWC's existing WRAPP and would be included in the tendering process for key phases of the Project.

4.6.2 Water

Components

The most significant water uses relate to concrete batching and dust suppression. Cement is mixed with water at an approximate ratio of 3:1. Batching of 10,000 tonnes of cement would therefore require approximately 3,500 m^3 (3.5 megalitres) of water. The amount of water required for dust suppression cannot be accurately estimated as this would be determined by the extent of bare ground, soil moisture content, local topography and prevailing meteorological conditions.

Measures to reduce, reuse and recycle water

This section outlines issues for consideration for the sustainable use of water for the Project in the construction and operation phases of the Project. The implementation of these and other strategies would be subject to the on-going development of the Project, contractor requirements, and innovation and technology advances.

Construction stage:

- utilise a local water source
- utilise dust suppression only when necessary to avoid evaporation of water
- utilise native drought tolerant plants in landscaping activities
- incorporate water saving technology including composting toilets, flow restricting tap fixtures
- regular maintenance of equipment to ensure water efficiency is maintained
- if quality is sufficient, reuse wastewater for watering of landscaping establishment
- recycle waste water from de-watering or wash down for use in other parts of the construction or to a sufficient quality to be suitable for release back into the Williams River.

Operation:

- incorporate water saving technology including composting toilets and diversion of rainwater in water tanks
- install rainwater tanks for use in the buildings
- regular maintenance of equipment to ensure water efficiency is maintained
- reuse wastewater for watering landscaping.

4.7 Waste management

A consequence of resource use is the generation of waste, specifically the use of materials and water for the construction and operation phases of the Tillegra Dam Project. The strategies identified for material and water use would be implemented to prevent waste generation as a far as practicable. Any resulting unavoidable waste would need to be addressed through an appropriate waste management plan. A waste management plan would be developed as part of the construction environmental management plan for the Project.

5. Inundation Area Resource Recovery Strategy

5.1 Inventory

The Project would result in the inundation of a number of existing materials. A high level inventory of materials that presently exist within the inundation area, including the composition of those materials, provides an understanding of what could be lost as a result of the Project, and conversely what could be available for reuse or recycling.

This preliminary inventory is provided in Table 7. It may be seen that quantities for many items are currently not known with respect to what may be able to be recycled and what would need to be disposed of or left in the inundation area (provided there would be no or minimal risk to water quality). Subject to Project approval, this list would be reviewed regularly and revised as quantities of structures may change prior to inundation of the area.

TABLE 7 MATERIALS CURRENTLY LOCATED WITHIN THE INUNDATION AREA

STRUCTURE	ESTIMATED QUANTITY	MATERIAL COMPOSITION	MATERIAL QUANTITY	QUANTITY AVAILABLE FOR REUSE/ RECYCLING	NON-REUSABLE MATERIALS
House	27 – including RFS station	bricks, steel, glass, wood, copper piping, electrical wires, telephone wires	8 km- electrical and phone wires – does not include connection to houses/ buildings	–	Fibro sheeting asbestos, starter-fluoro lights, lead paint (walls) electrical boxes and transformers, housing 1900-1980 asbestos,
Shed	55	steel, wood, bricks	250 t	95%	Wood and brick material
Grain storage	2	steel, wood, plastic	–	100%	Grain silos can be sold or recycled as scrap metal

STRUCTURE	ESTIMATED QUANTITY	MATERIAL COMPOSITION	MATERIAL QUANTITY	QUANTITY AVAILABLE FOR REUSE/ RECYCLING	NON-REUSABLE MATERIALS
Road	8 km	Bitumen, aggregate	–	Nil	Bitumen seal and base cannot be recycled
Bridges	3	Concrete, wood	–	Nil	Unlikely to be practicable opportunities for reuse of materials
Road signs	10	metal, concrete	0.5 t	100%	Nil
Cattle transport yards	4	wood, steel	–	100%	Steel gates, fence panels, crushes etc can be sold or recycled if acquired as an inclusion by HWC land acquisition
Irrigation equipment and water pumps	5	Stainless steel vats, associated milking machinery	–	95%	Trenched irrigation pipes cannot be reclaimed
Dairying equipment	4	Stainless steel vats, associated milking machinery	–	100%	All equipment can be sold or recycled
Fences	–	Wire, fence posts	–	95%	Majority of fencing materials could be reused or recycled
Gates	–	Wood, metal	–	100%	Nil
Water tanks, septic tanks	76	Metal, plastic	–	50%	Recovery of plastic water tanks is dependant on condition. Recovery of septic tanks will not be viable
Power poles	250	Wood	–	95%	Poles with significant decay will not be able to be reused

5.2 Prioritisation and removal process

5.2.1 Prioritisation

The area of land within the inundation area would need to be cleared of resources prior to inundation. A preliminary prioritisation is provided in Table 8. This would be reviewed and revised prior to commencement of filling of the storage with protection and maintenance of water quality being a key criterion.

TABLE 8 RANKING OF INUNDATION RESOURCE REMOVAL PROCESSES

PRIORITY RANKING	RESOURCE TYPE	JUSTIFICATION OF RANKING	MATERIALS INCLUDED	REUSE AND RECYCLING OPPORTUNITIES
1	Potentially hazardous materials	Prevention of contamination of the water body Prevention of hazard to the environment and humans	Metals and other materials	N/A
2	Materials required to be removed for recreational safety	Safety of recreational users	Power poles Other structures Electrical wiring Other protrusions in the inundation area Tall trees	Landscaping, recycling of metals, milling of high value hard wood timber, firewood
3	Materials that can have a high value for reuse/ recycle	Waste prevention Minimisation of resource consumption	Sheds Fences Gates Housing materials (bricks, wood, tiles) Water tanks Trees and other vegetation	Reuse of materials by external parties for example recycling facilities Replanting of trees for landscape values and mulching
4	Materials for aesthetic purposes	Removal of items that may detract from the aesthetic appeal of the area	Trees on edge of inundation area that may die due to water logging Roads that may be seen able to be seen when dam depth is reduced Buildings / structures	As above Trees and woody debris may be left in situ in some areas as this constitutes valuable fish habitat

5.2.2 Removal process

A possible process for removal of resources within the inundation area is as follows:

- develop an inventory of the resources currently located within the inundation area
- tender process for the removal of potentially hazardous materials and sources of contamination of the water body
- removal of any remaining potentially hazardous materials and sources of contamination of the water body
- recovery of resources for reuse/recycling, removal for the safety of recreational users and removal for aesthetic reasons
- tender process for the removal of resources for reuse/recycling and the safety of recreational users.

6. Conclusion

The sustainable use of resources is an important consideration in the overall sustainability performance of the Project. HWC aims to implement a resource management approach that incorporates best practice measures to achieve the sustainability goals of the Project. Specifically, HWC aims to achieve a carbon neutral status, in addition to achieving a high performing ranking for various social, economic and environmental impacts captured within the sustainability assessment framework.

This report has provided estimates of the resource needs of the Project and potential avoidance, minimisation and mitigation measures for the use of energy, water and materials.

The mitigation measures contained within this report are therefore important in fulfilling the sustainable resource use objectives of the Project in the context of the over-arching sustainability assessment framework. HWC is committed to implementing as far as practicable these measures, including:

- efficient resource use
- avoidance of unnecessary resource consumption
- minimisation of resources consumed
- resource recovery
- waste management
- integrated resource management and planning.

This report has also identified that HWC's commitment to achieving carbon neutrality for the Project would best be served through a portfolio approach facilitated through a combination of carbon sequestration with 331,800 trees planted in the corridor, provision for a mini HEP plant and abatement measures.

Report prepared by

7. References

Abril, G, Guérin, F, Richard, S, Delmas, R, Galy-Lacaux, C, Gosse, P, Tremblay, A, Varfalvy, L, dos Santos AM & Matvienko, B 2005 'Carbon dioxide and methane emissions and the carbon budget of a 10-years old tropical reservoir (Petit-Saut, French Guiana)' Global Biogeochemical Cycle (in press) Reservoirs and Natural Aquatic Ecosystems. In Tremblay, A, Varfalvy, L, Roehm, C and Garneau, M (Eds.) *Greenhouse gas Emissions: Fluxes and Processes, Hydroelectric Reservoirs and Natural Environments* Environmental Science Series, Springer, Berlin, Heidelberg, New York, pp. 209-231

Australian Competition and Consumer Commission 2008 *Carbon Claims and the Trade Practices Act* Australian Government Canberra.

Australian Greenhouse Office 2007 Greenhouse *Friendly Forest Sink Abatement Projects* Commonwealth of Australia

Barton, C 2009 Tillegra Dam – Carbon Offset Corridor, Assessment of Crabon Sequestration Potential, NSW Department of Primary Industries, NSW

Bureau of Meteorology (BoM) 2008 Weather Station Data www.bom.gov.au/climate/data/weather-data.shtml

Castro, LC and Mensah, AM 2004 'Sustainable Resource Use & Sustainable Development: A Contradiction?!' *Zentrum fur Entwicklungsfourschung* (ZEF), Centre for Development Research, University of Bonn

Cole, JJ and Caraco, NF 2001 'Carbon in catchments: connecting terrestrial carbon losses with aquatic metabolism. Marine and Freshwater Research' 52:101-110

CSIRO 2004 *Sustainability Network Update* 36E

Delmas, R, Richard, S, Guérin, F, Abril, G, Galy-Lacaux, C, Delon, C & Grégoire, A 2005 'Long Term Greenhouse Gas Emissions from the Hydroelectric Reservoir of Petit Saut (French Guiana) and Potential Impacts' In Tremblay, Varfalvy, AL, Roehm, C and Garneau, M (Eds.) *Greenhouse gas Emissions: Fluxes and Processes, Hydroelectric Reservoirs and Natural Environments* Environmental Science Series, Springer, Berlin, Heidelberg, New York, pp. 293-312

Department of Climate Change 2008 *National Greenhouse and Energy Reporting System – Regulations Policy Paper* Commonwealth of Australia

Department of Environment and Conservation 2007 Waste Reduction and Purchasing Policy 2007 – Construction, Demolition and WRAPP

Department of Environment and Conservation 2001 Environmental Matters – Waste https://www.dec.nsw.gov.au/envirom/wastepest.htm

Department of Environment and Climate Change 2008 'Glossary' http://www.environment.nsw.gov.au/downtoearth/glossary.htm

Department of the Environment and Heritage, Australian Greenhouse Office December 2007 'Technical Guidelines for the Estimation of Greenhouse Emissions and Energy at Facility Level – Energy, Industrial Process and Waste Sectors in Australia'

Department of the Environment and Heritage, Australian Greenhouse Office 2006 'Planning forest sink projects – a guide to forest sink planning, management and carbon accounting'

Department of the Environment and Heritage, Australian Greenhouse Office 2005 'National Carbon Accounting Toolbox and Data Viewer'

Department of the Environment, Transport and the Regions: London, 2000, 'Building a Better Quality of Life: A Strategy for more Sustainable Construction', Department of Environment, Transport and the Regions, London Government

Division of Information Technology, Engineering and the Environment, 2003 'Environmentally Sustainable Development' University of South Australia
http://www.unisa.edu.au/itee/news/LecSem/2003/lecSeries2/GZill/Zillante.ppt

Elbakidze, L & McCarl, BA 2007 'Sequestration Offsets versus Direct Emissions Reductions: Consideration of Environmental Co-Effects' *Ecological Economics* 60 pp. 564-571

EPA Victoria & RMIT University 2008 Carbon Offset Guide Australia
http://www.carbonoffsetguide.com.au/

Environment Australia 1998 WasteWise Construction Program – Handbook techniques for Reducing Construction Waste Commonwealth Department of Environment, Canberra

Hélie, JF 2004 'Geochemistry and fluxes of organic and inorganic in aquatic systems of eastern Canada: examples of the St-Lawrence River and Robert-Bourassa reservoir: Isotopic approach' PhD. Dissertation, Université du Québec à Montréal, Montréal (Québec), Canada, pp. 205

Houel, S 2003 'Dynamique de la matière organique terrigène dans les réservoirs boréaux' PhD. Dissertation, Université du Québec à Montréal, Montréal (Québec), Canada, pp.121

Huttunen, JT, Väisänen, TS, Hellsten, SK Heikkinen, M, Nykänen, H, Jungner, H, Niskanen, A, Virtanen, MO, Lindqvist, OV, Nenonen, OS & Martikainen, PJ 2002 'Fluxes of CH4, CO_2, and N_2O in hydroelectric reservoir Lokka and Porttipahta in the northern boreal zone in Finland' *Global Biogeochemical Cycles*, 16, 1, doi:10.1029/2000GB001316

Hunter Water Corporation 2001 *Waste Reduction and Purchasing Policy and Action Plan* Hunter Water Corporation

Huttunen, JT Alm, J Liikanen, A, Juutinen, S, Larmola, T, Hammar, T, Silvola, J and Martikainen, PJ 2003 'Fluxes of methane, carbon dioxide and nitrous oxide in boreal lakes and potential anthropogenic effects on the aquatic greenhouse gas emissions' Chemosphere 52, 609-621

Independent Pricing and Regulatory Tribunal (IPART), NSW Greenhouse Gas Reduction Scheme November 2007 'Fact Sheet – The NSW Pool Coefficient'

Intergovernmental Panel on Climate Change (IPCC) 2000 Land Use, Land-Use Change and Forestry: Summary for Policy Makers

McCarl, BA & Schneider, UA 2000 'US Agriculture's Role in a Greenhouse Gas Emission Mitigation World: an Economic Perspective' *Review of Agricultural Economics* 22, pp. 134-159

McHale, MR, McPherson, EG & Burke, IC 2007 'The Potential of Urban Tree Plantings to be Cost Effective in Carbon Credit Markets' Urban Forestry and Urban Greening 6, pp. 49-60

McKinsey & Company 2008 The *Australian Cost Curve for Greenhouse Gas Reduction* McKinsey & Company Australia

Murray, J & Dey, C 2007 'Carbon Neutrality – Sense and Sensibility' Centre for Integrated Sustainability Analysis at the University of Sydney, Australia

Nova: Science in the news 1998 'Cleaner production – a solution to pollution?' *Australian Academy of Science* http://www.science.org.au/nova/034/034print.htm

Perez, C, Roncoli, C, Neely, C & Steiner, JL 2007 'Can carbon sequestration markets benefit low– income producers in semi-arid Africa? Potentials and challenges' *Agricultural Systems* 94 pp. 2-12

Plantinga, AJ & Wu, J 2003 'Co-Benefits from Carbon Sequestration in Forests: Evaluating Reductions in Agricultural Externalities from an Afforestation Policy in Wisconsin' *Land Economics* 79 pp. 74-85

Product & Consumption Branch (UNEP) 2001 'Cleaner Production- Key Elements' United Nations Environment Programme http://www.unep.fr/pc//cp/understanding_cp/home.htm#definition

Soumis, N, Lucotte, M, Duchemin, É, Canuel, R, Weissenberger, S, Houel, S & Larose, C (2005) 'Hydroelectric reservoirs as anthropogenic sources of greenhouse gases' In *Water Encyclopedia Volume 3: Surface and agricultural water,* sous la dir. de J. H. Lehr et J. Keeley. p. 203-210 Hoboken, NJ: John Wiley & Sons

Standards Australia 2006 *AS ISO 1406.1-2006 Greenhouse gases Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals* Standards Australia

STEAG State Power Inc. (SPI) 2008 'Glossary' http://www.steag-statepower.com/spi/default.aspx

Therrien J, Tremblay A and Jacques R (2005) 'CO_2 Emissions from Semi-arid Reservoirs and Natural Aquatic Ecosystems' In Tremblay, A., L. Varfalvy, C. Roehm et M. Garneau (Eds.). *Greenhouse Gas Emissions: Fluxes and Processes, Hydroelectric Reservoirs and Natural Environments. Environmental Science Series*, Springer, Berlin, Heidelberg, New York, pp. 233-250.

Total Environment Centre (TEC) 2007 *Carbon Neutral Watch: Corporates, Consultants and Credibility* (online document http://www.tec.org.au/, date of access 4 July 2007)

Tremblay, A, Therrien, J, Hamlin, B, Wichmann, E & LeDrew, L 2005 'GHG Emissions from Boreal US EIA 2008 – Glossary' Energy Information Administration, Department of *Energy, United States Government* http://www.eia.doe.gov/glossary/glossary_e.htm

World Business Council for Sustainable Development & World Resources Institute 2005 *The Greenhouse Gas Protocol for Project Accounting (Project Protocol)*

World Business Council for Sustainable Development & World Resources Institute 2002 *The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard* Revised Edition World Business Council for Sustainable Development & World Resources Institute